

# World Journal of *Hepatology*

*World J Hepatol* 2019 October 27; 11(10): 701-724



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**RESPONSIBLE EDITORS FOR THIS ISSUE**

Responsible Electronic Editor: *Yu-Jie Ma*

Proofing Production Department Director: *Xiang Li*

**NAME OF JOURNAL**

*World Journal of Hepatology*

**ISSN**

ISSN 1948-5182 (online)

**LAUNCH DATE**

October 31, 2009

**FREQUENCY**

Monthly

**EDITORS-IN-CHIEF**

Ke-Qin Hu, Koo Jeong Kang, Nikolaos Pyrsopoulos

**EDITORIAL BOARD MEMBERS**

<https://www.wjgnet.com/1948-5182/editorialboard.htm>

**EDITORIAL OFFICE**

Ruo-Yu Ma, Director

**PUBLICATION DATE**

October 27, 2019

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## Retrospective Cohort Study

## Impact on 30-d readmissions for cirrhotic patients with ascites after an educational intervention: A pilot study

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**Author contributions:** Lim N and Olson A designed the study; Lim N gathered the data; Sanchez O compiled figures and tables, and performed statistical analysis; Lim N and Olson A wrote the initial and final drafts of the manuscript; All authors have read and approved the final manuscript.

**Institutional review board**

**statement:** This study was conducted with the approval of the institutional review board at the University of Minnesota, No. 1601S83245.

**Informed consent statement:** Due to its retrospective nature, informed consent was not required for this study.

**Conflict-of-interest statement:** The authors have no financial disclosures or conflicts-of-interest to declare.

**Data sharing statement:** Technical appendix, statistical code, and dataset available from the corresponding author at [nlim@umn.edu](mailto:nlim@umn.edu). Informed consent was not required due to the retrospective nature of this study but all presented data are anonymized and risk of identification is low.

**STROBE statement:** The guidelines of the STROBE Statement have been adopted.

**Open-Access:** This article is an

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## Abstract

## BACKGROUND

A low proportion of patients admitted to hospital with cirrhosis receive quality care with timely paracentesis an important target for improvement. We hypothesized that a medical educational intervention, delivered to medical residents caring for patients with cirrhosis, would improve quality of care.

## AIM

To determine if an educational intervention can improve quality of care in cirrhotic patients admitted to hospital with ascites.

## METHODS

We performed a pilot prospective cohort study with time-based randomization over six months at a large teaching hospital. Residents rotating on hospital medicine teams received an educational intervention while residents rotating on hospital medicine teams on alternate months comprised the control group. The primary outcome was provision of quality care- defined as adherence to all quality-based indicators derived from evidence-based practice guidelines- in admissions for patients with cirrhosis and ascites. Patient clinical outcomes- including length of hospital stay (LOS); 30-d readmission; in-hospital mortality and overall mortality- and resident educational outcomes were also evaluated.

## RESULTS

Eighty-five admissions (60 unique patients) met inclusion criteria over the study period-46 admissions in the intervention group and 39 admissions in the control group. Thirty-seven admissions were female patients, and 44 admissions were for alcoholic liver disease. Mean model for end-stage liver disease (MELD)-Na score

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**Manuscript source:** Unsolicited manuscript

**Received:** June 17, 2019

**Peer-review started:** June 18, 2019

**First decision:** July 17, 2019

**Revised:** September 23, 2019

**Accepted:** October 2, 2019

**Article in press:** October 2, 2019

**Published online:** October 27, 2019

**P-Reviewer:** Soldara T, Streba LAM

**S-Editor:** Ma YJ

**L-Editor:** A

**E-Editor:** Ma YJ



at admission was 25.8. Forty-seven (55.3%) admissions received quality care. There was no difference in the provision of quality care (56.41% *vs* 54.35%,  $P = 0.9$ ) between the two groups. 30-d readmission was lower in the intervention group (35% *vs* 52.78%,  $P = 0.1$ ) and after correction for age, gender and MELD-Na score [RR = 0.62 (0.39, 1.00),  $P = 0.05$ ]. No significant differences were seen for LOS, complications, in-hospital mortality or overall mortality between the two groups. Resident medical knowledge and self-efficacy with paracentesis improved after the educational intervention.

## CONCLUSION

Medical education has the potential to improve clinical outcomes in patients admitted to hospital with cirrhosis and ascites.

**Key words:** Cirrhosis; Education; Paracentesis; Quality

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**Core tip:** Quality care remains relatively low in patients admitted to hospital with cirrhosis. Diagnostic paracentesis in patients with ascites has been identified as a target to improve quality in these patients. We developed and administered an educational intervention focused on paracentesis to medical residents caring for patients with cirrhosis using time-based randomization. After adjustment for model for end-stage liver disease-Na score, age and gender, patients in the intervention group had reduced 30-d readmissions. As health care costs rise, our results justify further study into the use of medical education to improve the delivery of quality care in patients with cirrhosis.

