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Brief Communication

Declining Cirrhosis Hospitalizations in the Wake of the COVID-19 Pandemic: A National Cohort Study

Short Title: COVID and Declining Cirrhosis Admissions

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Abbreviations:

CI = confidence interval; COVID-19 = coronavirus disease-2019; LOS = length of stay; MELD = model for end-stage liver disease; SIP = shelter-in-place; VHA = Veterans Health Administration; VOCAL = Veterans Outcomes and Costs Associated with Liver Disease

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Introduction

The coronavirus disease-2019 (COVID-19) pandemic has caused abrupt shifts in United States (US) healthcare delivery.[1] To preserve inpatient resources and minimize COVID-19 transmission, many health systems have expanded telemedicine, limited hospital transfers, and established stringent hospitalization criteria for non-COVID-19-related conditions. States have also enacted, on varying timelines, shelter-in-place (SIP) or equivalent orders to further limit COVID-19 spread. The broader impact of these changes on healthcare utilization and outcomes in high-risk and vulnerable populations, such as those with cirrhosis, are unknown.

To address these gaps, we used national data in the Veterans Health Administration (VHA), a single integrated system of care and the largest single US provider of liver-related care, to: (1) investigate the impact of the COVID-19 pandemic on the volume of national cirrhosis hospitalizations, and (2) identify salient changes in hospitalization-level characteristics.

Methods

This was a retrospective cohort study of VHA cirrhosis hospitalizations using the Veterans Outcomes and Costs Associated with Liver Disease (VOCAL) cohort.[2, 3] VOCAL includes patients with cirrhosis identified using a validated algorithm from 1/1/2008-12/31/2016 in 125 hospitals nationwide.[4] We included patients age ≥18 who were hospitalized for any reason between January 1st and April 15th in 2019 or 2020, and excluded those with prior liver transplantation.

We collected hospital-level data including length of stay (LOS), hospital region, rurality, community or academic hospital, and discharge disposition. International Classification of Diseases-10 discharge codes were used to classify reasons for admission. Patient-level data included demographics, pre-hospitalization comorbidities, baseline model for end-stage liver disease (MELD) score and Child-Turcotte-Pugh class (measures of liver disease severity), and admission laboratory parameters. Admission MELD was categorized as ≤15, 16-24, and ≥25. Etiology of liver disease was ascertained using a VHA validated algorithm.[5] State-level data for new COVID-19 daily cases and deaths, and dates of state SIP orders were obtained from publicly-available databases.[6] The primary outcome was national weekly cirrhosis hospitalizations.

We plotted weekly hospitalization counts for each year through April 15th. Using linear regression, we estimated the difference in weekly hospitalizations in 2019 and 2020 before and after February 29th (date of first publicized US COVID-19 death; called pre-COVID and during-COVID periods herein). We then compared the magnitude of this change (i.e., difference-in-differences) between years. Linear regression limited to 2020 was then used to investigate effects of SIP orders, and number of incident COVID-19 cases and deaths on cirrhosis hospitalizations, adjusted for linear time trends in pre- and during-COVID periods. SIP was computed as the proportion of hospitalizations in a given week in a state with an active SIP order. To investigate changes in patient and hospital-level characteristics during the pandemic, we defined three 2020 subgroup eras: pre-COVID (before February 29th), early-COVID (February 29th to March 25th), and late-COVID (March 26th to April 15th). March 26th was chosen because the VHA announced a COVID-19 Response Plan on March 23rd which was widely implemented within three days.[7] Across these periods, we compared summary statistics using Chi-squared or Kruskal-Wallis testing as indicated.

Results

We identified 12,467 hospitalizations from 7,216 unique patients in 2019 and 2020. Baseline patient characteristics were similar between years and across equivalent pre- and during-COVID dates (data not shown). In difference-in-differences analysis, weekly cirrhosis hospitalizations were on average 159.47 lower (95% confidence interval [CI] -250.03, -68.90) in the 2020 during-COVID period relative to an expected counterfactual trend (p<0.001; **Figure 1; STable 1**). When adjusting for a significant linear decrease in weekly hospitalizations in the during-COVID period (-53.51; 95% CI -61.32, -45.71; p<0.001), we did not find

independent effects of SIP orders (p=0.938), incident COVID-19 cases (p=0.682), or incident COVID-19 deaths (p=0.875) on weekly hospitalizations.

We identified significantly higher admission MELD in the late-COVID era, indicating higher degree of liver disease severity (p=0.029; **STable 2**). The late-COVID era was also characterized by significantly fewer academic hospital admissions (63.6% vs. 68.1% pre-COVID; p=0.014), shorter LOS (median 2 vs. 3, p<0.001), and fewer hospital transfers (7.5% versus 11.1% pre-COVID; p=0.046). There were significant differences in post-hospitalization disposition (p=0.029), with more patients being discharged to home in the late-COVID era (91.1% vs. 88.8% pre-COVID) and fewer to facilities (5.1% vs. 9.0% pre-COVID).

