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Quality of Care, Cirrhosis, Process-based Measurement, Clinical Outcome

RESEARCH ARTICLE

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Relationship between Quality Practice Metrics and Treatment Outcomes in Hospitalized Cirrhotic Patients

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Abstract

Background/Aims: Variations in cirrhosis management practices and care quality affect patient prognoses and outcomes. We aimed to evaluate the number of successful cirrhosis care processes and the relationship between the quality statement implementation and clinical outcomes in patients with cirrhosis. **Methods:** This retrospective cohort study included hospitalized patients with cirrhosis. Eighteen process-based methods were independently assessed. Measurement indices for each participant were selected per cirrhosis severity. Service quality was determined using standard settings for each process-based gap scale. The optimal care group comprised participants who adhered to all instruction quality indices. Kaplan-Meier survival analysis assessed the 90-day readmission and mortality rates relating to the optimal quality care. **Results:** Of the 205 patients (73.2% male; mean age, 62.7±11.8 years), the median Model for End-stage Liver Disease score was 15.35 (9.37–21.37), and the majority were Child–Pugh B/C. Previously set performance gaps were observed for 13/18 quality processes, and 5/13 clinical processes attained the final goal. Paracentesis in ascites patients, antibiotic administration within 12 hours of spontaneous bacterial peritonitis diagnosis, and precipitating factors identification with lactulose therapy were the top three quality index (QI) accomplishments. Out of 205 patients, 84 attained optimal care. Concerning optimal care, although the readmission rate remained same, patients with decompensated Child-Pugh C who received excellent complete QI care had significantly increased both 1-month (100% vs. 43.5%; p=0.022) and 3-month (100% vs. 26.1%; p=0.022) survival in comparison to those receiving incomplete QI care. **Conclusion:** Using quality metrics for the appropriate stage of individual cirrhosis treatment is advocated as best practice. Adherence to standard practices improves clinical outcomes.

Keywords: Quality of care- Cirrhosis- Process-based measurement- Clinical outcome

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Introduction

Cirrhosis, the final stage of liver disease, leads to a variety of liver-related problems [1] and has a high mortality rate, particularly among hospitalized patients. International clinical guidelines have proposed several good evidence-based practices for the care of patients with cirrhosis [2-5]; disease outcomes are affected by physicians' and patients' adherence to these guidelines. Previous studies addressing measuring the quality of care in cirrhosis-related problems used a quality index (QI) based on instructions regarding liver-related complications, dietary lifestyle, and hepatocellular carcinoma surviellance [6].The QI was used to quantify the quality of treatment provided to patients with cirrhosis; however, only a minority of patients attained all quality indicators corresponding to disease severity [7, 8]. Regarding the standard of care, information on whether metric measurement influences the overall disease prognosis is limited, and currently, there is no evidence of high care quality being correlated with disease severity and prognosis. Our study aimed to assess the quality of treatment provided to hospitalized patients with varying degrees of liver cirrhosis and track adherence to all QI measures and liver-related outcomes, including hospital readmission.

Materials and Methods

Study design

This retrospective cohort study included hospitalized patients with cirrhosis aged >18 years between September 2021 and June 2022 at a tertiary center. The International Classification of Diseases, 10th edition, Clinical Modification code K74.6, was used to index the hospital database. The existence of liver nodularity detected using ultrasonography or liver stiffness >13 kPa was used to diagnose cirrhosis, as indicated in the medical records. Patients with cirrhosis-related complications were also enrolled in this study. Data regarding patient characteristics, cirrhosis etiology, disease severity, presence of cirrhosis-related sequelae, and laboratory

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values were collected. The 90-day mortality rate was used as a surrogate for survival rates. Patients who were not diagnosed with cirrhosis at preadmission or those who were admitted with other emergency non-liver-related conditions were excluded.

