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Identifying Quality Gaps in Preventive Care for Outpatients With Cirrhosis Within a Large, Academic Health Care System

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We sought to identify specific gaps in preventive care provided to outpatients with cirrhosis and to determine factors associated with high quality of care (QOC), to guide quality improvement efforts. Outpatients with cirrhosis who received care at a large, academic tertiary health care system in the United States were included. Twelve quality indicators (QIs), including preventive care processes for ascites, esophageal varices, hepatic encephalopathy, hepatocellular carcinoma (HCC), and general cirrhosis care, were measured. QI pass rates were calculated as the proportion of patients eligible for a QI who received that QI during the study period. We performed logistic regression to determine predictors of high QOC ($\geq 75\%$ of eligible QIs) and receipt of HCC surveillance. Of the 439 patients, the median age was 63 years, 59% were male, and 19% were Hispanic. The median Model for End-Stage Liver Disease–Sodium score was 11, 64% were compensated, and 32% had hepatitis C virus. QI pass rates varied by individual QIs, but were overall low. For example, 24% received appropriate HCC surveillance, 32% received an index endoscopy for varices screening, and 21% received secondary prophylaxis for spontaneous bacterial peritonitis. In multivariable analyses, Asian race (odds ratio [OR]: 3.7, 95% confidence interval [CI]: 1.3–10.2) was associated with higher QOC, and both Asian race (OR: 3.3, 95% CI: 1.2–9.0) and decompensated status (OR: 2.1, 95% CI: 1.1–4.2) were associated with receipt of HCC surveillance. A greater number of specialty care visits was not associated with higher QOC. **Conclusion:** Receipt of outpatient preventive cirrhosis QIs was variable and overall low in a diverse cohort of patients with cirrhosis. Variation in care by race/ethnicity and illness trajectory should prompt further inquiry into identifying modifiable factors to standardize care delivery and to improve QOC. (*Hepatology Communications* 2020;4:1802–1811).

Cirrhosis is a common condition associated with significant morbidity and mortality.^(1,2) It is the twelfth leading cause of death in the United States⁽³⁾ and carries a burden of disease that is projected to increase over the next decade due to a rising incidence of alcohol-associated liver disease and nonalcoholic steatohepatitis (NASH).^(4,5) Cirrhosis is also associated with significantly decreased quality

Abbreviations: aOR, adjusted odds ratio; CI, confidence interval; GI, gastroenterology; HCC, hepatocellular carcinoma; ICD-9, International Classification of Diseases, 9th revision; ICD-10, International Classification of Diseases, 10th revision; IQR, interquartile range; MELD-Na, Model for End-Stage Liver Disease–Sodium; NASH, nonalcoholic steatohepatitis; OR, odds ratio; QI, quality indicator; QOC, quality of care; SBP, spontaneous bacterial peritonitis; VA, Veterans Affairs.

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of life and high health care use.^(6,7) Compared to patients with congestive heart failure, patients with cirrhosis experience higher rates of hospitalizations, longer hospital stays, and more readmissions, resulting in substantial and increasing morbidity and economic burden.⁽⁸⁻¹⁰⁾

Clinical guidelines for managing and preventing complications of cirrhosis are well-established, and several process measures including hepatocellular carcinoma (HCC) surveillance and antibiotic prophylaxis for ascites have been linked to improved survival.⁽¹¹⁻¹³⁾ Unfortunately, adherence to many of these practices remains poor.⁽¹⁴⁻¹⁸⁾ Pooled data from national cohorts of patients with cirrhosis have shown that less than 20% receive appropriate HCC surveillance.^(19,20) In a retrospective study in the Veterans Affairs (VA) health care system, only 24% of patients with cirrhosis received an upper endoscopy within a year of diagnosis.⁽²¹⁾

Most prior quality improvement efforts in cirrhosis have focused more narrowly on improving only a few process measures in an effort to reduce health care use and improve patient-reported outcomes.⁽²²⁻²⁴⁾ However, to guide stakeholders into promoting and prioritizing quality improvement efforts within a health system for patients with cirrhosis, we must first more broadly evaluate and identify quality gaps. These data can then lay the groundwork for future studies, identifying barriers and facilitators to achieve higher rates of important process measures with the goal of developing interventions to improve cirrhosis quality of care (QOC).

