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Paracentesis is Associated with Reduced Mortality in Patients Hospitalized with Cirrhosis and Ascites

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Abstract

Background & Aims—Diagnostic paracentesis is recommended for patients with cirrhosis admitted to the hospital for ascites or encephalopathy. However, it is not known if clinicians in the United States adhere to this recommendation; a relationship between paracentesis and clinical outcome has not been reported. We analyzed a US database to determine the frequency of paracentesis and its association with mortality.

Methods—The 2009 Nationwide Inpatient Sample (which contains data from approximately 8 million hospital discharges each year) was used to identify patients with cirrhosis and ascites admitted with a primary diagnosis of ascites or encephalopathy. In-hospital mortality, length of stay, and hospital charges were compared for those who did and did not undergo paracentesis. Outcomes were compared for those who received an early paracentesis (within 1 day of admission) and those who received one later.

Results—Of 17,711 eligible admissions, only 61% underwent paracentesis. In-hospital mortality was reduced by 24% among patients who underwent paracentesis (6.5% vs 8.5%, adjusted odds ratio [OR], 0.55; 95% confidence interval [CI], 0.41–0.74). Most paracenteses (66%) occurred ≤1 day after admission. In-hospital mortality was lower among patients who received early paracentesis than those who received it later (5.7% vs 8.1%; *P*=.049), although this difference was

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not significant after adjustment for confounders (OR, 1.26; 95% CI, 0.78–2.02). Among patients who underwent paracentesis, the mean hospital stay was 14% longer, and hospital charges were 29% greater than for patients that did not receive the procedure.

Conclusions—Paracentesis is underused for patients admitted to the hospital with ascites; the procedure is associated with increased short-term survival. These data support practice guidelines derived from expert opinion. Studies are needed to identify barriers to guideline adherence.

Keywords

Peritonitis; Quality of Health Care; Health Services; NIS Analysis; Liver Fibrosis

INTRODUCTION

Ascites is the most common complication of cirrhosis,[1] and its development is associated with substantially increased mortality.[2] One of the most feared complications of ascites is spontaneous bacterial peritonitis (SBP), which occurs in 25% of patients and is fatal in 30%.[3, 4] SBP is present in 10–30% of all hospitalized patients with ascites,[5] and the risk of complications from diagnostic paracentesis is negligible.[6, 7] Therefore, for more than a decade experts have recommended that a diagnostic paracentesis be performed to exclude SBP in all patients with ascites admitted to the hospital.[5, 8, 9]

Recently, a set of quality indicators was developed for the care of patients with cirrhosis, and a diagnostic paracentesis in patients admitted to the hospital for symptoms from ascites or encephalopathy was identified as one of the most important indicators of quality.[10] Despite practice guideline recommendations and its selection as a quality indicator, diagnostic paracentesis is done in less than 60% of indicated cases within the Veteran Affairs health system.[11] However, this low adherence has not been described in a broader population. Furthermore, despite the strong evidence supporting specific interventions for SBP (e.g., antibiotics and albumin) in improving patient outcomes,[12, 13] data linking the widespread use of paracentesis with clinical outcomes are lacking, and diagnostic paracentesis is rated as a “Level C” quality indicator (based on expert opinion or case series).[10] Demonstrating improved outcomes with early paracentesis in a large hospitalized population may help increase the uptake of current recommendations in the community.

We therefore sought to estimate the frequency of paracentesis in a nationally representative sample of patients with cirrhosis hospitalized for ascites or hepatic encephalopathy and to evaluate the association between paracentesis and mortality, length of stay, and hospital charges. Among those who did receive a paracentesis, we also examined the relationship between delayed paracentesis and mortality.

METHODS

Data Source

We utilized data from the 2009 Nationwide Inpatient Sample (NIS), the largest all-payer database of hospital discharges in the US, totaling approximately 8 million discharges yearly. It is a component of the Healthcare Cost and Utilization Project, sponsored by the

Agency for Healthcare Research and Quality.[14] The NIS represents a 20% sample of non-federal acute care hospitals in the US and is stratified on hospital ownership/control, size, teaching status, location, and region. The sampling design supports national estimates of study findings. Each record represents a single patient discharge and contains demographic information, up to 25 diagnoses and 15 procedures, admission type, patient disposition, length of stay, hospital charges, and hospital characteristics.