Process and outcome measure

All patients were assessed since their initial admission. As each patient was admitted several times, only their initial admissions were included in the analysis. We registered significant QIs in accordance with global standard guidelines [2-5]. All best practices for cirrhosis care were categorized into 18 QIs from 7 clinical domains separated by etiology treatment (2 indices), cirrhosis-associated complication (ascites [3 indices], spontaneous bacterial peritonitis [3 indices], esophageal varices [5 indices], hepatic encephalopathy [2 indices]), a therapy panel of acute kidney injury (2 indices), and hepatocellular carcinoma (HCC) screening (1 index). The validation of the quality measures for cirrhosis was based on previously published sets of process measures [6, 7]. The number of quality measurements for an individual was determined by the severity of the disease and any associated comorbidities. For each admission, according to each QI, the fraction of patients receiving quality care was evaluated with the number of patients who received quality care appropriate for their disease stage as the numerator and the total number of indicated participants in each specific QI care as the denominator. The fraction was multiplied by 100 to determine the percentage of patients who attained the QI. Optimal care was defined as the completion of all the required individual QIs for each patient. Kanwal et al. [6] analyzed the specifics of each quality care statement by evaluating the difference between actual practice performance in the real world and the desired performance using the "performance gap" for each QI evaluated based on a modified Delphi method [6]. The QI with the largest estimate corresponded to a 9-point difference, whereas the QI with the smallest estimate corresponded to a 1-point difference. We determined that a performance gap of 1–3 points required a "goal" of 100 percent of participants receiving treatment followed by specified QI, while a gap of 4–6 points required a "goal" of 80 percent, and a gap of 7–9 points, which was challenging to achieve, required a "goal" of 50 percent.

Statistical analysis

To achieve sufficient statistical power to identify the proportion of patients with cirrhosis who attained the maximum score on the QI, the minimum sample size was evaluated using the formula by Ghaoui et al. [8] the estimated sample size was 163. To account for the recalculated extra 20%, our study required 205 participants. Categorical variables are presented as frequencies and percentages, and continuous variables are presented as means and standard deviations or medians and interquartile ranges, as appropriate. The Clopper–Pearson method was used to calculate the QI's 95% confidence interval (CI). The chi-squared test was performed to determine whether there was a significant difference in categorical variables between "complete" and "incomplete" care. The survival function was calculated using the Kaplan–Meier method.

Ethical approval

The study protocol adhered to the ethical criteria of the 1975 Declaration of Helsinki and was approved by the Institutional Review Board of the Faculty of Medicine, Vajira Hospital (COA 033/2565). The Institutional Review Board of the Faculty of Medicine, Vajira Hospital, waived the need for informed consent due to the study's retrospective nature.

Results

A total of 205 hospitalized patients with cirrhosis were included in this study. The mean age of patients was 62.7±11.8 years, and the majority (73.2%) were men. The most prevalent causes of cirrhosis were chronic viral hepatitis (46.3%), alcoholic liver disease (30.2%), and nonalcoholic fatty liver disease (11%). The median Model for End-Stage Liver Disease (MELD) score was 15.35. (9.3–21.4). The proportions of Child-Pugh (CP) A, B, and C patients were 44.1%, 42.2%, and 13.7%, respectively. The median levels of bilirubin, alanine aminotransferase, and alpha-fetoprotein were 1.71 (0.9–3.6) mg/dL, 42.5 (21–111) U/L, and 5.02 (2.88–58) ng/mL, respectively. At the time of admission, end-stage complications, such as ascites (24.4%), acute kidney injury (AKI) (11.2%), spontaneous bacterial peritonitis (SBP) (7.3%), variceal hemorrhage (6.3%), and hepatic encephalopathy (2.9%) were observed. HCC was observed in 45.9% of patients with cirrhosis. Table 1 presents the baseline demographic, clinical, and laboratory data.

Reach was defined as the number of patients who could apply each statement, with the lowest reach indicating "applicable to few or no patients" and the highest reach indicating "applicable to practically all patients." The highest prevalence index indicating the need for evaluation was esophagogastroduodenoscopy (EGD) screening for decompensated cirrhosis without previous gastrointestinal bleeding (n=112; 54.63%), followed by antiviral accessibility in chronic hepatitis-related cirrhosis and eligibility for the HCC screening program (n=98; 47.8%). Within the clinical domain of HCC, our analysis identified HCC treatment based on disease stage as the third most prevalent index (n=93; 45.36%).