In this study, we aimed to evaluate the receipt of evidence-based preventive quality indicators (QIs) provided to outpatients with cirrhosis in our health system, a high-volume, academic tertiary health care

system, and to determine factors associated with higher QOC.

Methods

COHORT IDENTIFICATION

We performed a retrospective chart review of adult patients with cirrhosis who were seen by an outpatient provider at least once at the University of California, Los Angeles (UCLA) Health System between January 1, 2013, and January 31, 2018. Patients were followed through January 31, 2019. Patients were first identified using International Classification of Diseases, 9th revision (ICD-9)^(25,26) and 10th revision (ICD-10)⁽²⁷⁾ codes for cirrhosis or its related complications (Supporting Table S1). Next, we excluded patients who did not meet at least one of the following criteria confirming a diagnosis of cirrhosis: (1) imaging consistent with cirrhosis within 5 years of their initial clinic visit; (2) liver biopsy demonstrating cirrhosis within 10 years of their initial clinic visit; or (3) a progress note from a provider indicating a diagnosis of cirrhosis. Finally, we excluded patients who did not have established care with an outpatient primary care provider in our health system and who received a liver transplant before 2013.

CHART ABSTRACTION

Data were abstracted by a team of clinician abstractors with experience using the electronic medical record and training from research personnel on how to use our data abstraction sheet. Before data abstraction, each abstractor completed 10 test cases. Near the end

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of data abstraction, one primary clinician abstractor reviewed a 10% random sample from each abstractor's data sample to assure accuracy of data. The study team discussed and resolved any discrepancies by consensus.

Patient Characteristics

We abstracted information for patient demographics (age, gender, race, ethnicity, marital status, primary language), etiology of cirrhosis, laboratory studies (serum sodium, creatinine, bilirubin, international normalized ratio), receipt of specialty care, and date of diagnosis. If patients were seen by a gastroenterologist or transplant hepatologist for one or more visits for more than 1 year before the date of the chart review, they were classified as having received continuity specialty care.

Quality Indicators

The quality of outpatient preventive care was measured using 12 specific QIs. These QIs were chosen from a larger set of QIs measuring care provided to patients with cirrhosis previously described in the literature.⁽²⁸⁾ These included four QIs focusing on general preventive care (immunized against hepatitis A, immunized against hepatitis B, alcohol counseling in patients with alcohol-associated cirrhosis, and driving counseling in patients with moderate hepatic encephalopathy), five varices-related QIs (screening in compensated cirrhosis, screening in decompensated cirrhosis, primary prophylaxis of small varices, primary prophylaxis of medium to large varices, and secondary prophylaxis of bleeding varices), two ascites-related QIs (spontaneous bacterial peritonitis [SBP] prophylaxis in patients with a documented history of SBP and SBP prophylaxis in patients with ascites total protein < 1.1 g/dL and serum total bilirubin > 2.5 mg/dL), and one HCC surveillance QI (HCC surveillance in those without a history of HCC). Given that the quality of evidence varied by individual QI, we only included indicators that were graded as class I or IIa by the GRADE method.⁽²⁹⁾

STATISTICAL ANALYSIS

Estimating Rates of QI Adherence

For each subject, we determined eligibility for each QI (included in the denominator for each QI).

We then determined the receipt of recommended care within the specified time frame. QI pass rates were calculated by dividing the number of patients who passed the QIs by the number of patients eligible for that QI. Patients were censored at date of death or transplantation, or date of HCC diagnosis for the HCC surveillance quality measure. For HCC surveillance, patients were considered to have achieved the quality measure if they received an abdominal imaging test (ultrasound, contrast-enhanced computed tomography, or magnetic resonance imaging, regardless of indication) every 6 months over their entire follow-up period (with a 1-month grace period to allow for scheduling delays). Serum alpha-fetoprotein was not included in this indicator. Patients were only eligible for the HCC surveillance quality measure if they were alive for at least 6 months following the cirrhosis diagnosis.