Study Sample

We used International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) codes to identify all patients ≥ 18 years old with a primary discharge diagnosis of ascites (789.59) or SBP (567.23). We also included patients with a primary diagnosis of hepatic encephalopathy (ICD-9-CM 572.2) if they had a secondary diagnosis of ascites. We required that all patients have a secondary diagnosis of cirrhosis (ICD-9-CM 571.2, 571.5, 571.6). The first listed diagnosis was considered the primary diagnosis, and additional diagnoses were considered secondary. The study sample was chosen to resemble the denominator for the associated quality indicator (those "admitted to the hospital for evaluation and management of symptoms related to ascites or encephalopathy").[10] We repeated the main analyses for patients with *any* (primary or secondary) diagnoses of ascites and/or SBP. We excluded patients transferred from another health facility to avoid misclassifying patients who had received a paracentesis prior to transfer. The codes used to define the sample were previously validated.[11, 15, 16]

Variables

Our primary factor of interest was the performance of a paracentesis as determined with a validated definition (ICD-9-CM 54.91).[17] In the subgroup who received a paracentesis, we examined early versus delayed paracentesis (≤ 1 day versus > 1 day after admission). We considered patient age, sex, race/ethnicity (white, black, Hispanic, or other), weekday versus weekend admission, elective versus non-elective admission, primary health insurance payer (Medicare, Medicaid, private insurance, self-pay, or other), median household income quartile for the patient's home zip code, and comorbidities measured by the Elixhauser comorbidity index (excluding the "liver disease" comorbidity).[18, 19] Age was specified categorically (< 55, 55–64, or ≥ 65) in models because the relationship between age and paracentesis was non-linear. Additionally, we examined diagnoses of sepsis (ICD-9-CM 038, 020.2, 790.7, 117.9, 112.5, 112.81) and acute renal failure (584.5, 584.6, 584.7, 584.8, 584.9) using validated definitions.[20, 21] We examined hospital factors including size (small, medium, or large), ownership/control (non-federal government, non-profit private, or investor-owned private), US region (Northeast, Midwest, South, or West), teaching status, and location (rural versus urban). Race/ethnicity was missing in 10% of observations, and 9% were missing time-to-paracentesis; no other variable was missing in more than 3%. Missing data were handled using listwise deletion; analyses were repeated after assigning all observations with missing time-to-paracentesis to both the early and delayed groups.

Outcomes

The primary outcome was in-hospital mortality. Secondary outcomes were hospital length of stay (days) and total hospital charges (US dollars).

Statistical Analysis

Categorical variables were compared with Pearson's χ^2 test, and continuous variables were compared with Student's t-test. Factors associated with paracentesis performance were assessed using multivariate logistic regression. Logistic regression was also used to evaluate the association between paracentesis and mortality. To account for potential selection bias of moribund patients in whom paracentesis may be deemed futile, the relationship between paracentesis and mortality was also examined after excluding those who died on the day of admission. Within the subgroup who received a paracentesis, additional logistic models examined the relationship between delayed paracentesis and mortality, and factors associated with delayed paracentesis. Poisson regression was used to examine the relationship between paracentesis and length of stay. The relationship between paracentesis and hospital charges was modeled using linear regression with logarithmic transformation of charges. Coefficients were exponentiated to determine the percentage change in charges associated with paracentesis. All multivariate models included age, sex, race/ethnicity, weekend and elective admission, primary payer, median zip code income, comorbidities, sepsis, acute renal failure, hospital size, ownership/control, region, teaching status, and location. In mortality models, interaction terms for age, sex, weekend and elective admission, comorbidities, acute renal failure, and sepsis were assessed but were not statistically significant, and were not included in the final models.

Analyses were performed using Stata version 12.1 (StataCorp LP, College Station, TX). All analyses accounted for the stratified cluster sampling design and incorporated discharge-level weights to produce national estimates with 95% confidence intervals (CI). All *p*-values were based on 2-sided tests, and were considered statistically significant when $p < 0.05$. The University of North Carolina Institutional Review Board approved this study.