Before the analysis, 13/18 QIs had a previously documented performance gap. Twelve of the 13 QIs (92.3%) had a predicted performance of 80%, except for HCC screening, which had a predicted performance of 50%. Our data indicated that only 5/13 QIs (38.5%) attained the final goal. Regardless of target setting, all participants achieved the following four index objectives across three domains: paracentesis in individuals with either new-onset ascites or high suspicion of SBP, antibiotics administration within 12 h of SBP diagnosis, and offering screening for precipitating factors and lactulose therapy in case of a hepatic encephalopathy diagnosis (Table 2).

For certain essential quality measures lacking performance documentation gaps, for suspected

Table 1. Baseline Patient Demographics and Laboratory and Clinical Data (n=205)

Characteristics; N (%)	
Age, mean (SD)	62.7 (11.86)
Male	150 (73.2)
Etiology of cirrhosis	
Chronic viral hepatitis	95 (46.3)
Alcoholic	62 (30.2)
Nonalcoholic steatohepatitis	23 (11.2)
Cryptogenic	14 (6.8)
Other	11 (5.3)
Presence of complication at index admission	
Hepatocellular carcinoma	94 (45.9)
Ascites	50 (24.4)
Acute kidney injury	23 (11.2)
Spontaneous bacterial peritonitis	15 (7.3)
Variceal bleeding	13 (6.3)
Hepatic encephalopathy	6 (2.9)
Child-Pugh score (A/B/C)	90 (44.1)/ 86 (42.2) /28 (13.7)
MELD score (mean+ SD)	16.57+ 9.8
Baseline laboratory parameter at index admission, median (IQR)	
Platelet Count (10^3 cell/cumm^3)	105 (76-192)
PT (sec)	16.6 (14.9-19.8)
AST (U/L)	101 (44-259)
ALT (U/L)	42.5 (21-111)
ALP (U/L)	111 (81.5-191)
Total bilirubin (mg/dL)	1.71 (0.91-3.68)
Albumin (g/dL)	2.7 (2.2-3.2)
AFP (ng/ml)	5.02 (2.8-58)
Sodium(mmol/L)	134 (131-138)
Creatinine(mg/dL)	1.05 (0.7-1.6)
90-day readmission	67(32.7)
90-day morality	42 (20.5)

Abbreviation: ALT, alanine aminotransferase; AFP, alpha-fetoprotein; ALP, Alkaline Phosphatase; AST, aspartate aminotransferase; IQR: Interquartile range; MELD, Model For End-Stage Liver Disease; PT, Prothrombin time; SD, standard deviation

esophageal varices hemorrhage, approximately half of the patients received somatostatin. For the volume-challenge stage of AKI, approximately a quarter of the participants were eligible for intravenous albumin. However, the combination of terlipressin and albumin has been demonstrated to be adequate for all patients with AKI if hepatorenal syndrome is suspected. Finally, most patients received proper treatment according to the Barcelona Clinic Liver Cancer (BCLC) staging. Approximately one-third (32.7%) of the patients were readmitted within 90 days and 20% died.

Optimal QI care was provided to 84 patients (41%). Over half (58.3%) of the complete care group had CP-A. As disease severity increased, fewer patients received optimal care (54.4%, 34.9%, and 17.9% for CP-A, CP-B, and CP-C, respectively) (Table 3). Regarding CP-A and B, significant differences between the optimal quality care group and the incomplete care group regarding readmission and mortality were not observed. However, patients with CP-B cirrhosis who received comprehensive QI care had a significantly lower SBP incidence than patients with CP-B cirrhosis who received incomplete QI care (p=0.02). Even though the 90-day readmission rate was not substantially different from that in previous reports [9-11], decompensated CP-C patients who received excellent QI care had increased 1-month and 3-month survival rates compared with those who received insufficient care (100% vs. 43.5%; p = 0.022); (100% vs. 26.1%; p = 0.022) (Table 4, Figure 1).

