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A comprehensive evaluation of emergency department utilization by patients with cirrhosis

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Abstract

BACKGROUND: Emergency Department (ED) based care is required for cirrhosis management, yet the burden of cirrhosis-related ED healthcare utilization (HCU) is understudied. We aimed to describe ED utilization within a statewide health system and compare the outcomes of high ED use (HEDU) versus non-HEDU in individuals with cirrhosis.

METHODS: We retrospectively reviewed charts of adults with cirrhosis who presented to any of 16 EDs within the Indiana University Health system in 2021. Patient characteristics, features of the initial ED visit, subsequent 90-day healthcare use, and 360-day outcomes were collected. Multivariable logistic regression models were used to identify predictors HEDU status which was defined as ≥2 ED visits within 90 days after the index ED visit.

RESULTS: There were 2124 eligible patients (mean age 61.3 years, 53% male, and 91% White). Major etiologies of cirrhosis were alcohol (38%), MASH (27%), and viral hepatitis (21%). Cirrhosis was newly diagnosed in the ED visit for 18.4%. Most common reasons for ED visits were abdominal pain (21%), shortness of breath (19%), and ascites/volume overload (16%). Of the initial ED visits 20% (n=424) were potentially avoidable. The overall 90-day mortality was 16%. Within 90 days, there were 366 HEDU (20%). Notable variables independently associated with

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HEDU were MELD-Na (aOR=1.044, 95% CI 1.005–1.085), prior ED encounter (aOR=1.520, 95% CI 1.136–2.034), and avoidable initial ED visit (aOR=1.938, 95% CI 1.014–3.703).

Conclusions: Abdominal pain, shortness of breath, and ascites/fluid overload are the common presenting reasons for ED visits for patients with cirrhosis. Patients with cirrhosis presenting to the ED experience a 90-day mortality rate of 16%, and among those who initially visited the ED, 20% were HEDU. We identified several variables independently associated with HEDU. Our observations pave the way for developing interventions to optimize the care of patients with cirrhosis presenting to the ED and to lower repeated ED visits.

Keywords

Cirrhosis; Emergency Department use; High Utilizers

INTRODUCTION

The utilization of emergency departments (ED) by patients in the United States has been steadily increasing over the past two decades with one in five Americans vising at least once. (1, 2). In parallel, cirrhosis is now the fourth leading cause of mortality in those aged 45–64 years.(3, 4) Acute care for cirrhosis-related complications such ascites, variceal bleeding, hepatic encephalopathy (HE) often starts in the ED with the overall annual cost of acute care estimated at $7.37 billion.(5–7) Taken together, there is a need to develop, implement and disseminate effective ED-based healthcare delivery strategies for the cirrhosis population.(8)

Despite the significant utilization of hospital-based services by the individuals with cirrhosis, there is limited data to describing ED utilization by individuals with cirrhosis. To date, studies evaluating ED use in cirrhosis do not provide a comprehensive picture of drivers of ED utilization within the cirrhosis population as many are not based in the context of the American health system (9–13), focus on specific reasons for presentation such as fall (14) or need for hospitalization.(15, 16) In the background of a rising on acute care utilization by those with cirrhosis, there is a gap in our understanding of the cirrhosis population's ED utilization and growing need to identify those that disproportionately contribute to ED-based health care utilization. Therefore, we aimed to examine the characteristics of individuals with cirrhosis presenting to the ED within a large statewide health system and the outcomes of these visits. Further, we aimed to describe high ED utilizers (HEDU) with cirrhosis.

METHODS

STUDY DESIGN

We completed a retrospective cohort study of adults diagnosed with cirrhosis who completed an ED visit between 1/1/2021–12/31/2021, using an enterprise comprehensive clinical data warehouse (CDW). This CDW encompasses seventeen EDs and associated hospitals including the only liver transplant center in Indiana. Study participants were identified through cirrhosis-related ICD-10 codes followed by a manual chart review to confirm cirrhosis diagnosis (Supplementary Table 1, Figure 1). Reasons for exclusion included age

below 18 years, lack of confirmation of cirrhosis diagnosis during chart review and a history of liver transplant prior to the initial ED visit.

Variables of Interest

The CDW was queried to ascertain individual baseline demographics, relevant laboratory tests results (Model for End-Stage Liver Disease-Sodium (Meld-Na) score), ICD-10 diagnosis codes to calculate the Elixhauser comorbidity index (ECI, score derived by summing presence or absence of 30 comorbidities ranging from 0–30, Supplementary Table 1), number of encounters (ED, inpatient, no-show visits, and outpatient) within the 12 months prior to the initial ED visit, completion of investigations during the first 8 hours of the ED visit (laboratory studies, urine studies, blood cultures, imaging procedures), as well as liver transplant status (evaluated and/or listed), date of liver transplant and/or death. Geocodes were used to calculate the social deprivation index (SDI) which is a composite measure of seven demographic variables from the 5-year American Community Survey based on census track and ranges from 0, least disadvantaged, to 100, most disadvantaged. (17, 18) Chart review was then completed to confirm etiology and complications of cirrhosis, specialist consultations, and reasons for the ED visits (categorized during chart review guided by prior literature (2)) and hospital discharge diagnosis (if ED visit led to hospitalization, Supplementary Table 1). Social drivers including alcohol or other substance use, non-adherence to medications/diet at home, transport challenges, caregiver issues, unable to schedule a timely visit with PCP or specialist were documented.