RESULTS

Study Sample Characteristics and Paracentesis

Of the nearly 40 million national discharges in 2009, 17,711 met inclusion criteria and were included in the analysis. 10,500 had a primary diagnosis of hepatic encephalopathy, 2,977 had a primary diagnosis of ascites, and 4,233 had a primary diagnosis of SBP. Overall, 10,743 patients (60.7%; 95% CI, 58.6–62.7%) had a paracentesis during the hospitalization. Paracentesis was performed in 3,262 patients with a primary diagnosis of SBP (77.1%; 95% CI, 74.0–80.1%), compared to 7,481 of those with a primary diagnosis of encephalopathy or ascites (55.5%; 95% CI, 53.3–57.7%) (Supplementary Table). Only 50.9% of patients with *any* diagnosis of ascites had a paracentesis. The mean age was 58.2 years, 63.7% were male, and 66.5% were Caucasian. Patient demographics stratified by the receipt of a paracentesis are shown in Table 1. Those who received a paracentesis were slightly younger, had a higher median income in their home zip code, were more likely to have concurrent sepsis or acute renal failure, were less likely to be in the South region, and were more likely to be in a teaching or urban hospital. Paracentesis performance ranged from 56.4% in the South to 64.1% in the Northeast. Sex, race/ethnicity, admission circumstances, primary payer status, comorbidities, hospital size, and ownership did not differ between the two groups. In multivariate analysis, paracentesis was independently associated with self-pay (compared to private insurance) (odds ratio [OR] 1.41; 95% CI, 1.02–1.96), sepsis (OR 1.43; 95% CI, 1.02–2.00), acute renal failure (OR 1.53; 95% CI, 1.29–1.81), and hospital teaching status (OR 1.32; 95% CI, 1.08–1.61). In contrast, paracentesis was less likely to occur in those admitted on the weekend (OR 0.84; 95% CI, 0.71–1.00) and those in the South region (OR 0.76; 95% CI 0.57–1.00).

Paracentesis and In-Hospital Mortality

Patients who received a paracentesis had lower in-hospital mortality than those who did not get a paracentesis (6.5% versus 8.5%, $p = 0.03$). The results of bivariate and multivariate mortality analyses are shown in Table 2. The mean age of those who died (59.7) was slightly higher than that of those who lived to discharge (58.1). Those who died had more comorbidities (mean 4.0) than those who lived (3.6). Mortality was greater in those with sepsis (27.2% versus 5.7%) and in those with acute renal failure (16.4% versus 4.0%). In-hospital mortality was lower in the Midwest (4.6%) than in the other regions (7.9%). Bivariate analyses of other factors showed no differences in in-hospital mortality. The performance of paracentesis was associated with decreased in-hospital mortality in multivariate analysis (OR 0.55; 95% CI, 0.41–0.74). This mortality benefit was seen exclusively for those with a primary diagnosis of encephalopathy or ascites (6.8% versus 9.1%, adjusted OR 0.54; 95% CI, 0.38–0.76) and not for those with a primary diagnosis of SBP (5.8% versus 4.7%, adjusted OR 0.91; 95% CI, 0.38–2.19) (Supplementary Table). After excluding the 2.3% of in-hospital deaths that occurred on the day of admission, paracentesis remained associated with reduced mortality in multivariate analysis (OR 0.59; 95% CI, 0.43–0.80). Paracentesis was also associated with reduced mortality in alternative samples that included patients with any diagnosis of ascites or SBP (Supplementary Table).

Delayed Paracentesis

Among those who received a paracentesis, approximately 6,479 (66.0%) received it ≤ 1 day after admission. Those who received a delayed paracentesis were slightly older, were more likely to be female, were more likely to be admitted on a weekend day, were more likely to have Medicare, had more comorbidities, were more likely to have acute renal failure, were more likely to be in a private, non-profit hospital, and were less likely to be in a teaching hospital (Table 3). Race/ethnicity, elective versus non-elective admission, patient home zip code income, concurrent sepsis, hospital size, region, and location (urban/rural) were not related to delayed paracentesis in bivariate analyses. In multivariate analysis, delayed paracentesis was associated with female sex (OR 1.39; 95% CI, 1.11–1.74), weekend admission (OR 1.80; 95% CI, 1.38–2.35), increasing comorbidities (OR 1.16; 95% CI, 1.09–1.24), and acute renal failure (OR 1.30; 95% CI, 1.06–1.61). Paracentesis was less likely to be delayed in teaching hospitals (OR 0.75; 95% CI, 0.57–0.98), and there was regional variation, with delay less likely in the South (OR 0.72; 95% CI, 0.53–0.99) and West (OR 0.61; 95% CI, 0.43–0.85) compared to the Northeast.