Predictors of Higher QOC

We defined high QOC as having received $\geq 75\%$ of all QIs for which a given patient was eligible. For each patient, we determined whether high QOC was achieved across all QIs and for the HCC surveillance domain alone. We used multivariable logistic regression to determine patient factors associated with receipt of higher QOC. Given that the number of eligible QIs may itself reflect the severity of illness (i.e., patients eligible for more QIs were likely sicker than those eligible for fewer QIs), we also performed a sensitivity analysis that included the number of eligible QIs in our multivariable analysis. Finally, we performed a secondary analysis to explore factors associated with HCC surveillance, given that receipt of HCC surveillance has been associated with a reduction in mortality.⁽¹²⁾ Variables with a *P* value of less than 0.1 in univariate analysis or considered to be clinically relevant were included in multivariate models. We reported our results as odds ratios (ORs) with 95% confidence intervals (CIs), in which ORs are the odds of receiving a recommended QI for which a patient was eligible. We considered *P* < 0.05 as statistically significant. We used SAS (version 9.4) for all statistical analyses (SAS Institute, Cary, NC).

Results

DEMOGRAPHICS AND CLINICAL CHARACTERISTICS

There were 439 patients who met the inclusion criteria and were eligible for at least one outpatient preventive care QI. Table 1 provides the baseline characteristics of the cohort. Median age was 63 years (interquartile range [IQR] 56-71), 59% were male, and 54% were non-Hispanic white. Hepatitis C virus was the most common (32%) primary etiology of cirrhosis, followed by alcohol (25%). Most of the patients (64%) were compensated at their index visit, and the baseline median Model for End-Stage Liver Disease–Sodium (MELD–Na) score was 11 (IQR 8-15). Most patients received continuity specialty care by an outpatient gastroenterology or transplant hepatology provider (93%). The median follow-up time was 29 months (IQR 15-42). Of the total cohort, 72 (16%) died during follow-up, with a median time to death of 20 months (IQR 12-30), and 27 (6%) were transplanted with a median time to transplant of 14 months (IQR 7-23).

QI PASS RATES

Table 2 provides the final list of the 12 QIs measured with their corresponding domains, definitions, and units of measurement. Table 3 lists the numerator and denominator for each QI, during which an indicated process was required to occur. A patient who was eligible for a QI received a score of 1 if the recommended process measure was received; otherwise, he or she received a score of 0. QI pass rates varied significantly both within and across domains. The QI with the lowest pass rate was the percentage of patients with received appropriate secondary prophylaxis for variceal bleeding, with only a 2% pass rate. The QI with the highest pass rate was the percentage of patients with alcohol-associated cirrhosis who were counseled to abstain from alcohol consumption, with an 83% pass rate. Regarding variceal care, only 32% of patients with compensated cirrhosis received a screening upper endoscopy during the first year after the cirrhosis diagnosis. However, 61% of patients with decompensated cirrhosis without a prior gastrointestinal bleed had an upper endoscopy within 3 months of diagnosis. Rates of ascites preventive care uptake

TABLE 1. SOCIODEMOGRAPHIC AND CLINICAL CHARACTERISTICS OF THE TOTAL COHORT (n = 439)

	Total (Median, IQR or n, %)
Age in years	63 (56-71)
Gender	
Male	261 (59)
Female	178 (41)
Race	
Non-Hispanic white	239 (54)
Hispanic	83 (19)
Non-Hispanic black	22 (5)
Non-Hispanic Asian	49 (11)
Other	24 (5)
Unknown	22 (5)
Marital status	
Married	241 (55)
Not married	177 (40)
Unknown	21 (5)
Primary language	
English	374 (85)
Non-English	65 (15)
Etiology of cirrhosis	
Hepatitis C	142 (32)
Alcohol	109 (25)
NASH	102 (23)
Others	86 (20)
Illness severity at index visit	
Compensated	280 (64)
Decompensated	155 (35)
Unknown	4 (1)
Baseline MELD–Na score	11 (8-15)
Continuity care by a GI/hepatology provider	408 (93)
Average number of gastroenterology/hepatology visits per year	2.6 (1.3-5)