In addition, charts were assessed by a clinician study investigator to determine if the ED visit could have been avoided using a pre-determined list of possible outpatient interventions (with an urgent outpatient hepatology visit, urgent paracentesis, expansion of outpatient service hours outside weekdays/“banker’s hours” (8am-5pm), improved outpatient medication management, and/or availability of durable medical equipment at home. Hepatology driven reasons for a visit to be avoidable included urgent outpatient hepatology visit, urgent paracentesis and improved management of lactulose and diuretics. High ED utilizers (HEDUs) were considered those patients with 2 or more visits to the ED in the 90 days following the initial ED visit as this cutoff incorporated the highest quartile of ED visits in our study cohort.

Outcomes

Outcomes after the initial ED visit were assessed at 90-days following the initial encounter (ED or hospital discharge date if the ED visit led to hospitalization) to capture the following HCU outcomes: number of repeat ED visits, time to return to ED, repeat hospitalizations, liver transplantation and/or death. For those individuals who had repeat visits to the ED, reasons for subsequent visits were collected using the same categories as for the initial visit. For those surviving the initial 90-days, the CDW was queried for date of liver transplant or death over an additional 360-day period (Figure 1).

Statistical analyses

Descriptive and summary statistics are presented using mean, standard deviation (SD) or median, interquartile range (IQR) for continuous measures and frequencies for categorical measures.

Characteristics and outcomes HEDU status were compared using independent two samples t-tests (normally distributed continuous variables), the Wilcoxon Rank Sum test (non-normally distributed continuous variables) and Chi-square tests or Fisher's exact tests for categorical outcomes. Multivariable logistic regression model was fitted to estimate the probability of HEDU status with covariates associated with HEDU (p-value ≤0.1 on bivariate analysis). Odds ratios (ORs) and their 95% confidence intervals (CI) were calculated to show the association between HEDU status and baseline characteristics. As assessment of avoidable visits can be subjective and included both hepatology driven and non-hepatology driven avoidable reasons, we completed two sensitivity analyses. First, we did not include the avoidable visit variable in our regression model. In another model, we limited avoidable visits to those avoidable only with hepatology-driven interventions. 360-day survival stratified by HEDU status was analyzed using Kaplan-Meier survival curves and the Log-rank test, censoring at the time of liver transplant. A significant level of 0.05 was considered for all tests. Data analyses were performed using SAS version 9.4 (SAS Institute, Inc., Cary, NC, USA).

RESULTS

Study population

Table 1 describes the study cohort (n =2124). Cirrhosis was diagnosed for the first time during the initial ED visit in 18.4% and cause of liver disease was undetermined (still being investigated) or unknown (could not be determined based on available medical record) in 18%. At baseline about 66% of study participants had an established GI/Hepatology provider. At presentation, complications from cirrhosis were common in the population (ascites 49%, HE 32%). The median MELD-Na score for the overall cohort was 17 (IQR 11.0–23.6). The median ECI was 7 (IQR 4–10) and SDI was 55.0 (IQR 28.5 – 81.0).

Initial ED visit

Table 2 summarizes the top 10 reasons for the initial ED visit as well as interventions and outcomes of this visit. The most common reasons were abdominal pain (21%), shortness of breath (19%), and ascites/volume overload (16%). The most common ED investigations were laboratory testing (91%), imaging studies (80%), and urine studies (20%). The most common imaging studies were chest X-rays (38%) and CT scan of the abdomen (35%). A GI/Hepatology consultation during the ED visit was documented for 6% of participants. Only 4% had paracentesis and 7% had blood cultures performed.

Twenty percent of initial ED visits (n=424) were potentially avoidable, most commonly with urgent outpatient evaluation to hepatology (34%), urgent paracentesis (25%) and improved outpatient medication management (23%).

Disposition from the initial ED visit was most commonly hospitalization (60%) followed by discharge home (37%) while only 2% were transferred to the observation unit. Of those who were hospitalized, 71% were discharged with a liver-related diagnosis. (Supplementary Figure 1). Although abdominal pain was a common reason for the ED visit, only 3% had discharge diagnosis of nonspecific abdominal pain. Post-hospital discharge clinic appointment was arranged in 25% of the hospitalized individuals and 71% attended the visit following discharge.

90-day outcomes after Initial ED visit

The overall 90-day mortality rate of the entire cohort was 16%. During the initial 90-day follow up period, 42% returned to the ED and 34% were re-hospitalized (Table 3). In those who returned, the mean number of ED encounters was 0.8 (SD 1.4), mean hospitalizations was 0.5 (SD 0.9). The median time to return to the ED and hospital was 22.0 days (IQR: 7.6–46.0) and 13.0 days (IQR: 0.9–41.0), respectively.

More than 25% returned for a reason similar to their initial ED visit (Figure 2, Supplementary Table 2). For example, of 240 patients who initially presented with altered mental status, 100 returned to the ED, of whom 43 (43%) returned for altered mental status. Similarly, of 438 patients who presented initially with abdominal pain, 207 returned, of whom 88 (42%) returned for the same reason.

High ED Utilizers

High utilizers (HEDUs) and non-HEDUs are compared in Supplementary Table 3. HEDUs were younger (61.0±12.7 yrs vs. 58.7±13.6 yrs, p=0.002), more likely to be White (93% vs. 90%, p=0.035), and have alcohol-related liver disease (43% vs. 36%, p=0.006), compared to non-HEDU. In addition, they had higher frequency of ascites (55% vs. 43%, p<0.001) and HE (37% vs 29%, p=0.002) with higher MELD-Na (19.0 vs 15.0, p<0.001). Social drivers (active substance use, medication non-adherence, transport/caregiver issues, unable to get visit with primary care or specialty physician) were not different between the two groups. HCU in the 1-year prior was higher in the HEDU group (prior ED visits: 1.4±2.9 vs 0.5±1.2, p<.001 and hospitalizations: 0.9±1.7 vs 0.4±0.9, p<.001). Those who were being evaluated or listed for LT were more likely to be in the HEDU group (evaluated: 10% vs. 5%, p<0.001, listed 4% vs. 2%, p=0.014). Reasons for the ED visit between the two groups were also different. HEDUs were more likely to present with abdominal pain (27% vs 19%, p=0.002) and ascites/volume overload (21% vs 14%, p=0.001). We did note a trend towards a greater number of avoidable initial visits in HEDUs (25% vs 20%, p=0.061).