Delayed Paracentesis and In-Hospital Mortality

In-hospital mortality was 5.7% for those whose paracentesis was performed = 1 day after admission, compared to 8.1% when paracentesis was delayed ($p = 0.049$). However, in the multivariate model, the association between delayed paracentesis and mortality was not statistically significant (OR 1.26; 95% CI, 0.78–2.02). Removing variables that did not change the point estimate did not improve precision. Assigning the 9% of patients with missing time-to-paracentesis to both the early and delayed groups did not change the results (data not shown).

Hospital Length of Stay and Charges

Mean length of stay for those who received a paracentesis was 6.6 days compared to 5.3 days for those who did not receive a paracentesis (Table 4, $p < 0.001$). After adjustment in the multivariate regression model, those who received a paracentesis had a 14% longer length of stay. Likewise, hospital charges were greater for those who had a paracentesis ($44,586 versus $31,746, $p < 0.001$), and remained 29% greater in the multivariate model.

DISCUSSION

In this nationally representative sample of hospital admissions, we found that only 61% of patients with cirrhosis admitted for ascites or encephalopathy had a paracentesis. When paracentesis was performed, only 66% were done ≤ 1 day after admission. Therefore, overall only 40% of eligible patients had a timely paracentesis. Paracentesis was associated with a significant reduction in mortality but also longer hospital stay and greater expense.

In light of the safety and diagnostic value of paracentesis,[5–7] our finding that nearly 40% of potentially eligible patients did not receive this care is concerning. The lack of detail in the NIS does not allow for firm conclusions on the reasons for underutilization, but potential reasons may include a low index of suspicion among providers and a lack of knowledge about the high prevalence of SBP, even among asymptomatic patients.[5] Alternatively, some practitioners may elect to give empiric antibiotics for SBP without performing a paracentesis. Providers may overestimate bleeding risk in the setting of thrombocytopenia and coagulopathy or lack comfort in performing paracentesis. Survey data from 1996 indicated that the vast majority of graduating internal medicine residents were comfortable performing paracentesis,[22] but subsequent changes in resident training and the potential for increasing reliance on interventional radiologists could have reduced this confidence. Our finding that weekend admissions were associated with delayed paracentesis may reflect outsourcing to radiologists during the week. The fact that patients in teaching hospitals were more likely to have had a paracentesis likely reflects greater access to hepatologists and gastroenterology didactic sessions on cirrhosis care as well as 24/7 coverage by medical house staff.

A novel finding of this study is the association between paracentesis and improved survival, which to our knowledge has not been previously reported. Kanwal et al. demonstrated a reduction in 12-month mortality for patients who received optimum cirrhosis care, including paracentesis in hospitalized patients with ascites.[11] However, individual quality measures were not reported separately, and the effect was not statistically significant, probably because of power limitations. Our findings support current recommendations for paracentesis, which have been based largely on expert opinion, and therefore add legitimacy to its use as an indicator of quality.[10]

The mechanism for this beneficial effect cannot be ascertained from the NIS, but is presumably related to increased detection and treatment of SBP. Our finding that mortality was not altered for those with a primary SBP diagnosis is consistent with this explanation. Patients who are diagnosed clinically with SBP without a paracentesis are likely to receive appropriate antibiotics and albumin and are therefore likely to have a good outcome. This would serve to obscure any direct relationship between paracentesis and survival amongst those diagnosed clinically with SBP. The mortality difference for the remaining patients diagnosed with ascites or encephalopathy is likely the result of improved SBP diagnosis because of the potential for underreporting and under-recognition of SBP. Under-recognition of SBP may also explain the lower mortality for the subgroup with an SBP diagnosis compared to the subgroup with ascites and encephalopathy diagnoses because the latter group likely includes patients with unrecognized and untreated SBP. The lack of sensitivity in SBP reporting has been reported elsewhere[15] and makes such analyses difficult. In fact, this low sensitivity was the rationale for including patients with ascites or encephalopathy in the study sample and underscores the need for paracentesis in patients with ascites even when SBP is not suspected. Interestingly, patients who received a paracentesis were more likely to have concurrent diagnoses of sepsis or acute renal failure. How this finding is related to the mortality benefit is unknown, since early diagnosis and treatment of SBP would be expected to prevent the development of sepsis and renal failure. It is plausible that the presence of renal failure or sepsis on admission would raise the index of suspicion for SBP and lower the threshold for providers to perform paracentesis. Alternatively, the performance of paracentesis may be a marker of adherence to other evidence-based practices, such as albumin for SBP or prophylactic antibiotics for gastrointestinal bleeding.[13, 23]

In contrast to the benefit of paracentesis, delayed paracentesis (compared to early) was not associated with increased mortality in multivariate analysis. Although early paracentesis leading to diagnosis and treatment of SBP might result in a clinical benefit, patients with suspected SBP who receive empiric antibiotics prior to delayed paracentesis may also have a good outcome. Such an effect could attenuate the association between delayed paracentesis and mortality. Indeed, mortality was reduced for those with prompt paracentesis in bivariate analysis.

