Paracentesis Is Associated With Reduced Mortality in Patients Hospitalized With Cirrhosis and Ascites

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BACKGROUND & AIMS: **Diagnostic paracentesis is recommended for patients with cirrhosis who are admitted to the hospital for ascites or encephalopathy. However, it is not known whether clinicians in the United States adhere to this recommendation; a relationship between paracentesis and clinical outcome has not been reported. We analyzed a U.S. 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 who were 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, 0.55; 95% confidence interval, 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 not significant after adjustment for confounders (odds ratio, 1.26; 95% confidence interval, 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 who 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.

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 who are 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 (eg, antibiotics and

Abbreviations used in this paper: 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.

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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 (on the basis of 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 who were 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 used data from the 2009 Nationwide Inpatient Sample (NIS), the largest all-payer database of hospital discharges in the United States, which totals 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 United States 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 $\geq$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 before 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 ($\leq$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 $\geq$65 years) in models because the relationship between age and paracentesis was nonlinear. In addition, 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) by using validated definitions.[20,21] We examined hospital factors including size (small, medium, or large), ownership/control (non-federal government, nonprofit private, or investor-owned private), U.S. 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 by using list-wise 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 (U.S. dollars).

Statistical Analysis

Categorical variables were compared with Pearson χ^2 test, and continuous variables were compared with Student t test. Factors associated with paracentesis performance were assessed by 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 by 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 by 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 (CIs). All P values were based on 2-sided tests and were considered statistically significant when $P < .05$. 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. Of these, 10,500 had a primary diagnosis of hepatic encephalopathy, 2977 had a primary diagnosis of ascites, and 4233 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 3262 patients with a primary diagnosis of SBP (77.1%; 95% CI, 74.0%–80.1%), compared with 7481 of those with a primary diagnosis of encephalopathy or ascites (55.5%; 95% CI, 53.3%–57.7%) (Supplementary Table 1). 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 white. 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 2 groups. In multivariate analysis, paracentesis was independently associated with self-pay (compared with 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%, $P = .03$). 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 1). 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 1).

Delayed Paracentesis

Among those who underwent a paracentesis, approximately 6479 (66.0%) underwent it $\leq$1 day after admission. Those who underwent 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, nonprofit 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,

Table 1. Characteristics of Cirrhotic Patients Admitted With Ascites, According to the Receipt of a Paracentesis

	Paracentesis (n = 10,743)	No paracentesis (n = 6968)	*P* value[a]
Age, mean (*y*) (95% CI)	57.8 (57.2–58.5)	58.8 (58.1–59.5)	.03
<55, %	43.0	38.5	.02
55–64, %	30.4	31.2	
≥65, %	26.6	30.3	
Male (%)	64.2	62.9	.44
Race/ethnicity (%)			
White	66.2	67.0	.40
Black	10.0	8.6	
Hispanic	17.2	18.8	
Other	6.6	5.6	
Weekend admission (%)	22.0	24.3	.10
Elective admission (%)	7.1	6.4	.52
Primary payer (%)			
Medicare	38.5	43.0	.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	.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)	.43
Sepsis (%)	8.7	5.7	.002
Acute renal failure (%)	29.1	21.3	<.001
Hospital size (%)			
Small	9.6	10.4	.48
Medium	25.0	26.6	
Large	65.4	63.0	
Ownership/control (%)			
Government, non-federal	16.5	16.6	.12
Private, nonprofit	69.5	65.9	
Private, investor-owned	14.0	17.5	
Hospital region (%)			
Northeast	18.9	16.3	.02
Midwest	19.4	17.9	
South	35.6	42.4	
West	26.2	23.5	
Teaching hospital (%)	52.7	43.5	<.001
Rural (vs urban) location (%)	9.8	13.0	.01

[a]Student *t* test used to compare means; Pearson χ^2 test used to compare proportions.

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 with 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 with 8.1% when paracentesis was delayed ($P = .049$). 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 underwent a paracentesis was 6.6 days compared with 5.3 days for those who did not undergo a paracentesis (Table 4, $P < .001$). After adjustment in the multivariate regression model, those who underwent a paracentesis had a 14% longer

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	.03	0.55	0.41–0.74
No	8.5		Reference	
Age, mean (*y*) (alive/died)	58.1/59.7	.05		
<55	7.0	.39	Reference	
55–64	6.8		1.01	0.70–1.45
≥65	8.2		1.39	0.89–2.19
Sex				
Male	6.9	.36	Reference	
Female	7.9		1.18	0.84–1.66
Race/ethnicity				
White	8.0	.13	Reference	
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	.93	Reference	
Weekend	7.3		0.97	0.70–1.37
Non-elective	7.4	.25	Reference	
Elective	5.4		0.64	0.33–1.23
Primary payer				
Private	6.4	.21	Reference	
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	.64	Reference	
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	<.001	1.10	1.00–1.21
Sepsis				
Yes	27.2	<.001	5.94	3.93–8.98
No	5.7		Reference	
Acute renal failure				
Yes	16.4	<.001	4.71	3.37–6.57
No	4.0		Reference	
Hospital size				
Small	7.0	.62	Reference	
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	.45	Reference	
Private, nonprofit	6.8		0.72	0.44–1.18
Private, investor-owned	8.0		0.95	0.55–1.63
Hospital region				
Northeast	7.3	.04	Reference	
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	.87	Reference	
Teaching	7.2		0.91	0.65–1.27
Location				
Rural	6.8	.72	Reference	
Urban	7.3		1.00	0.55–1.81