Discussion

In this national VHA analysis, we identified a substantial decline in cirrhosis hospitalizations attributable to COVID-19, an effect which has intensified over time. We also identified important changes in hospitalization-level characteristics in the late-COVID era, including significant declines in academic center hospitalizations, decreased LOS, fewer hospital transfers, increased admission MELD, and more frequent discharge to home rather than facilities. These changes likely reflect initiatives to preserve inpatient resources, and guidance encouraging patients to remain home. It is also likely that patients, perhaps due to personal concerns about COVID, are avoiding hospital presentation until symptoms are severe. Importantly, our findings with cirrhosis likely parallel changes in other inpatient resource-intensive conditions such as congestive heart failure, chronic obstructive pulmonary disease, and myocardial infarction.[8]

These findings have significant health systems implications. There has been a clear drop-off in hospitalizations for patients who ordinarily would meet acute care criteria. It is unclear how these patients are being managed as outpatients, and given the baseline vulnerability of patients with cirrhosis, it is likely that many do not currently have adequate healthcare access. Likewise, abbreviated inpatient care may adversely impact outcomes such as short-term mortality, and changes in post-hospital disposition away from facilities may increase hospital readmissions and outpatient acuity. Finally, these data may inform anticipatory changes in resource allocation during future pandemics based on expected shifts in utilization.

This study has several limitations. First, there is the possibility of misclassification of exposures and outcomes. Second, we do not yet have access to mortality data this early in the pandemic. Third, our findings in the VHA cohort may not be generalizable to other settings.

In conclusion, national cirrhosis hospitalizations have dramatically declined due to the COVID-19 pandemic. Increased liver disease severity in hospitalized patients raise serious concerns that near-term clinical outcomes may be adversely impacted. Future studies will need to investigate the impact of COVID-19 on cirrhosis-related morbidity and mortality.
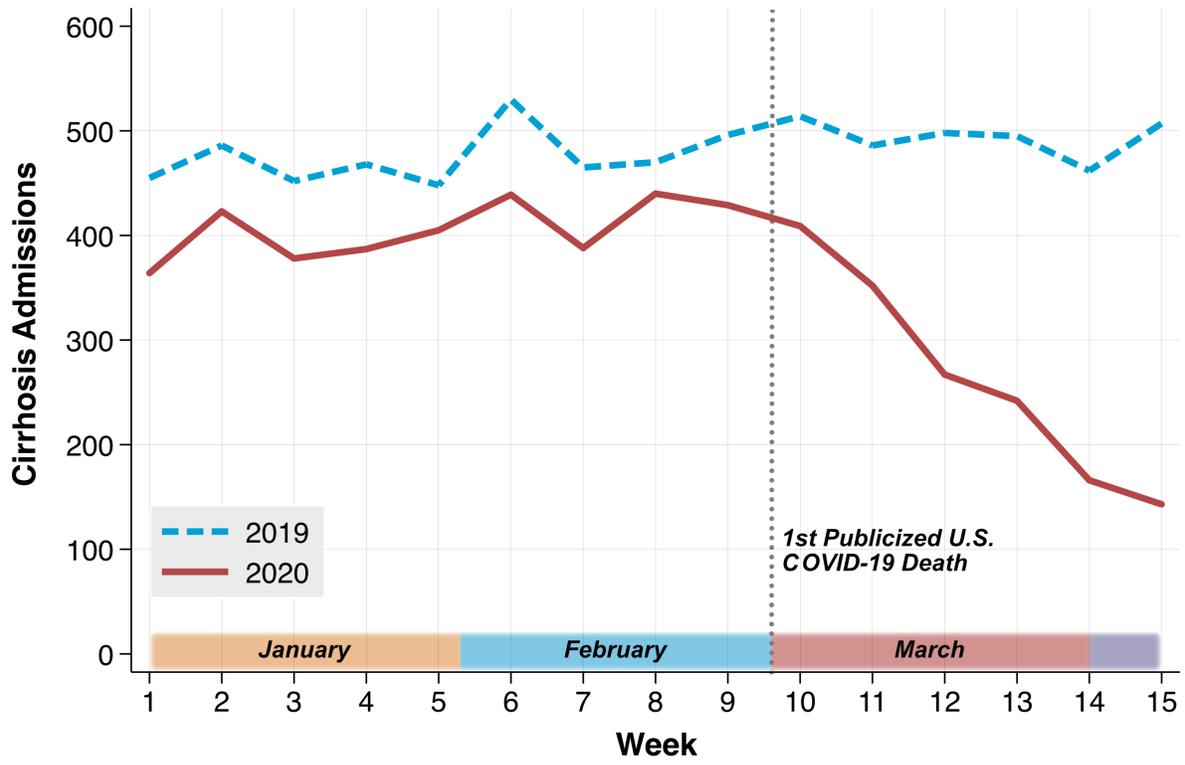
Acknowledgements

Figure Legends

Figure 1 – National Weekly Cirrhosis Hospitalizations between January 1st and April 15th in 2019 and 2020
* N.B. Recent reports on April 22nd, 2020 suggest that the first true COVID-19-related death in the United States occurred in early February, 2020. However, prior to April 22nd, the first widely publicized death was on February 29th, 2020.

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