HCU and clinical outcomes for HEDUs and non-HEDUs after the initial ED visit are summarized in Table 4. During the first 90-day period, HEDUs returned to ED sooner (16 days, IQR:7–33) than non-HEDUs (34.5, IQR:11–63, p=<.001) and had more hospitalizations (1.4±1.3 vs. 0.2±0.5, p=<.001). During the second 360-day follow up period, HEDUs underwent LT more often (2.8% vs. 1.3% at day 360, p=0.042). Importantly, the HEDUs group experienced higher mortality rates at 360-days (34% vs. 19%, p<0.001). Censored for transplant, the HEDUs group was less likely to survive over the 360-day follow up period (log-rank p<0.001, Figure 3).

Predictors of High ED Utilization

Multivariable-adjusted independent predictors of HEDU status are listed in Table 5 and they include age (aOR=1.030, 95%CI:1.003–1.058, p=0.027), undetermined etiology of cirrhosis at time of initial visit (aOR=18.950, 95%CI:1.980,181.349, p=0.011), MELD-Na (aOR=1.044, 95%CI:1.005–1.085, p=0.027), number of prior ED encounters (aOR=1.520, 95%CI:1.136–2.034, p=0.005), shorter time to return to the ED (aOR=0.973, 95%CI:0.961,0.985, p=<.0001), need for rehospitalization (aOR=4.335, 95%CI:2.317–8.113, p<.0001). Importantly, an avoidable initial ED visit was associated with HEDU (avoidable aOR=1.938,95%CI: 1.014,3.703, p=0.045). Being established with a GI/hepatology provider and being evaluated for LT were not independently associated with HEDU. In our sensitivity analyses, when the avoidable ED visit variable was removed from the model, the point estimates for the remaining independent predictors of HEDU remained largely unchanged (Supplementary Table 4). Furthermore, when avoidable visits were limited to hepatology driven avoidable reasons, these avoidable visits remained an independent predictor of HEDU and the point estimates for the remaining independent predictor associated with HEDU status remained largely unchanged (Supplementary Table 5).

DISCUSSION

Acute care for cirrhosis often begins with ED visits.(5, 7) Using a state-wide health system, we are able to provide a snapshot of cirrhosis-based ED use that informs the characteristics of patients with cirrhosis visiting the ED, the reason for ED visit and the care they get as they move through the healthcare system. In addition, we provide a clinically meaningful definition of HEDU. Our analysis of HEDUs highlights areas where improvements can be made to the existing healthcare system to optimize their healthcare experience.

Using detailed chart review as well as a comprehensive, state-based data warehouse, we described what patients with cirrhosis look like as they present to the ED for care. We found that nearly 1 out of 5 are newly diagnosed with cirrhosis during their ED visit. Furthermore, having an undetermined etiology of cirrhosis was a strong predictor of ED recidivism and HEDU even after controlling for severity of liver disease. These data indicate that ED use may be a frequent part of the early journey for individuals with cirrhosis. Currently, there are no other studies that describe healthcare use around the time of a new cirrhosis diagnosis, however, a prior study did show that cost of care is highest in the first year after HCC diagnosis.(19) Further studies are needed to better understand HCU and its drivers around the time of cirrhosis diagnosis. In addition, our data suggest that outpatient specialty care that is designed for more intense diagnostic and therapeutic management required early in cirrhosis care access are needed as an alternative to ED-based care to reduce both the financial and patient burden. Specifically, multi-disciplinary care, patient navigation programs and/or enhanced case management have reduced ED visits in patients with other end-stage diseases such as heart failure, chronic obstructive pulmonary disease and chronic kidney disease or those with complex care needs due to multi-comorbidity inflammatory bowel disease, mental health disorders, and sickle cell disease.(20–30) In fact, in the general

population, eliminating revisits and inappropriate ED use could reduce health care spending by as much as $32 billion each year.(31)

We also found that abdominal pain is the most common reason for individuals with cirrhosis seeking ED care. Other studies have shown that abdominal pain is a frequent symptom experienced by the individuals with cirrhosis and also the leading cause of chronic opiate use.(32) Abdominal pain is also a common reason for ED visit in general population.(33) Within our cohort, while many presented with abdominal pain, most individuals went on to receive a liver-related diagnosis at the end of their hospitalization and only 3% had non-specific abdominal pain as a discharge diagnosis. Furthermore, 35% of individuals who initially presented for abdominal pain experienced ED revisits due to abdominal pain during the initial 90-day follow-up. These results highlight the need for a system-based approach pain management as part of cirrhosis care, either within the hepatology practice and through improved coordinated, multi-disciplinary care. Specifically, studies have shown involving palliative care earlier can likely result in lower readmission rates in cirrhosis.(34) Alternatively, involving chronic pain management teams into the care of cirrhosis patients with pain may reduce repeated ED utilization.(35) In line with our results in cirrhosis, pain ranks as one of the most common reasons for preventable ED visits for patients with cancer.(36, 37) Oncology studies have shown that implementing a patient centered navigation system with standardized procedures (nurse based regularly monitoring of pain levels coupled with standardized prescription of analgesics using WHO's Pain Ladder and close outpatient follow up) led to 80% reduction in ED visit for pain.(38)