Discussion

Quality of care is the most critical factor in managing chronic liver diseases. Herein, we report on the quality of real-life care practices, which differ from the set-target benchmark performance. Even though screening for HCC is mandatory for all patients with cirrhosis, the previously reported wide performance gap may have been due to the heterogeneity of the achievement varying from urban to community-based hospitals, physicians' knowledge, and most importantly, patient understanding and compliance. Our tertiary hospital demonstrated a higher proportion of

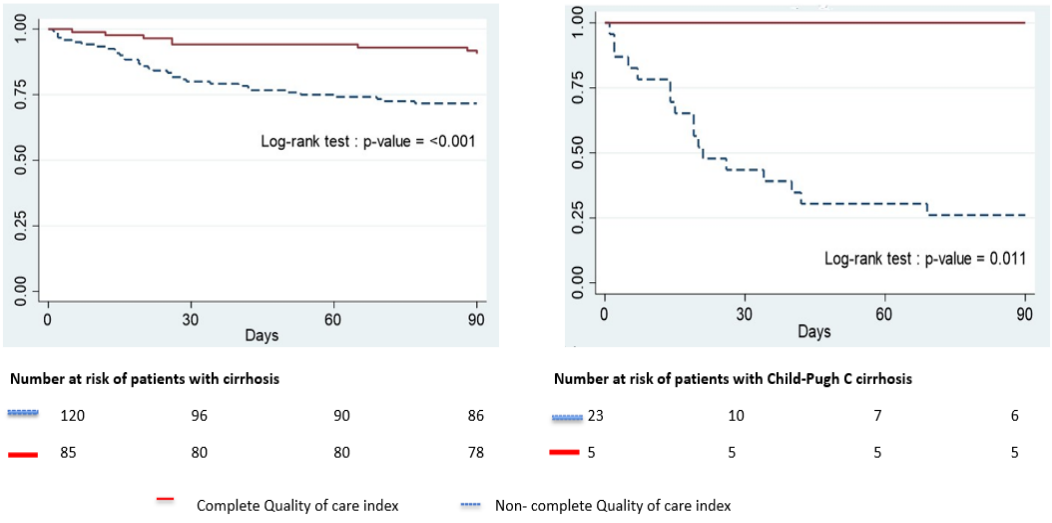

Figure 1. The 90-day Survival Analysis of Cirrhotic Patients According to the Quality of Care

Table 2. Conformity to the Quality Index* is Classified by Clinical Outcome Domain and Etiology Statement