[a]Student *t* test used to compare means; Pearson 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 vs Delayed

	≤1 Day after admission (n = 6479)	>1 Day after admission (n = 3340)	*P* value[a]
Age, mean (*y*) (95% CI)	57.2 (56.4–58.1)	58.9 (58.0–59.9)	.005
<55, %	44.1	40.6	.04
55–64, %	31.1	29.0	
≥65, %	24.7	30.5	
Male (%)	67.4	58.8	<.001
Race/ethnicity (%)			
White	66.3	64.9	.48
Black	9.4	11.7	
Hispanic	18.0	17.2	
Other	6.3	6.2	
Weekend admission (%)	19.4	28.7	<.001
Elective admission (%)	6.7	6.9	.88
Primary payer (%)			
Medicare	35.4	45.1	.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	.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)	<.001
Sepsis (%)	8.2	9.4	.36
Acute renal failure (%)	26.2	35.1	<.001
Hospital size (%)			
Small	10.1	7.6	.16
Medium	27.1	24.7	
Large	62.8	67.7	
Ownership/control (%)			
Government, non-federal	18.3	12.2	.016
Private, nonprofit	66.6	73.8	
Private, investor-owned	15.0	14.1	
Hospital region (%)			
Northeast	19.4	22.1	.09
Midwest	14.7	17.9	
South	35.7	35.7	
West	30.2	24.3	
Teaching hospital (%)	54.2	48.4	.046
Rural (vs urban) location (%)	9.9	7.9	.17

[a]Student *t* test used to compare means; Pearson χ^2 test used to compare proportions.

length of stay. Likewise, hospital charges were greater for those who had a paracentesis ($44,586 versus $31,746, $P < .001$) 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 who were 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. Kanwal et al[11] demonstrated a reduction in 12-month mortality for patients who received optimum cirrhosis care, including paracentesis in hospitalized patients with ascites. 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 among 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

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)	<.001	14.1	(6.6–22.1)
Mean hospital charges, *$* (95% CI)	44,586 (39,967–49,205)	31,746 (28,568–34,924)	<.001	28.7	(19.9–38.2)

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

and under-recognition of SBP. Under-recognition of SBP may also explain the lower mortality for the subgroup with an SBP diagnosis compared with 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 underwent 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, because 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 with 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 before 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 underwent 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 because 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 because 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 details 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 undergo a paracentesis because of perceived risks, coagulopathy, or futility. However, patients who underwent 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[11] found that patients with worse liver disease are more likely to receive recommended ascites care. 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 United States. Therefore, it can yield the best national estimate of paracentesis utilization compared with 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 United States with cirrhosis and ascites who were hospitalized for ascites or encephalopathy often do not undergo 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

Note: To access the supplementary material accompanying this article, visit the online version of *Clinical Gastroenterology and Hepatology* at www.cghjournal.org, and at http://dx.doi.org/10.1016/j.cgh.2013.08.025.

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Conflicts of interest
The authors disclose no conflicts.

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Supplementary Table 1. Paracentesis and Mortality Sample Subgroups and Sensitivity Analyses

Sample[a]	Paracentesis (%)	Mortality (%)				
		Paracentesis	No paracentesis	*P* value[b]	Adjusted OR[c]	95% CI
Main study sample[d]	60.7	6.5	8.5	.03	0.55	0.41–0.74
Main sample subgroups						
Primary ascites or encephalopathy	55.5	6.8	9.1	.03	0.54	0.38–0.76
Primary SBP	77.1	5.8	4.7	.57	0.91	0.38–2.19
Alternative samples[e]						
Any ascites	50.9	7.4	9.5	<.001	0.66	0.60–0.73
Any SBP	71.8	12.8	16.8	.03	0.61	0.43–0.86
Any ascites and/or SBP	50.9	7.5	9.6	<.001	0.66	0.60–0.73

[a]All samples required that patients have a diagnosis of cirrhosis.
[b]Pearson χ^2 test used to compare proportions.
[c]Based on a logistic regression model adjusting for all covariates.
[d]The main study sample includes patients with a primary diagnosis of ascites or SBP or a secondary diagnosis of ascites with a primary diagnosis of encephalopathy.
[e]Samples based on listed diagnoses regardless of order.