Among the cohort of individuals who visited the ED, a majority underwent laboratory studies and imaging, while blood cultures were obtained in only a limited number of cases. Notably, a significant proportion of hospitalized individuals were diagnosed with sepsis (11% in our study, 12%−35% in prior studies).(39, 40) Individuals with cirrhosis are at high risk of sepsis and its related complications. Furthermore, sepsis is associated with increased mortality approximating about 16% to 44%, (41, 42), highlighting the importance of timely and accurate diagnosis of infections in this high-risk population. Although there is conflicting data on the utility of obtaining blood cultures in the ER, with some studies suggesting overuse and false-positive results, and others showing no significant difference in patient management.(43–46) Studies in cancer patients, who may be similarly immunosuppressed as cirrhosis patients, show they are at high risk of mortality due to sepsis, with blood cultures yielding positive results in at least 47% of those visiting the ED. (47, 48) Careful follow up and prompt antibiotic intervention have been shown to reduce mortality. (49) However, there is a lack of data regarding the appropriate use of blood cultures in the ED for optimizing subsequent treatment plans in cirrhosis patients. Therefore, further investigation, including prospective studies and the development of standardized order sets, is warranted to identify the most effective interventions in the ED to optimize follow-up care and improve patient outcomes in this vulnerable population.

Importantly, our study establishes a definition for high ED utilization in the cirrhosis population. Prior studies have looked at ED use over 1 year and shown that some patients with cirrhosis present more than 4 times in the same year.(9) Given the poor short term outcomes in those with decompensated liver disease, we sought to identify an at-risk

population by using a 90-day period. Similar to other chronic conditions such as congestive heart failure and chronic obstructive pulmonary disease, we have observed increased ED utilization over a 90-day period in high risk populations.(50, 51) Using this definition of a HEDU population within cirrhosis, we establish predictors of HEDU and show that this HEDU group experiences higher rates of mortality. Beyond mortality, our study is also the first to show that 22% of high utilizers' initial ED visits were avoidable, often with earlier outpatient hepatology-driven interventions. In addition, having an avoidable initial ED visit was an independent predictor of HEDU. We also found that the majority of hospitalized individuals were discharged with liver-related diagnoses yet only a small percentage received consultations from gastroenterology/hepatology specialists during the ED visit. This raises the question of whether involving GI/hepatology specialists earlier in the care process could potentially prevent initial and recurrent ED visits. Notably, a recent survey among hepatologists and ED physicians showed that most hospitalizations and ED visits are preventable with targeted outpatient interventions.(52) In addition, previous data indicate the success of preventable admissions through the implementation of a dedicated paracentesis clinic and possible improved medication management.(53–55) Therefore our findings prompt the need for further exploration of similar healthcare delivery models targeted to individuals seeking ED based care.

By tracking ED use and hospitalizations using our statewide data warehouse, we were able to capture prior ED encounters and show their association with future HEDU independent of other demographic and clinical features like liver disease severity. This aligns with the current evidence in the general population which establishes prior health consumption is a strong predictor of future ED visits.(56–58) In fact, a prior study within a large health system revealed that many patients reported "pattern, preference, or habit" as the reason for their ED revisits.(59) In follow up, the team developed a targeted program using community health workers to disrupt the patterned behavior, leading to a 77% reduction in visits. Future studies which focus on individuals with cirrhosis who have had prior ED use, possible through intensive case-management or earlier post-acute care follow up are poised to reduce future ED revisits.(59–61)

It is important to note that our study used retrospective chart review and clinical databases which were initially intended for clinical rather than research purposes. This dependence introduces limitations particularly with regards to missing data for variables which can impact outcomes. It is possible we had more complete data for those with decompensated cirrhosis and are missing important predictors of HEDU in those with compensated or newly diagnosed cirrhosis. We also used chart review to capture individual social determinants of ED use but these may be under-documented in the EHR leading to an underestimation of their role in driving HEDU. In addition, our study cohort was largely non-Hispanic and White limiting generalizability of our findings to other racial and ethnic groups. Despite this limitation, our study cohort is representative of a statewide population and, therefore, captures both the rural and urban population as well as the breadth of socioeconomic status. Finally, our adjudication process for determining reasons for the visit, discharge diagnosis, and avoidable nature of the initial ED visit relied on opinions from a single study investigator. While the investigators have clinical training and used a standard process for these determinations, it is possible a second review may have led to different conclusions.

Despite these limitations, our study is unique in providing detailed data on a large cohort of individuals who received ED care and provides much-needed understanding of ED use in cirrhosis.

Conclusions

In summary, individuals with cirrhosis who visit the ED are at risk of becoming high utilizers, which is linked to higher rates of mortality. Beyond severity of liver disease, a new diagnosis of cirrhosis, prior HCU, and coming to the ED for avoidable reasons are important drivers of HEDU. Our study identifies several targets for healthcare delivery reform both in the ED and in the outpatient settings which are poised to reduce the burden of acute HCU in cirrhosis.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Data statement:

The analytic methods used in this study are detailed in the methods. Due to HIPAA regulations, individual level data are not available publicly from this retrospective study. However, interested investigators are encouraged to contact the corresponding author for appropriate data sharing.

ABBREVIATIONS

ED	Emergency department
AKI	Acute kidney injury
HRS	Hepatorenal syndrome
HE	Hepatic encephalopathy
SBP	Spontaneous bacterial peritonitis
HEDU	High emergency department utilizer
NHEDU	Nonhigh emergency department utilizer

ECI	Elixhauser comorbidity Index
SDI	Social Deprivation Index
MASH	Metabolic associated 3steatohepatitis
HCV	Hepatitis C virus
HBV	Hepatitis B virus
MELD-Na	Model for end stage liver disease-sodium
CPS	Child Pugh Score
HCC	Hepatocellular carcinoma
CT	Computed Tomography
GI	gastrointestinal
OR	Odds ratio
CI	Confidence interval
SD	Standard deviation
IQR	Inter quartile range.
LT	Liver Transplant

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STUDY HIGHLIGHTS

What is Known:

- Acute care for cirrhosis-related complications such ascites, variceal bleeding, hepatic encephalopathy often starts in the Emergency Department (ED).
- There is limited data describing ED utilization by individuals with cirrhosis.