Abbreviations: GI, gastroenterology; MELD, Model for End Stage Liver Disease; NASH, nonalcoholic steatohepatitis.

were low, with only 21% of patients with documented SBP and 9% of patients with ascitic fluid total protein < 1.1 g/dL and serum total bilirubin > 2.5 mg/dL receiving long-term antibiotics. Overall, only 11 (3%) of 439 patients achieved all of the QIs for which they were eligible, and 61 (14%) achieved greater than 75% of eligible QIs (Table 3).

PREDICTORS OF QOC

In adjusted regression analyses, non-Hispanic Asian race was associated with high-quality care: adjusted

TABLE 2. CIRRHOSIS QIS MEASURED, INCLUDING DEFINITION OF HOW MEASUREMENTS WERE TAKEN

Cirrhosis QI	Domain Measured	Definition	Unit of Measurement
1. Patients with cirrhosis should receive hepatitis A vaccinations	General preventive care	Patients who had documented receipt or were recommended to receive the vaccination, or were immunized against hepatitis A	Patient
2. Patients with cirrhosis should receive hepatitis B vaccinations	General preventive care	Patients who had documented receipt or were recommended to receive the vaccination, or were immunized against hepatitis B	Patient
3. Patients with alcohol-associated cirrhosis should be counseled to abstain from alcohol consumption	General preventive care	Patients with alcohol listed as the primary or secondary etiology of cirrhosis who received counseling to abstain from alcohol use; documented in their medical record	Patient
4. Patients with moderate hepatic encephalopathy should be counseled to avoid driving	General preventive care	Patients with hepatic encephalopathy who received counseling to avoid driving; documented in their medical record	Patient
5. Patients with cirrhosis without a prior diagnosis of HCC should receive imaging every 6 months	HCC surveillance	Patients who received serial abdominal imaging (liver ultrasound, contrast-enhanced CT/MRI) at least every 7 months from the time of cirrhosis diagnosis	Patient
6. Patients with compensated cirrhosis should be screened for varices with an EGD within 12 months of their initial clinic visit or cirrhosis diagnosis	Variceal bleeding	Patients with at least one upper endoscopy within 12 months of their initial clinic visit or cirrhosis diagnosis	Patient
7. Patients with decompensated cirrhosis should be screened for varices with an EGD within 3 months of their initial clinic visit or cirrhosis diagnosis	Variceal bleeding	Patients with at least one upper endoscopy within 3 months of their initial clinic visit or cirrhosis diagnosis	Patient
8. Patients with decompensated cirrhosis and small varices on EGD who are not on NSBBs should have a repeat EGD within 1 year	Variceal bleeding	Patients without a NSBB on their medication list with small varices on endoscopy who receive at least one additional upper endoscopy within 12 months of the endoscopy showing small varices	Endoscopy
9. Patients with cirrhosis and medium/large varices on EGD should receive NSBBs or variceal ligation within 1 month of varices diagnosis	Variceal bleeding	Patients with medium/large varices on endoscopy who receive at least one additional upper endoscopy or have a documented clinic visit with a beta-blocker listed on their medication list within 1 month of the endoscopy showing medium/large varices	Endoscopy
10. Patients with cirrhosis and variceal bleeding should receive variceal ligation every 4 weeks until obliteration, beta-blockers, or a combination of variceal ligation and beta-blockers for secondary prevention	Variceal bleeding	Patients with variceal bleeding on endoscopy who receive serial endoscopies within 4 weeks of the prior endoscopy requiring banding until there are no varices seen on endoscopy and/or have a documented clinic visit with a beta-blocker listed on their medication list within 1 month of variceal bleeding	Endoscopy
11. Patients with cirrhosis and SBP should receive long-term outpatient antibiotics	Ascites	Patients with a history of SBP documented in their medical record who also have an antibiotic with gram-negative coverage (such as ciprofloxacin, norfloxacin, bactrim) listed on their medication list	Patient
12. Patients with cirrhosis, history of ascites, and ascitic fluid total protein < 1.1 g/dL and serum total bilirubin > 2.5 mg/dL should receive long-term outpatient antibiotics	Ascites	Patients with ascitic fluid studies at any time in their medical record showing ascites total protein < 1.1 g/dL and serum total bilirubin > 2.5 mg/dL who also have an antibiotic with gram-negative coverage (such as ciprofloxacin, norfloxacin, bactrim) listed on their medication list	Patient