Length of stay and hospital charges were both increased for patients who received paracentesis. How much the 31% higher mortality in the non-paracentesis group contributed to shorter stay and less charges is unknown. Some may have had undiagnosed SBP with early death and may have otherwise survived with longer hospitalization and increased cost. Patients with unrecognized early SBP may have been discharged before the development of overt SBP, incurring a shorter length of stay and lower cost during the index hospitalization only to be readmitted later. Because the unit of observation is the hospitalization, readmissions for complications of previously unrecognized SBP cannot be determined.

Indeed, some observations may represent readmissions, potentially contributing to the associations with renal failure, sepsis and increased length of stay. The increased costs and length of stay could also be related to paracentesis complications such as bleeding or ascites leak.

Our study is subject to the limitations of administrative data, including potential misclassification of subjects and variables. Where possible, we used previously validated codes. In defining the study sample, we used codes for cirrhosis and its complications that have been shown to have good specificity.[15, 16] Thus our sample likely does reflect an at-risk group who should undergo paracentesis. In addition, coding for paracentesis had > 80% sensitivity in a Canadian study,[17] so our estimate of underutilization should be reliable. These data do not distinguish between diagnostic and therapeutic paracenteses, procedures with different indications and consequences. Our focus was diagnostic paracentesis, and the results may be biased since therapeutic procedures could not be excluded. In particular, therapeutic paracentesis is more likely to result in complications, which may contribute to increased cost and length of stay. Finally, some patients may have insignificant ascites seen on imaging only. Such patients may have been misclassified and incorrectly included in this study as needing paracentesis. However, such patients would seem uncommon since all had a primary or secondary diagnosis of ascites, implying clinically significant fluid.

Missing data may lead to unmeasured confounding and selection biases. The NIS lacks detail needed to assess liver disease severity, which impacts both the decision to perform paracentesis and mortality. One could argue that severely ill patients may not receive a paracentesis because of perceived risks, coagulopathy, or futility. However, patients who received a paracentesis were actually more likely to have sepsis or acute renal failure, both markers of illness severity. In addition, the benefit of paracentesis persisted after excluding deaths on the first hospital day. Kanwal et al. found that patients with worse liver disease are more likely to receive recommended ascites care.[11] Our findings may therefore underestimate the benefit of paracentesis. Finally, because of the retrospective observational design of this study, we can determine associations, but cannot conclude causality.

Despite these limitations, this study has strengths that make it an important contribution to quality of care in cirrhosis. The NIS is a population-based sample that allows for generalizability to all non-federal acute care hospitals in the US. Therefore, it can yield the best national estimate of paracentesis utilization compared to other sources. In addition, the large sample size allows for analyses of clinical outcomes accounting for multiple confounders while maintaining precision.

In conclusion, we found that patients in the US with cirrhosis and ascites hospitalized for ascites or encephalopathy often do not receive a paracentesis. These data highlight the large gap between current practice and the optimal care of patients with cirrhosis. We also found that the performance of paracentesis is associated with improved mortality. These results support recommendations that emphasize diagnostic paracentesis as a quality indicator for these patients. Future work is needed to identify barriers to diagnostic paracentesis at the patient, provider, and system levels, and to implement interventions to increase the appropriate use of this procedure to improve patient outcomes.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Abbreviations

CI	confidence interval
ICD-9-CM	International Classification of Diseases, Ninth Revision, Clinical Modification
NIS	Nationwide Inpatient Sample
OR	odds ratio
SBP	spontaneous bacterial peritonitis