What is New Here:

- Of 2124 eligible cirrhosis patients who visited the ED, the primary reasons for the initial ED visits included abdominal pain, shortness of breath, and ascites/volume overload.
- The 90-day mortality rate was 16% and 20% experienced high ED use (≥2 ED visits within 90 days after the index ED visit).
- We identify several factors associated with high ED use which can be used to guide future interventions to improve cirrhosis-related ED utilization and outcomes.

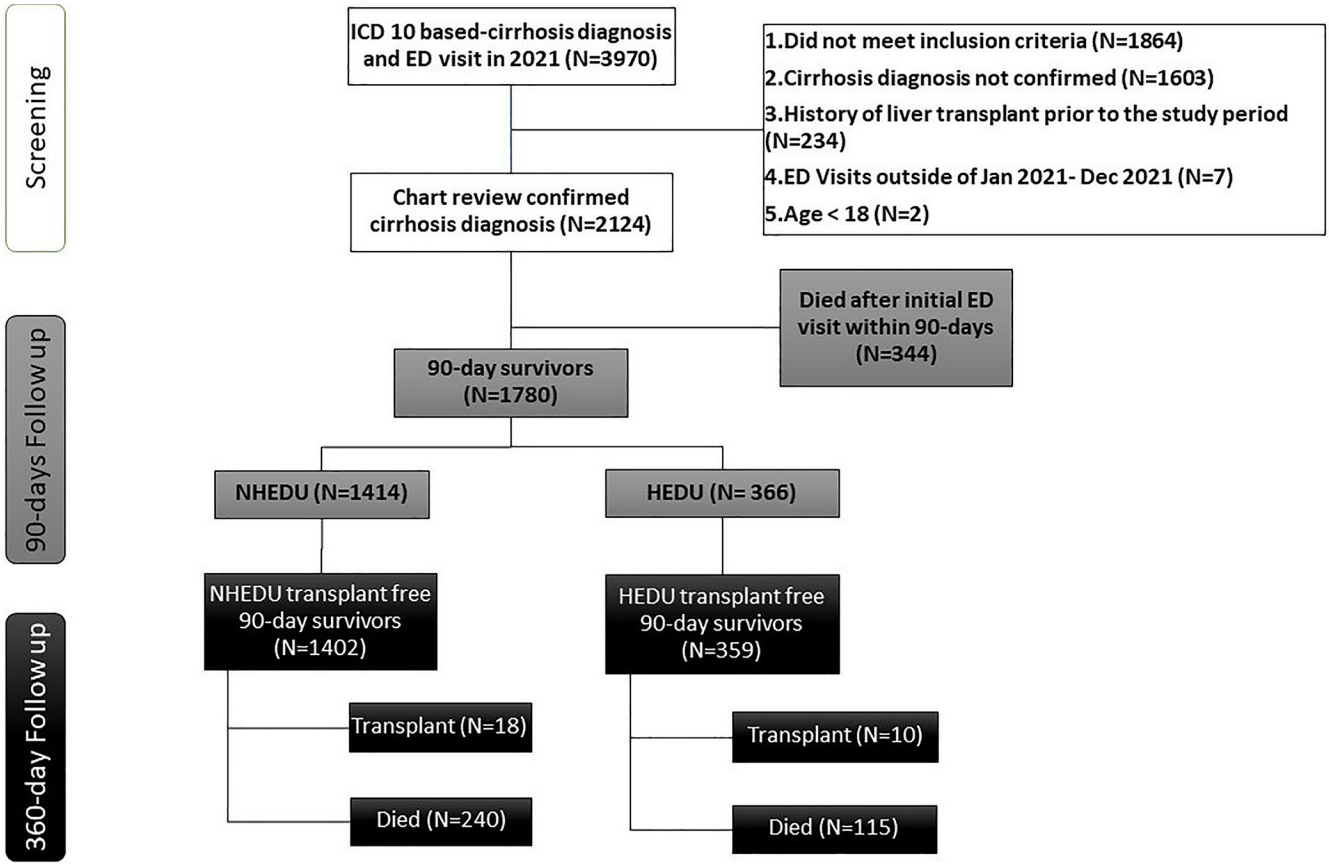

Figure 1.
Flow of study participants depicted via Consort Diagram

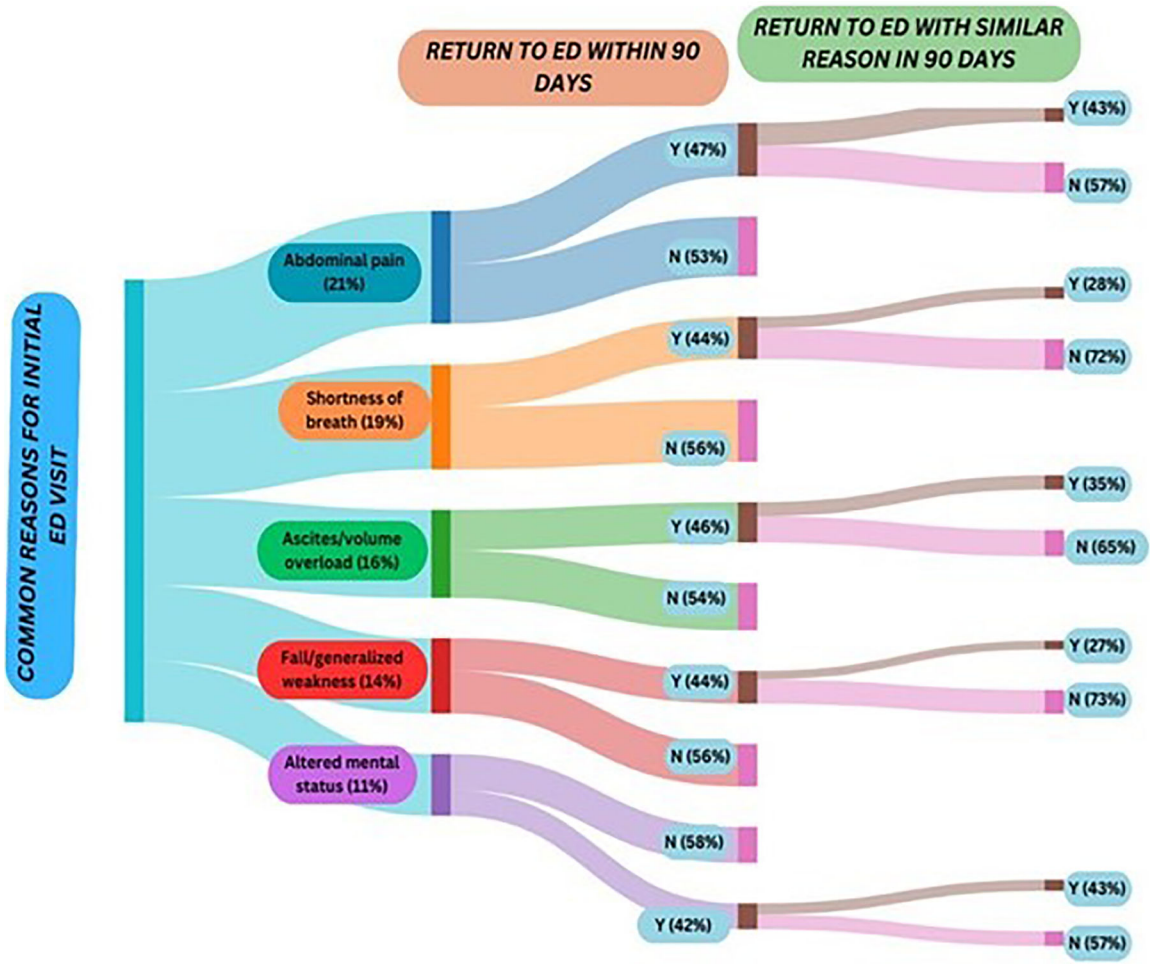

Figure 2.

Sankey diagram showing rates of return to ED within 90-days and rates of return for same reason within 90 days compared to the initial ED visit.