Abbreviations: CT, computed tomography; EGD, esophagogastroduodenoscopy; MRI, magnetic resonance imaging; NSBB, nonselective beta-blocker.

odds ratio (aOR): 3.69 (95% CI: 1.34-10.15) (Table 4). Age, gender, etiology of cirrhosis, MELD-Na score, severity of illness (compensated/decompensated), and number of specialty visits per year were not significantly associated with high-quality care. Similarly,

having been referred for liver transplant evaluation was not associated with high-quality care in either unadjusted or adjusted analyses. In a sensitivity analysis that included the number of eligible QIs, our multivariable analysis results were similar (Supporting Table S2).

TABLE 3. ADHERENCE RATES FOR QIS, DEFINED AS PERCENTAGE OF PATIENTS WITH CIRRHOSIS WHO RECEIVED THE CARE INDICATED BY EACH INDICATOR (NUMERATOR) AMONG THOSE WHO WERE ELIGIBLE FOR THE INDICATOR (DENOMINATOR)

Quality Indicators	Rate of Adherence	Eligible for QI (n)
General preventive care		
Among the patients with cirrhosis, the percentage who received hepatitis A vaccinations, were recommended to receive the vaccination, or had immunity in the chart	51%	439
Among the patients with cirrhosis, the percentage who received hepatitis B vaccinations, were recommended to receive the vaccination, or had immunity in the chart	54%	416
Among the patients with alcohol-associated cirrhosis, the percentage who were counseled to abstain from alcohol consumption	83%	136
Among the patients with moderate hepatic encephalopathy, the percentage who have received counseling for avoidance of driving	5%	130
Among patients eligible for HCC surveillance, the percentage who received screening with imaging every 6 months (with a 1-month buffer)	24%	393
Primary and secondary prevention of variceal bleeding		
Among the patients with compensated cirrhosis at their initial GI/hepatology visit, the percentage who have been screened for varices with an EGD within 12 months of their initial GI/hepatology visit or date of cirrhosis diagnosis	32%	280
Among the patients with decompensated cirrhosis at their initial GI/hepatology visit, the percentage who have been screened for varices with an EGD within 3 months of their initial GI/hepatology visit or date of cirrhosis diagnosis	61%	155
Among the patients with decompensated cirrhosis who have small varices on EGD and are not on NSBBs, the percentage who have a repeat within 1 year	45%	75
Among patients with cirrhosis and medium/large varices on endoscopy, the percentage who received either NSBBs or variceal ligation within 1 month of varices diagnosis	75%	91
Among patients with cirrhosis and variceal bleeding, the percentage who had variceal ligation performed every 4 weeks until obliteration, beta-blockers, or a combination of variceal ligation and beta-blockers for secondary prevention	2%	45
SBP prophylaxis		
Among patients with cirrhosis and documented SBP, the percentage who were on long-term outpatient antibiotics	21%	28
Among patients with cirrhosis, history of ascites, and ascitic fluid total protein <1.1 gm/dL and serum total bilirubin >2.5 mg/dL, the percentage who were on long-term outpatient antibiotics	9%	77

Abbreviations: EGD, esophagogastroduodenoscopy; HCC, hepatocellular carcinoma; NSBB, nonselective beta-blocker; SBP, spontaneous bacterial peritonitis.