Clinical domain	Condition	Quality indicator (QI)	Met	Indicate	Proportion (95%CI)	Gap	Goal	Achievement
Ascites								
1	New onset or complicated ascites	Diagnostic paracentesis in new onset grade 2 or 3 ascites, or in worsening of ascites	46	46	100 (92.3-100)	6	80%	1
2	New onset or complicated ascites	Patients with ascites and/or hepatic hydrothorax should be managed with both sodium restriction and diuretics	14	46	30.4 (17.7-45.8)	4	80%	0
3	Large Volume Paracentesis (≥ 5 L)	Patients undergoing large-volume paracentesis (>5 liters) plasma volume expansion should be performed by infusing albumin (8 g/L of ascites removed)	2	3	66.7 (9.4-99.2)	5	80%	0
Spontaneous bacterial peritonitis								
4	SBP	Hospitalized patients with ascites, with an ascitic fluid polymorphonuclear count of ≥250 cells/mm3, should receive empiric antibiotics and albumin within 12 hours of the test result.	15	15	100 (78.1-100)	6	80%	1
5	High risk SBP	Albumin (1.5 g/kg at diagnosis and 1 g/kg on day 3)	1	15	6.7 (0.2-31.9)	6	80%	0
6	Recurrent SBP	Prophylactic Norfloxacin (400 mg/day, orally) is recommended in patients who recover from an episode of SBP	4	11	36.4 (10.9-69.2)	NA	NA-	NA
Esophageal varices								
7	Decompensated cirrhosis (without bleeding)	Patients in whom decompensation develops should have EGD performed to screen for gastro-esophageal varices	55	112	49.11 (39.5-58.7)	5	80%	0
8	High-risk varices (without bleeding)	Primary prophylaxis must be initiated upon detection of high-risk varices; small varices with red wale marks or Child-Pugh C should be treated with NSBBs, medium-large varices should be treated with either NSBBs or EVL	9	16	56.3 (29.9-80.2)	4	80%	0
9	Variceal bleeding	EGD should be performed within the first 12 h after admission	6	13	46.1 (19.2-74.9)	5	80%	0
10	Variceal bleeding	Patients with cirrhosis who survive an episode of acute variceal hemorrhage should receive a combination of EVL and NSBBs	8	13	61.5 (31.6-86.1)	5	80%	0
11	Variceal bleeding	Vasoactive drug therapy should be initiated as soon as acute variceal bleeding is suspected. Terlipressin, somatostatin or octreotide are accepted options	7	13	53.8 (25.1-80.8)	NA	NA	NA
Hepatic encephalopathy								
12	Hepatic encephalopathy	Patients who are hospitalized and have an acute episode of overt hepatic encephalopathy should receive lactulose4	6	6	100 (54.1-100)	4	80%	1
13	Hepatic encephalopathy	Patients with hepatic encephalopathy should have a search for evidence of precipitating factors	6	6	100 (54.1-100)	6	80%	1
Acute kidney injury								
14	AKI (AKIN ≥ 1)	In case of no obvious cause of AKI, 20% albumin solution should be used at the dose of 1 g of albumin/kg of body weight for two consecutive days	6	23	26.1 (10.2-48.4)	NA	NA	NA
15	Hepatorenal syndrome	Terlipressin plus albumin (20–40 g/day) should be considered as the first-line therapeutic option for the treatment of HRS-AKI	3	3	100 (29.2-100)	NA	NA	NA
Hepatocellular carcinoma screening								
16	Cirrhosis	Patients with cirrhosis should undergo HCC screening using abdominal imaging with serum alpha-fetoprotein every 6-12 months	72	98	73.5 (63.5-81.9)	8	50%	1
Treatment of etiology								
17	Chronic viral hepatitis	Patients with untreated hepatitis B and C cirrhosis should be considered for antiviral therapy	59	98	60.2 (49.8-70.0)	5	80%	0
18	HCC	Treatment of HCC should be initiated according to stage	83	93	89.2 (81.1-94.7)	NA	NA	NA

Abbreviations: AKI, acute kidney injury; AKIN, acute kidney injury network; EGD, esophagogastroduodenoscopy; EVL, endoscopic variceal ligation; HCC, hepatocellular carcinoma; HRS, hepatorenal syndrome; NSBB, non-selective beta-blocker; SBP, spontaneous bacterial peritonitis. Achievement 1, yes; 0, no; NA, not available; *Adapted from reference 3,4

Table 3. Number of Patients who Followed the Statement of Care according to Disease Severity

Child–Pugh score	Incomplete care; n (%)	Complete care; n (%)	P
A 5–6	41(34.2)	49(58.3)	0.001*
B 7–9	56(46.7)	30(35.7)	0.117
C 10–15	23(19.2)	5(6.0)	0.007*

*Denotes statistical significance at the level of p<0.05.

Table 4. Outcomes of Cirrhosis according to the Quality of Care

	Child–Pugh 5–6			Child–Pugh 7–9			Child–Pugh 10–15		
	Incomplete N (%)	Complete N (%)	p	Incomplete N (%)	Complete N (%)	p	Incomplete N (%)	Complete N (%)	p
30-day mortality	0 (0)	1 (2)	0.35	11 (19.6)	4 (13.3)	0.46	13 (56.5)	0 (0)	0.022*
90-day mortality	0 (0)	2 (4.1)	0.19	17 (30.4)	6 (20.2)	0.3	17 (73.9)	0 (0)	0.002*
90-day readmission	11 (26.8)	16 (32.7)	0.54	24 (42.9)	8 (26.7)	0.13	7 (30.4)	1 (20.0)	0.64
AKI	2 (4.9)	0 (0)	0.18	8(14.3)	3 (10.0)	0.57	10 (43.5)	0 (0)	0.64
SBP	0 (0)	0 (0)	NA	9 (16.1)	0 (0)	0.02*	6 (26.1)	0 (0)	0.19
Variceal bleeding	4 (9.8)	2 (4.1)	0.28	5 (8.9)	1 (3.3)	0.33	1 (4.3)	0 (0)	0.63