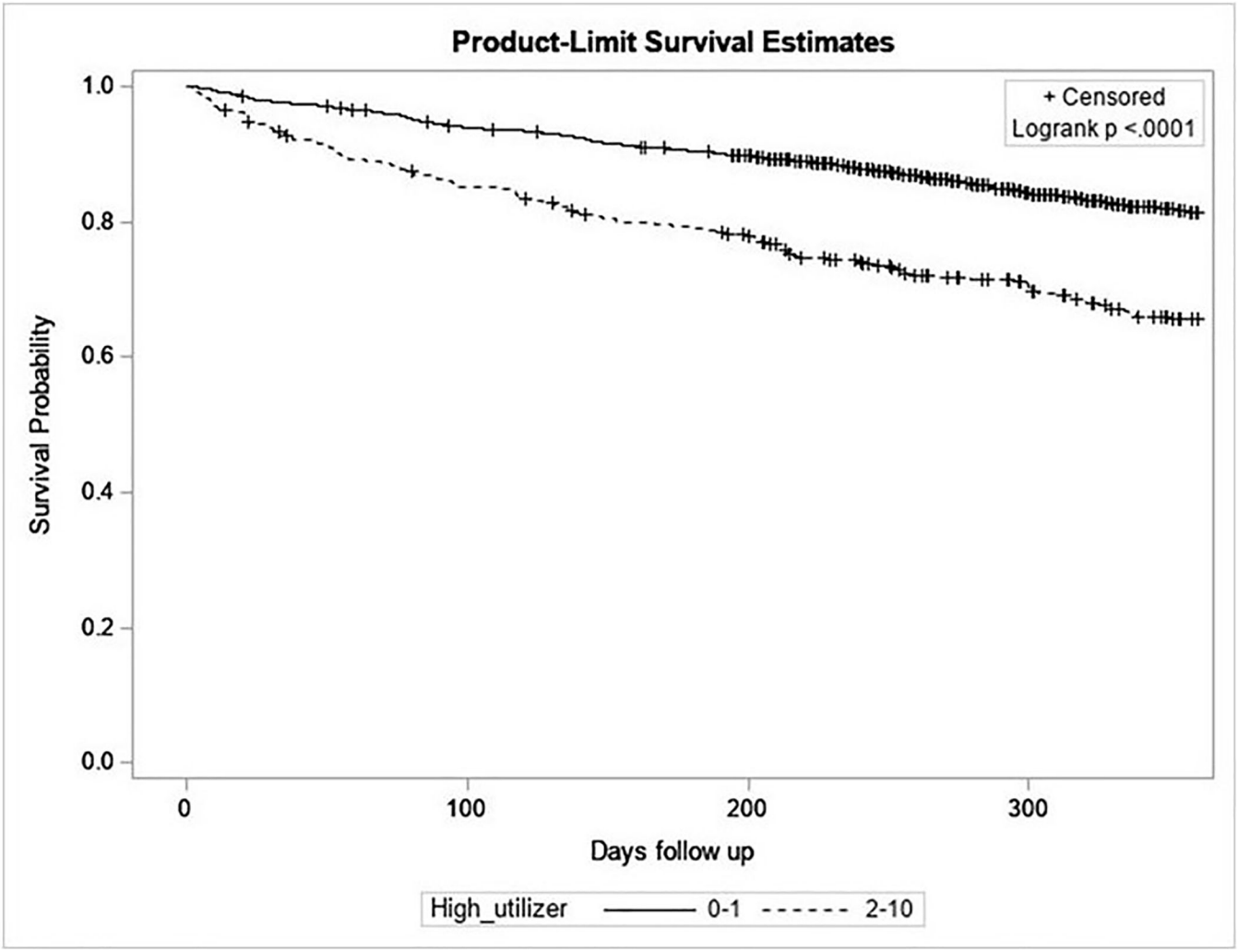

Figure 3.
Comparison of Kaplan-Meier survival curves between high ED utilizers (HEDU) and non-HEDU.

Table 1.

Demographics and clinical characteristics of study cohort

Characteristic	Total Cohort N = 2124 N (%)
Age *	61.3 ± 12.9
Male Gender	1130 (53%)
Race	
White	1900 (91%)
Non-White ^	195 (9%)
Non-Hispanic or Latino Ethnicity	2051 (98%)
Insurance	
Medicaid	420 (20%)
Medicare	1107 (52%)
Private/HMO/Other	597 (28%)
Living Situation prior to ED presentation	
Home	1927 (91%)
Facility	193 (9%)
Elixhauser comorbidity index †	7 (4 –10)
Newly diagnosed with cirrhosis in the ED	390 (18.4%)
Etiology of Cirrhosis:	
Alcohol	803 (38%)
MASH	563 (27%)
Viral Hepatitis	448 (21%)
Other	185 (9%)
Undetermined/Unknown #	373 (18%)
Complications of Cirrhosis:	
None	631 (29.7%)
Ascites	1029 (49%)
Hepatic Encephalopathy	675 (32%)
Varices	720 (34%)
Hepatocellular Carcinoma	148 (7%)
MELD-Na †	17.0 (11.0 – 23.6)
Child-Pugh Score †	8.0 (7.0 – 10.0)
Social Deprivation Index †	55 (28.5 – 81)
Social Drivers of ED Visit	
None	1741 (82%)
Alcohol/Substance Use	302 (14%)
Non-Adherence to medications	80 (4%)
Transporter/Caregiver Issues	18 (1%)

Characteristic	**Total Cohort N = 2124 N (%)**
Unable to get visit to PCP/specialist	36 (2%)
Healthcare use in 12 months prior	
Prior ED encounters *	0.6 ± 1.7
Prior inpatient encounters *	0.5 ± 1.2
Prior outpatient encounters *	4.3 ± 7.4
No-show visits to clinic *	0.2 ± 0.5
Established with GI / Hepatology	1389 (66%)
Evaluated for liver transplant	132 (6%)
Listed for liver transplant	37 (2%)

* Mean ± SD

† Median (IQR)

^ Other race categories include Black (8.26%), Asian (0.76%), American Indian or Alaskan Native (0.14%), Native Hawaiian or Pacific Islander (0.05%).

†† Other etiologies of liver disease: Autoimmune, cholestatic, cryptogenic, Budd Chiari syndrome, Hereditary hemochromatosis, alpha-1 antitrypsin deficiency, Congenital biliary atresia, IgG4 sclerosing cholangitis, Congenital hepatic fibrosis, cystic fibrosis, granulomatous hepatitis, sarcoidosis.

Undetermined: 100 (4.7%), Unknown: 273 (12.9%).