References

1. Gines P, Quintero E, Arroyo V, et al. Compensated cirrhosis: natural history and prognostic factors. Hepatology. 1987; 7:122–8. [PubMed: 3804191]
2. D’Amico G, Garcia-Tsao G, Pagliaro L. Natural history and prognostic indicators of survival in cirrhosis: a systematic review of 118 studies. J Hepatol. 2006; 44:217–31. [PubMed: 16298014]
3. Tandon P, Garcia-Tsao G. Renal dysfunction is the most important independent predictor of mortality in cirrhotic patients with spontaneous bacterial peritonitis. Clin Gastroenterol Hepatol. 2011; 9:260–5. [PubMed: 21145427]
4. Planas R, Montoliu S, Balleste B, et al. Natural history of patients hospitalized for management of cirrhotic ascites. Clin Gastroenterol Hepatol. 2006; 4:1385–94. [PubMed: 17081806]
5. Rimola A, Garcia-Tsao G, Navasa M, et al. Diagnosis, treatment and prophylaxis of spontaneous bacterial peritonitis: a consensus document. International Ascites Club J Hepatol. 2000; 32:142–53.
6. De Gottardi A, Thevenot T, Spahr L, et al. Risk of complications after abdominal paracentesis in cirrhotic patients: a prospective study. Clin Gastroenterol Hepatol. 2009; 7:906–9. [PubMed: 19447197]
7. Wong CL, Holroyd-Leduc J, Thorpe KE, et al. Does this patient have bacterial peritonitis or portal hypertension? How do I perform a paracentesis and analyze the results? JAMA. 2008; 299:1166–78. [PubMed: 18334692]
8. Runyon BA. Management of adult patients with ascites due to cirrhosis: an update. Hepatology. 2009; 49:2087–107. [PubMed: 19475696]
9. EASL clinical practice guidelines on the management of ascites, spontaneous bacterial peritonitis, and hepatorenal syndrome in cirrhosis. J Hepatol. 2010; 53:397–417. [PubMed: 20633946]
10. Kanwal F, Kramer J, Asch SM, et al. An explicit quality indicator set for measurement of quality of care in patients with cirrhosis. Clin Gastroenterol Hepatol. 2010; 8:709–17. [PubMed: 20385251]
11. Kanwal F, Kramer JR, Buchanan P, et al. The quality of care provided to patients with cirrhosis and ascites in the department of veterans affairs. Gastroenterology. 2012; 143:70–7. [PubMed: 22465432]
12. Felisart J, Rimola A, Arroyo V, et al. Cefotaxime is more effective than is ampicillin-tobramycin in cirrhotics with severe infections. Hepatology. 1985; 5:457–62. [PubMed: 3888810]

13. Sort P, Navasa M, Arroyo V, et al. Effect of intravenous albumin on renal impairment and mortality in patients with cirrhosis and spontaneous bacterial peritonitis. N Engl J Med. 1999; 341:403–9. [PubMed: 10432325]
14. HCUP Nationwide Inpatient Sample (NIS). Healthcare Cost and Utilization Project. Rockville, MD: Agency for Healthcare Research and Quality; 2009.
15. Lo Re V 3rd, Lim JK, Goetz MB, et al. Validity of diagnostic codes and liver-related laboratory abnormalities to identify hepatic decompensation events in the Veterans Aging Cohort Study. Pharmacoepidemiol Drug Saf. 2011; 20:689–99. [PubMed: 21626605]
16. Kramer JR, Davila JA, Miller ED, et al. The validity of viral hepatitis and chronic liver disease diagnoses in Veterans Affairs administrative databases. Alimentary Pharmacology and Therapeutics. 2008; 27:274–82. [PubMed: 17996017]
17. Quan H, Parsons GA, Ghali WA. Validity of procedure codes in International Classification of Diseases, 9th revision, clinical modification administrative data. Med Care. 2004; 42:801–9. [PubMed: 15258482]
18. Elixhauser A, Steiner C, Harris DR, et al. Comorbidity measures for use with administrative data. Med Care. 1998; 36:8–27. [PubMed: 9431328]
19. Myers RP, Quan H, Hubbard JN, et al. Predicting in-hospital mortality in patients with cirrhosis: results differ across risk adjustment methods. Hepatology. 2009; 49:568–77. [PubMed: 19085957]
20. Waikar SS, Wald R, Chertow GM, et al. Validity of International Classification of Diseases, Ninth Revision, Clinical Modification Codes for Acute Renal Failure. J Am Soc Nephrol. 2006; 17:1688–94. [PubMed: 16641149]
21. Martin GS, Mannino DM, Eaton S, et al. The epidemiology of sepsis in the United States from 1979 through 2000. N Engl J Med. 2003; 348:1546–54. [PubMed: 12700374]
22. Wickstrom GC, Kolar MM, Keyserling TC, et al. Confidence of graduating internal medicine residents to perform ambulatory procedures. J Gen Intern Med. 2000; 15:361–5. [PubMed: 10886469]
23. Chavez-Tapia NC, Barrientos-Gutierrez T, Tellez-Avila FI, et al. Antibiotic prophylaxis for cirrhotic patients with upper gastrointestinal bleeding. Cochrane Database Syst Rev. 2010:CD002907. [PubMed: 20824832]