Abbreviations: AKI, acute kidney injury; SBP, spontaneous bacterial peritonitis

patients who underwent HCC screening than the expected target because most of our patients had previously visited the subspecialty liver clinic and were familiar with the policies. Combined tumor markers may have a potential role in determining the prognosis of HCC [12]. During the admission period, the accomplishment of essential domain measures was controllable. In contrast to earlier studies, we demonstrated the importance of timeliness of therapy regarding paracentesis in cirrhotic ascites and standard empirical antibiotic administration for all patients diagnosed with SBP [8].The broad confidence interval of hepatic encephalopathy may be due to the small number of cases of hepatic encephalopathy diagnosis, which needs to be examined in larger populations.

Regarding upper gastrointestinal bleeding, rapid endoscopy, and a high suspicion of a non-variceal etiology based on physical examination, somatostatin or analog therapy was administered less frequently than anticipated. Antibiotic prophylaxis was not administered to some cirrhotic patients with recurrent SBP because several hospitalized patients with recurrent SBP had been admitted multiple times due to multidrug-resistant infections at multiple sites. Our secondary prophylaxis for recurrent SBP quality assurance report was similar to that used in a previous study [7]. The last unsettled gap was suboptimal albumin infusion as a volume expander for suspected AKI, which was due to preexisting chronic kidney diseases and the majority of AKI etiologies being pre-renal. Few pre-renal patients required volume expansion with colloid therapy to improve the glomerular filtration rate. Reimbursement for human albumin was restricted to suspected hepatorenal syndrome (HRS). Although HRS was suspected in a few patients, the QI for albumin with terlipressin or norepinephrine was provided to all patients. The multidisciplinary team advised decision-making regarding HCC, and management eligibility with the correct BCLC stage was ensured, except for a few patients who had difficulty accessing immunotherapy, experienced concurrent comorbidities, and showed poor patient compliance.

Due to patients' clinical features and comorbidities, actual QI adherence was lower than expected. In patients with ascites, we observed increased suboptimal use of diuretics and recommendation of a sodium-restricted diet. In a previous report, regardless of the sodium diet statement, the focus was limited to ascites patients with normal renal function who were on trial for 30 days after diuretic treatment initiation [7]. Due to concomitant AKI, electrolyte imbalance, and hemodynamic instability, some of our patients delayed the initiation of diuretic medication. Our sodium restriction out-of-target levels were comparable with those of a previous report and documented for a specific reason [8]. Some physicians recommend only modest salt restriction to increase patients' palatability, especially in malnutrition-related cirrhosis; a strict sodium diet is only required for individual personalized therapy. A minority of our high-risk patients with SBP received albumin to prevent AKI because more than half of patients had chronic kidney disease at baseline or were receiving palliative care for decompensated HCC.

There are two main reasons for the non-target achievement of EGD in our patients. First, we did not expand EGD screening to patients with CP-A cirrhosis with clinically significant portal hypertension (CSPH). Second, for first-time nonbleeding decompensation episodes, EGD screening was not performed at the time of admission. Based on the current Baveno guidelines [13-14], patients with CSPH should be assessed in future visits. In a previous QI assessment study, after omitting HCC, a satisfactory proportion of endoscopic therapy was achieved. [8] While HCC was detected in nearly half of the hospitalized patients with cirrhosis in our study, some with suspected active variceal bleeding were administered sandostatin without endoscopy as part of a palliative care hospital program. Beta-blocker administration was delayed or withheld in primary prophylaxis of high-risk

variceal hemorrhage or secondary prevention of variceal rebleeding due to contraindications, refractory ascites, and concurrent AKI hospitalization. Non-selective beta-blockers are not completely contraindicated in decompensated cirrhosis; therefore, a titrated dose was initiated during a post-discharge visit to a specialized clinic. Regarding the survey of viral etiology, at admission, eligible antiviral treatment was administered to all patients who were hepatitis B antigen-positive or had active chronic hepatitis C. Some patients with cirrhosis had not received antiviral therapy prior to admission due to undetectable hepatitis C viral load or poor compliance with nucleoside analogs in active chronic hepatitis B.