Abbreviations: HMO, MASH, MELD-Na, ED, PCP, GI.

Table 2.

Characteristics of initial Emergency Department visit

Characteristic	Total Cohort N = 2124 N (%)
ED visit outside business hours	820 (39%)
ED visit during weekend	494 (23%)
Reason for Visit	
Abdominal pain	438 (21%)
Shortness of breath	406 (19%)
Ascites / abdominal distension/volume overload	341 (16%)
Fall/generalized weakness	292 (14%)
Doctor instructions *	284 (14%)
GI symptoms ^	270 (13%)
Altered mental status	240 (11%)
Musculoskeletal pain / swelling	179 (8%)
GI bleeding	168 (8%)
Chest pain	131 (6%)
ED visit deemed avoidable	
No	1700 (80%)
Yes, with urgent visit to Hepatology	143 (7%)
Yes, with urgent paracentesis ‡	106 (5%)
Yes, with non-emergency weekend/holiday services	68 (3%)
Yes, with improved med management	99 (5%)
Yes, with Durable medical equipment	12 (1%)
Interventions during visit †	
Lab	1932 (91%)
Urine studies	415 (20%)
Blood cultures	148 (7%)
Imaging during visit †	
Chest x-ray	810 (38%)
CT Abdomen	748 (35%)
CT Chest	282 (13%)
CT Head	403 (19%)
Extremities imaging / doppler	182 (9%)
Abdominal ultrasound	121 (6%)
Spinal imaging	95 (5%)
Cardiac imaging	79 (4%)
Abdominal x-ray	14 (1%)
Procedures during the visit †	

Characteristic	Total Cohort N = 2124 N (%)
Paracentesis‡	84 (4%)
Thoracocentesis	3 (0.1%)
Other††	18 (1%)
Consults during the visit	
GI/Hepatology	130 (6%)
Other¶	66 (3%)
Disposition	
Hospitalized	1273 (60%)
Home	808 (38%)
ED Observation unit	33 (2%)
Other§	10 (1%)
Hospitalization discharge diagnosis	N=1273
Liver related diagnosis	900 (71%)
Non-liver related diagnosis	528 (42%)
Post-hospitalization clinic visit arranged	325 (25%)
Post-hospitalization clinic visit attended	230 (71%)

*Doctors instructions: Anormal labs, Abnormal imaging, Abnormal vitals

^GI symptoms: Nausea, vomiting, diarrhea, other GI symptom such as dysphagia

†During first 8 hours of ED visit

‡Paracentesis actually completed in ED is distinct from determination of avoidable visit by urgent paracentesis

††Other interventions: Central line, Intubation, Endoscopy, Incision and drainage, Splinting, Arthrocentesis, Suturing.