TABLE 4. RESULTS FROM UNIVARIABLE AND MULTIVARIABLE* REGRESSION ANALYSES TO DETERMINE FACTORS ASSOCIATED WITH HIGH-VALUE CARE (DEFINED AS MEETING \geq 75% OF ALL ELIGIBLE QIS)

Variable	Unadjusted OR	95% CI	aOR	95% CI
Age in years (reference > 60 years)	0.99	0.97-1.02	0.97	0.94-1.00
Female (vs. male)	1.11	0.64-1.91	1.12	0.54-2.32
Race (reference non-Hispanic white)				
Hispanic versus non-Hispanic white	1.52	0.74-3.12	1.53	0.61-3.83
Non-Hispanic Asian versus non-Hispanic white	2.96	1.39-6.29	3.69	1.34-10.15
Other versus non-Hispanic white	1.00	0.36-2.75	1.15	0.36-3.73
Married (vs. not married)	1.42	0.80-2.55		
Etiology of cirrhosis				
Hepatitis C (reference: alcoholic liver disease)	0.96	0.46-1.97		
NASH (reference: alcoholic liver disease)	1.08	0.50-2.32		
Non-English (reference: English)	2.14	1.11-4.12	1.44	0.59-3.54
Initial MELD-Na score (per point increase)	0.96	0.91-1.02		
Current MELD-Na score (per point increase)	0.96	0.92-1.00	0.98	0.93-1.04
Baseline decompensated (vs. compensated)	0.47	0.24-0.89	0.49	0.22-1.10
Outpatient GI/hepatology visits per year (per visit increase)	1.00	0.96-1.05	0.95	0.89-1.02
Referred for liver transplant evaluation	0.69	0.34-1.42	0.70	0.27-1.80

*Multivariable regression included the following variables: age, gender, race, current MELD-Na score, compensated status, number of outpatient GI/hepatology visits, and referral for liver transplantation.

PREDICTORS OF RECEIVING SURVEILLANCE FOR HCC

When evaluating factors associated with receipt of surveillance for HCC, we found that decompensated status was associated with a 2.14 higher odds of having received appropriate surveillance (aOR = 2.14; 95% CI: 1.09-4.17) (Table 5). Non-Hispanic Asian race was also associated with 3.28 greater odds of receiving HCC surveillance compared with non-Hispanic whites (aOR = 3.28; 95% CI: 1.20-8.96). Age, gender, MELD-Na score, number of specialty visits, and liver transplant candidacy were not associated with receiving HCC surveillance.

Discussion

In this retrospective cohort study measuring the QOC provided to an ethnically diverse cohort of outpatients at a high-volume tertiary center, we found both low uptake as well as wide variation in the receipt of several QIs. In our sample, only 2% of patients received appropriate secondary prophylaxis for variceal bleeding, yet 83% of patients with alcohol-associated cirrhosis received counseling to abstain from alcohol consumption. Despite 93% of patients in our sample receiving care by a gastroenterologist or hepatologist, there was suboptimal adherence for several QIs, including SBP prophylaxis, primary and secondary prevention of variceal bleeding, and surveillance for HCC. Finally, we found few patient-level factors associated with higher QOC.

Low receipt of QIs in our study mirrored the results from investigations that have measured individual QIs in the literature. Results from population-based cohorts and meta-analyses of single center studies have demonstrated low rates of HCC surveillance in patients with cirrhosis.^(30,31) One study found that patients were up to date with surveillance 23% of the time⁽³⁰⁾; another showed a 52% overall adherence rate to appropriate surveillance guidelines.⁽³¹⁾ In our study, only 24% of patients with cirrhosis received appropriate surveillance. Data from the VA have also reported major gaps in adherence to recommendations for ascites-related care, as well as varices screening and prophylaxis. In a cohort of 774 veterans with cirrhosis and ascites, only 30% of patients received recommended antibiotics for secondary prophylaxis after having a prior documented episode of SBP.⁽³²⁾ This is in line with our data, in which only 21% of patients with a documented episode of SBP received long-term outpatient antibiotics for secondary prophylaxis. Similarly, initial screening rates for varices in patients with a new diagnosis of compensated cirrhosis remained low at 32% in our cohort, paralleling a VA cohort in which 24% of patients received an upper endoscopy within a year of their cirrhosis diagnosis.⁽²¹⁾ QI adherence for secondary prevention of variceal bleeding was even lower; notably, among patients who had prior variceal bleeding, only 2% had variceal band ligation performed every 4 weeks until obliteration, a beta-blocker initiated within 4 weeks of bleeding, or a combination of the two.