Table 1

Characteristics of Cirrhotic Patients Admitted with Ascites, According to the Receipt of a Paracentesis

	Paracentesis (n = 10,743)	No Paracentesis (n = 6,968)	*p*-value[a]
Age in years, mean (95% CI)	57.8 (57.2–58.5)	58.8 (58.1–59.5)	0.03
< 55, %	43.0	38.5	0.02
55–64, %	30.4	31.2	
≥ 65, %	26.6	30.3	
Male, %	64.2	62.9	0.44
Race/ethnicity			
White, %	66.2	67.0	0.40
Black, %	10.0	8.6	
Hispanic, %	17.2	18.8	
Other, %	6.6	5.6	
Weekend admission, %	22.0	24.3	0.10
Elective admission, %	7.1	6.4	0.52
Primary payer			
Medicare, %	38.5	43.0	0.06
Medicaid, %	24.1	21.5	
Private, %	23.8	24.0	
Self-pay, %	9.0	7.0	
Other, %	4.6	4.6	
Median zip code income			
1st quartile, %	27.7	31.6	0.03
2nd quartile, %	26.2	27.5	
3rd quartile, %	25.4	23.3	
4th quartile, %	20.6	17.6	
Elixhauser index, mean (95% CI)	3.6 (3.5–3.7)	3.6 (3.5–3.8)	0.43
Sepsis, %	8.7	5.7	0.002
Acute renal failure, %	29.1	21.3	<0.001
Hospital size			
Small, %	9.6	10.4	0.48
Medium, %	25.0	26.6	
Large, %	65.4	63.0	
Ownership/control			
Government, non-federal, %	16.5	16.6	0.12
Private, non-profit, %	69.5	65.9	
Private, investor-owned, %	14.0	17.5	
Hospital region			
Northeast, %	18.9	16.3	0.02
Midwest, %	19.4	17.9	
South, %	35.6	42.4	
West, %	26.2	23.5	

	Paracentesis (n = 10,743)	No Paracentesis (n = 6,968)	*p*-value[a]
Teaching hospital, %	52.7	43.5	<0.001
Rural (vs. urban) location, %	9.8	13.0	0.01

Abbreviations: CI, confidence interval.

[a]Student's t-test used to compare means; Pearson's χ^2 test used to compare proportions.

Table 2

Characteristics Associated with In-Hospital Mortality, Bivariate and Multivariate Analyses

	Mortality (%)	*p*-value[a]	Adjusted OR[b]	(95% CI)
Paracentesis				
Yes	6.5	0.03	0.55	(0.41–0.74)
No	8.5		Ref	
Age in years, mean (alive/died)	58.1/59.7	0.05		
< 55	7.0	0.39	Ref	
55–64	6.8		1.01	(0.70–1.45)
≥ 65	8.2		1.39	(0.89–2.19)
Sex				
Male	6.9	0.36	Ref	
Female	7.9		1.18	(0.84–1.66)
Race/ethnicity				
White	8.0	0.13	Ref	
Black	4.3		0.54	(0.28–1.04)
Hispanic	7.2		0.76	(0.50–1.15)
Other	5.4		0.62	(0.29–1.32)
Admission circumstances				
Weekday	7.3	0.93	Ref	
Weekend	7.3		0.97	(0.70–1.37)
Non-elective	7.4	0.25	Ref	
Elective	5.4		0.64	(0.33–1.23)
Primary payer				
Private	6.4	0.21	Ref	
Medicare	7.3		0.93	(0.61–1.41)
Medicaid	6.9		1.34	(0.83–2.15)
Self-pay	8.9		1.88	(0.97–3.63)
Other	11.2		2.65	(1.33–5.25)
Median zip code income				
1st quartile	7.4	0.64	Ref	
2nd quartile	8.0		1.01	(0.64–1.60)
3rd quartile	6.2		0.86	(0.53–1.42)
4th quartile	7.5		0.78	(0.47–1.30)
Elixhauser index (alive/died)	3.6/4.0	<0.001	1.10	(1.00–1.21)
Sepsis				
Yes	27.2	<0.001	5.94	(3.93–8.98)
No	5.7		Ref	
Acute renal failure				
Yes	16.4	<0.001	4.71	(3.37–6.57)
No	4.0		Ref	
Hospital size				