¶Other^: Pulmonology, Critical care, General surgery, Nephrology, Cardiology, Neurology, Oncology, Gynecology, Neurosurgery, Hospitalist, Interventional Radiology, Psychiatry, Orthopedics, Podiatry, ENT, Urology, Vascular, Social work

§other dispositions: Died (n=6), ED transfer to another institution (n=4)

Abbreviations: ED, GI, CT.

Table 3.

Outcomes within 90-days after initial emergency department visit

Outcome	Total cohort N=2124, N (%)
Return to ED in 90 days	896 (42%)
ED encounters at 90 days *	0.8 ± 1.4
Time to return to ED (days)^	22 (8 – 46)
Return to hospital in 90 days^	714 (34%)
Inpatient encounters at 90 days *	0.5 ± 0.9
Time to return to hospital^	13.0 (0.9 – 41.0)
30- day mortality	199 (9%)
90- day mortality	344 (16%)
Days to death^	142 (34 – 357)
90- day liver transplant	19 (1%)
Days to transplant^	175.5 (85.0– 352.0)

*Mean ± SD

^Median (IQR)

Abbreviations: ED

Table 4:

Outcomes in high ED utilizers (HEDU) and Non HEDU after the initial ED visit.[‡]

	Non-HEDU (N=1402)	HEDU (N=359)	p-value
Outcomes during initial 90-day period			
Number of ED encounters [*]	0.3±0.4	3.1±1.6	<0.001
Time to return to ED (days)[^]	35.5 (11.0–63.0)	16 (7–33)	<0.001
Return to hospital	258 (19%)	259 (73%)	<0.001
Number of Hospitalizations [*]	0.2 ± 0.5	1.3 ± 1.2	<0.001
Time to return to hospital (days)	11 (0–50)	20 (4–43)	0.013
Outcomes during 360-day follow up period			
180- day mortality [†]	134 (9%)	74 (21%)	<0.0001
360- day mortality [†]	240 (19%)	115 (34%)	<0.0001
Time to death (days)[^]	335 (193–486)	276.5 (151.0–426.5)	0.009
Time to transplant (days)[^]	293 (184–418)	218 (127–229)	0.527
180- day transplant	7 (0.5%)	6 (1.7%)	0.032
360- day transplant	18 (1.3%)	10 (2.8%)	0.042

[‡]This table describes the outcomes after excluding the individuals who died (n=344) and those who underwent liver transplantation (n=19) within 90 day follow up after the initial ED visit.

[*]Mean ± SD

[^]Median (IQR)

[†]Estimated from survival analysis, 1 of 19 patient died post-transplant

Abbreviations: ED, HEDU

Table 5.

Multivariable model of factors associated with high ED utilization.*

Predictors	Odds ratio	95% Confidence Interval	p-value
Age	**1.030**	**1.003,1.058**	**0.027**
Race White	2.619	0.954,7.188	0.062
Insurance:			
Medicaid	0.970	0.466,2.016	0.934
Medicare	**0.469**	**0.217,1.014**	**0.054**
Active alcohol use	0.739	0.324,1.685	0.473
Healthcare use 12 months prior to the ED visit:			
Prior ED encounters	**1.520**	**1.136,2.034**	**0.005**
Prior inpatient encounters	0.969	0.742, 1.265	0.818
Prior no-show visits to clinic	1.524	0.891,2.606	0.124
Etiology of Cirrhosis:			
Alcohol	1.542	0.812,2.929	0.186
Viral hepatitis	1.015	0.485,2.126	0.968
Undetermined (if no diagnosis workup done)	**18.950**	**1.980,181.349**	**0.011**
Complications of Cirrhosis:			
Ascites	0.709	0.368,1.365	0.303
Hepatic encephalopathy	1.411	0.773,2.574	0.262
History of TIPS	0.505	0.177,1.443	0.202
MELD-Na score	**1.044**	**1.005,1.085**	**0.027**
Social Deprivation Index	1.004	0.994,1.013	0.449
Exlihauser Comorbidity Index	0.961	0.890,1.038	0.316
ED Interventions:			
Blood cultures	0.681	0.306,1.519	0.348
Abdominal CT	0.870	0.493,1.536	0.631
Chest X ray	1.108	0.646,1.903	0.709
90-day Outcomes			
Time to return to ED	**0.973**	**0.961,0.985**	**<.0001**
Return to hospital in 90 days	**4.335**	**2.317,8.113**	**<.0001**
Liver transplant in 90 days	0.829	0.100,6.840	0.862
Reasons for ED visit:			
Abdominal distension / volume overload	1.282	0.642,2.562	0.482
Abdominal pain	1.088	0.548,2.159	0.810
Musculoskeletal swelling / pain	0.316	0.094,1.059	0.062
Alcohol related abuse/ withdrawal/detox	2.002	0.364,11.028	0.425
Evaluated for liver transplant	1.151	0.466,2.841	0.761
ED visit could be avoided	**1.938**	**1.014,3.703**	**0.045**

*Factors included in model if p-value≤0.1 on bivariate analysis (see Supplementary Table 3)

Abbreviations: TIPS, MELD-Na, CT, ED