Although more data is needed regarding the patient-level and provider-level factors associated with

TABLE 5. RESULTS OF MULTIVARIABLE* REGRESSION ANALYSIS SHOWING THE FACTORS ASSOCIATED WITH RECEIVING HCC SURVEILLANCE

Variable	Unadjusted OR	95% CI	aOR	95% CI
Age in years (reference > 60 years)	1.01	0.99-1.03	1.00	0.97-1.02
Female (vs. male)	1.59	1.00-2.52	1.69	0.89-3.23
Race (reference non-Hispanic white)				
Hispanic versus non-Hispanic white	1.28	0.69-2.36	1.00	0.44-2.29
Non-Hispanic Asian versus non-Hispanic white	2.63	1.30-5.29	3.28	1.20-8.96
Other versus non-Hispanic white	1.40	0.65-2.99	1.26	0.47-3.37
Current MELD-Na score (per point increase)	1.07	1.04-1.11	1.07	1.02-1.12
Baseline decompensated (vs. compensated)	2.27	1.41-3.64	2.14	1.09-4.17
Outpatient GI/hepatology visits per year (per visit increase)	1.00	0.97-1.04	0.98	0.94-1.03
Referred for liver transplant evaluation	2.64	1.53-4.56	1.09	0.48-2.46

*Multivariable regression included the following variables: age, gender, race, current MELD-Na score, compensated status, number of outpatient GI/hepatology visits, and referral for liver transplantation.

lower QOC, one possible explanation for the consistently low adherence to cirrhosis QIs is that general cirrhosis quality measures are not tied to Medicare reimbursement or to most hospitals' compensation or incentive programs, unlike those for heart failure or hepatitis C virus screening and treatment. Our data add to a growing body of evidence showing that major gaps in QOC exist across a variety of different practice settings. To bridge these gaps, we recommend that the liver community not only explore the root causes of these variabilities in QI adherence in order to design meaningful interventions, but also use the electronic health record to track changes in quality measures.

Next, we were interested in identifying patient-level and provider-level factors that may be associated with higher value care. We found few variables that were associated with high QOC, which may be due to underpowering, as many individual quality measures had a small number of eligible patients. Interestingly, we found that receiving more visits with specialists within our health system was *not* associated with higher quality, which diverges from other studies showing greater adherence rates for HCC surveillance, ascites care, and varices surveillance with access to specialty care.^(19,21,32) One possible explanation for this difference is that our study may not have been powered to show an association, as only 8% of patients ($n = 35$) were not seen by a specialist. We did find that non-Hispanic Asian race was associated with higher rates of HCC surveillance as well as higher value care overall, compared with non-Hispanic white patients. The explanation for this association is not entirely clear, although one possible reason is that a greater proportion of these patients had chronic hepatitis B (31% vs. 2% in non-Hispanic whites in our cohort), which has been associated with higher rates of surveillance in prior studies.⁽³³⁾ Future studies are needed to examine the potential interaction between race and other factors, such as cirrhosis etiology, in impacting QOC. Decompensated cirrhosis was also associated with higher HCC surveillance rates, with a 2.1 greater odds of receiving appropriate and timely abdominal imaging even after controlling for the number of specialty visits and referral for liver transplant evaluation. This is in contrast to a prior study showing that the presence of comorbid conditions was associated with lower likelihood of receiving routine HCC surveillance.⁽¹⁹⁾ One potential explanation for our finding is that sicker, decompensated patients may receive

more intensive outpatient or inpatient care due to the inherent complexity of their illness.