	Mortality (%)	*p*-value[a]	Adjusted OR[b]	(95% CI)
Small	7.0	0.62	Ref	
Medium	6.5		1.01	(0.56–1.82)
Large	7.6		1.12	(0.65–1.90)
Ownership/control				
Government, non-federal	8.2	0.45	Ref	
Private, non-profit	6.8		0.72	(0.44–1.18)
Private, investor-owned	8.0		0.95	(0.55–1.63)
Hospital region				
Northeast	7.3	0.04	Ref	
Midwest	4.6		0.51	(0.29–0.92)
South	7.8		0.64	(0.41–1.02)
West	8.5		0.79	(0.49–1.26)
Teaching status				
Non-teaching	7.3	0.87	Ref	
Teaching	7.2		0.91	(0.65–1.27)
Location				
Rural	6.8	0.72	Ref	
Urban	7.3		1.00	(0.55–1.81)

Abbreviations: OR, odds ratio; CI, confidence interval

[a]Student's t-test used to compare means; Pearson's χ^2 test used to compare proportions.

[b]Based on a logistic regression model adjusting for all variables in the table

Table 3

Characteristics of Cirrhotic Patients Who Received a Paracentesis, Early versus Delayed

	≤ 1 Day After Admission (n = 6,479)	> 1 Day After Admission (n = 3,340)	*p*-value[a]
Age in years, mean (95% CI)	57.2 (56.4–58.1)	58.9 (58.0–59.9)	0.005
< 55, %	44.1	40.6	0.04
55–64, %	31.1	29.0	
≥ 65, %	24.7	30.5	
Male, %	67.4	58.8	<0.001
Race/ethnicity			
White, %	66.3	64.9	0.48
Black, %	9.4	11.7	
Hispanic, %	18.0	17.2	
Other, %	6.3	6.2	
Weekend admission, %	19.4	28.7	<0.001
Elective admission, %	6.7	6.9	0.88
Primary payer			
Medicare, %	35.4	45.1	0.003
Medicaid, %	26.3	22.1	
Private, %	23.9	22.5	
Self-pay, %	9.9	7.5	
Other, %	4.5	2.8	
Median zip code income			
1st quartile, %	27.6	27.5	0.30
2nd quartile, %	25.0	28.1	
3rd quartile, %	26.6	22.8	
4th quartile, %	20.8	21.7	
Elixhauser index, mean (95% CI)	3.4 (3.3–3.5)	4.0 (3.8–4.1)	<0.001
Sepsis, %	8.2	9.4	0.36
Acute renal failure, %	26.2	35.1	<0.001
Hospital size			
Small, %	10.1	7.6	0.16
Medium, %	27.1	24.7	
Large, %	62.8	67.7	
Ownership/control			
Government, non-federal, %	18.3	12.2	0.016
Private, non-profit, %	66.6	73.8	
Private, investor-owned, %	15.0	14.1	
Hospital region			
Northeast, %	19.4	22.1	0.09
Midwest, %	14.7	17.9	
South, %	35.7	35.7	
West, %	30.2	24.3	

	≤ 1 Day After Admission (n = 6,479)	> 1 Day After Admission (n = 3,340)	*p*-value[a]
Teaching hospital, %	54.2	48.4	0.046
Rural (vs. urban) location, %	9.9	7.9	0.17

Abbreviations: CI, confidence interval.

[a]Student's t-test used to compare means; Pearson's χ^2 test used to compare proportions.

Table 4

Hospital Length of Stay and Charges, According to the Receipt of a Paracentesis, Bivariate and Multivariate Analyses

	Paracentesis	No Paracentesis	*p*-value	% Increase[a]	(95% CI)
Mean length of stay, days (95% CI)	6.6 (6.3–6.9)	5.3 (5.0–5.5)	< 0.001	14.1	(6.6–22.1)
Mean hospital charges, $ (95% CI)	44,586 (39,967–49,205)	31,746 (28,568–34,924)	< 0.001	28.7	(19.9–38.2)

Abbreviations: CI, confidence interval.

[a]Based on Poisson (for length of stay) and linear (for log charges) regression models adjusting for all covariates.