Older age and male sex were the most critical risk factors for hospitalization among patients with cirrhosis, which also contributed to a high likelihood of unplanned readmission [15-17]. Previous studies from community and tertiary hospitals revealed that approximately one-third of patients with cirrhotic ascites received all recommended care. In broader domains, we discovered a greater success rate for optimal care in tertiary facilities [7]. In contrast to previous studies that focused exclusively on decompensated patients, [8] our analysis identified a care gap across all phases of cirrhosis depending on patient characteristics and comorbidities; this is a strength of our study.

Another distinguishing feature of our study is that we have reported the updated real-world adherence to QIs in cirrhosis, including the admission index and screening history, following the publication of the recent guidelines with confirmed reaches and performance gaps of QIs [6]. We have emphasized that excellent treatment quality in conjunction with CP status can improve short-term survival. We believe that vasoactive drug therapy with early EGD in variceal bleeding and albumin infusion in suspected AKI had the most impact on the patient's outcome. In the long term, we believe that early commitment to excellent care for all patients with cirrhosis will increase survival and decrease complications. Additional QI models regarding transplantation should be considered in patients with a MELD score ≥15, and immunization documentation should be part of the physician's evaluation [18].

Our study has some limitations. First, we focused primarily on the length of hospitalization of patients with cirrhosis. However, repeated examinations over varying follow-up intervals may lead to quality improvement. Second, while we observed an association between excellent care and lower mortality in decompensated cirrhosis, we cannot definitively attribute this to the small number of patients receiving complete care in the CP-C category, and some quality index may have less impact on short-term mortality. Lastly, according to the population heterogeneity and the significant presence of hepatocellular carcinoma in almost half of the patients, these trends in some quality indexes may be executed by real-world practice. Post-discharge remote monitoring is essential for improving quality of care, particularly for decompensated cirrhosis. Developing a system for systematic data collection and performance monitoring in the healthcare system is critical for maintaining care quality. Our existing electronic medical records or a future record form designed by specialists can aid in the collection of dynamic standard workflow care processes and trustworthy quality assessments. Special clinic-tailored artificial technologies, such as telemedicine, may be the first step in improving clinical care delivery, including patient engagement.

In conclusion, for patients with cirrhosis, quality index implementation should be made available in various healthcare settings to improve survival.

Author Contribution Statement

Natt Munsakul and Supatsri Sethasine contributed to the study's idea and design, data collection and statistical analysis, and data interpretation. Nalerdon Chalermsuksant contributed to data interpretation. Supatsri Sethasine contributed to the article's drafting as well as critical review. The final manuscript was read and approved by all writers.

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Declarations

Ethics approval and consent to participate

The study protocol adhered to the ethical criteria of the 1975 Declaration of Helsinki and was approved by the Institutional Review Board of the Faculty of Medicine, Vajira Hospital (COA 033/2565). The need for informed consent was waived due to the retrospective nature of the study.

Availability of data and materials

The data used in this work are available upon reasonable request from the corresponding author.

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Competing interests

The authors declare that they have no competing interests.

Abbreviations

ALT: alanine aminotransferase; AFP: alpha-fetoprotein; AKI: acute kidney injury; AKIN: acute kidney injury network; ALP: alkaline Phosphatase; AST: aspartate aminotransferase; BCLC: Barcelona clinic liver cancer; CP: Child-Pugh; CI: confidence interval; CSPH: clinically significant portal hypertension; EVL: endoscopic variceal ligation; EGD: esophagogastroduodenoscopy; HCC: hepatocellular carcinoma; HRS: hepatorenal syndrome;

IQR: Interquartile range; MELD: Model for End-Stage Liver Disease; NSBB: non-selective beta-blocker; PT: prothrombin time; QI: quality index; SBP: spontaneous bacterial peritonitis; SD: standard deviation

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