The information from this study will be presented to key stakeholders (including clinicians, staff, quality officers, and patients) within our health system, to determine the process measures to prioritize in future quality improvement efforts. After achieving consensus regarding the QI measures to target initially, potentially with modified Delphi methods,⁽³⁴⁾ our next goal will be to identify specific barriers and facilitators to each process of care before developing and testing interventions. We believe that similar gap analyses performed by health systems will be helpful to create interventions and can positively and sustainably affect health outcomes in patients with cirrhosis at a population level.⁽³⁵⁾ Recently, more updated guidelines on cirrhosis quality measures were established by the Practice Metrics Committee of the American Association for the Study of Liver Diseases.⁽³⁶⁾ The main differences between the new guidelines and prior established guidelines⁽²⁸⁾ are the use of more updated recommendations for cirrhosis management as well as the inclusion of outcome measures, including both clinical and patient-reported, as new quality metrics. Although these new guidelines were not relevant to our cohort, which received care *before* these new quality measures were published, it is important that future quality improvement studies use these updated recommendations. Furthermore, longitudinal studies are needed to evaluate the impact of patient nonadherence on QOC.

We acknowledge a few limitations to our study. First, we could not account for care that was provided outside of our health system. However, we mitigated this problem by only including patients who were receiving their primary care at UCLA and by including all outside information that was available within the electronic health record. We also acknowledge that we may have missed patients who carried a diagnosis of cirrhosis by using the ICD coding system; however, the ICD-9 and ICD-10 systems have been previously well-validated as accurately identifying cirrhosis and cirrhosis-related complications and have formed the basis for many clinical, epidemiologic, and health services research studies. Next, lower QOC scores may reflect patient preference, which should be factored in how these results are interpreted. We hope that future studies exploring barriers and facilitators to specific practices will help elucidate this further. We also could

not account for the potential lack of documentation, which may have led to underestimation of QI rates. For example, providers may have provided verbal counseling for driving to patients with hepatic encephalopathy, but this may not have been documented in the electronic medical record. However, only a few process measures are susceptible to underdocumentation, as many others are easily captured by objective laboratory or imaging data. Additionally, we chose 75% or more QIs achieved to define higher QOC, although we acknowledge that this is not a standard, defined endpoint. However, we also explored other cutoffs, including receipt of 50% or more QIs and of 75% or more of class I QIs and found similar patterns in multivariable regression analyses. Next, time of follow-up was variable within our cohort, although most of the QIs we evaluated were not time-dependent measures. Finally, our study took place at a single, tertiary care center, where most patients were seen by a specialist; thus, our findings may be less generalizable to other centers or the larger populations of U.S. patients with cirrhosis, many of whom are managed by primary care providers.

There were several strengths of our study. First, our cohort consists of an ethnically diverse population of patients with cirrhosis that is representative of people living with chronic liver disease across the United States. Second, we used previously validated definitions of cirrhosis in our inclusion criteria and additionally performed manual chart review to confirm a cirrhosis diagnosis. Our data also had the granularity and detail necessary to examine a range of patient-level variables that might affect adherence to QIs, allowing us to identify variations in care by race/ethnicity and illness trajectory. Finally, our study examined a wide range of preventive QIs using a population of non-VA patients receiving care at a large academic health system with excellent access to specialty care services. Ultimately, this study provides data on adherence rates to cirrhosis quality measures in a practice setting, and lays the groundwork for future studies examining more detailed patient, provider, and system-level factors that might inform interventions and impact QOC in this complex patient population.

In conclusion, we examined the quality of outpatient preventive care in a large, ethnically diverse cohort of outpatients with cirrhosis at a high-volume tertiary liver transplant center. Receipt of evidence-based QIs was variable and overall low. These findings

suggest that larger system redesign efforts are needed to improve the QOC, beyond just improving access to specialty providers. We believe that our approach to broadly examine gaps to high-quality care is crucial for organizing an approach on how to lead quality improvement efforts that can be replicated by any health system. Future studies are needed to identify modifiable factors to develop appropriate, targeted interventions that standardize care delivery, reduce practice variability, and improve the QOC among patients with cirrhosis.

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Supporting Information

Additional Supporting Information may be found at onlinelibrary.wiley.com/doi/10.1002/hep4.1594/supinfo.