**Citation:** Lim N, Sanchez O, Olson A. Impact on 30-d readmissions for cirrhotic patients with ascites after an educational intervention: A pilot study. *World J Hepatol* 2019; 11(10): 701-709

**URL:** <https://www.wjgnet.com/1948-5182/full/v11/i10/701.htm>

**DOI:** <https://dx.doi.org/10.4254/wjh.v11.i10.701>

## INTRODUCTION

The prevalence of cirrhosis is increasing annually and chronic liver disease is currently the twelfth leading cause of death in the United States<sup>[1-3]</sup>. As expected, this has led to an increase in hospitalizations in cirrhotic patients for all diagnoses, including hepatic encephalopathy, sepsis and renal failure<sup>[4,5]</sup>.

There is an increasing focus on the delivery of quality care in medicine, and hepatology in particular, due to rising health care costs and the use of alternative payment models in health care<sup>[6]</sup>. In 2010, a set of quality indicators for patients with cirrhosis were identified by an expert panel with the intention of setting a platform for the delivery of quality care<sup>[7]</sup>. Recent studies have examined the quality of care provided to hospitalized cirrhotic patients and concluded that the minority of patients receive high quality care<sup>[8-11]</sup>.

It is therefore important to develop processes that can improve the quality of care delivered to cirrhotic patients admitted to the hospital. One recent study showed that co-management between hepatologists and hospitalists increased the quality of care for patients admitted with spontaneous bacterial peritonitis (SBP) when compared to a standard generalist-consultant model<sup>[12]</sup>. Another study looked at the development of an order set in the electronic health record to improve clinical outcomes in the care of patients hospitalized with variceal bleeding and demonstrated improvements in the use and time to administration of antibiotics, a key quality indicator<sup>[13]</sup>.

In a previous study, we identified timely paracentesis as an area for improvement for physicians admitting cirrhotic patients with ascites to the hospital<sup>[14]</sup>. A multi-hospital discharge database study showed that early paracentesis has been shown to be associated with improved mortality in patients admitted to the hospital with ascites<sup>[14,15]</sup>.

The objective of this study was to evaluate how the use of medical education impacts on the provision of quality of care in cirrhotic patients admitted to hospital with ascites.



## MATERIALS AND METHODS

The University of Minnesota Medical Center (UMMC) is a tertiary care medical center with a high-volume liver transplant program. Similar to other high-volume transplant centers in the United States, patients with cirrhosis are admitted to either a hospital medicine team, staffed by a hospitalist with or without internal medicine residents, or the intensive care unit. This study was conducted with approval of the institutional review board at University of Minnesota. All authors had access to the study data and have reviewed and approved the final manuscript.

The University of Minnesota internal medicine and internal medicine-pediatrics residency programs comprise 42 residents per year. Residents alternate between inpatient and outpatient/elective rotations every 4 wk at three different teaching hospitals.

We performed a pilot prospective cohort study with time-based randomization over six months at one of the teaching hospitals (UMMC). Residents rotating on hospital medicine teams received an educational intervention (see below) while residents rotating on hospital medicine teams on alternate months comprised the control group.

The intervention was an educational session occurring at the beginning of the 4-wk rotation. The educational session comprised a 15-min tutorial and a 45-min practical training session. The didactic tutorial was delivered by an attending hepatologist and/or hospitalist and described indications, contraindications, and mechanics of paracentesis in addition to other aspects of care for patients with ascites. The practical training session involved hands-on teaching of ultrasound-guided paracentesis using a paracentesis training model. Residents in the intervention group also received a pocket-sized card with information on paracentesis and care for patients with ascites at the end of the educational session.

Residents in both groups completed a vignette-based medical knowledge assessment about caring for patients with ascites, as well as a survey regarding self-efficacy in paracentesis and caring for patients with ascites at the beginning of each rotation ([Supplement 1](#)). Residents in the intervention group completed another medical knowledge assessment and self-efficacy survey at the end of the educational session. A final self-efficacy survey was completed by residents in the intervention group 6 months after delivery of the educational intervention.

Patient data was then retrospectively collected on admissions for patients cared for by internal medicine residents on hospital medicine teams during the study period. Patients were included for analysis if they were admitted to the UMMC with cirrhosis and ascites to the hospitalist service *via* the UMMC emergency room. Patients were allocated to the intervention group if the residents caring for them had received the educational intervention at the beginning of their hospital medicine rotation. The control group comprised all other patients eligible for analysis.

Patients were excluded from analysis if they were not cared for by residents; if they were younger than 18 years old; had been transferred from another institution; if they were not admitted to the hospitalist service; if there was a concurrent diagnosis of hepatocellular carcinoma and/or if they had a “do not resuscitate” or “do not intubate” order that may have reduced the likelihood of invasive care measures.

### Outcomes

The primary outcome was delivery of quality care. Quality care was defined as adherence to all quality indicators for ascites derived from society-based clinical practice guidelines<sup>[1]</sup> ([Table 1](#)).

Secondary outcomes included length of hospital stay; complications; 30-d readmission; in-hospital mortality; 30-d mortality and overall mortality.

A complication was defined as a new, distinct clinical problem contributing towards length of stay. Complications included, but were not limited to, gastrointestinal bleeding; hepatic encephalopathy; acute kidney injury and sepsis. Complications were designated as “mild” *i.e.*, not life-threatening, “moderate” *i.e.*, possibly life-threatening or “severe” *i.e.*, life-threatening.

Educational outcomes were resident knowledge on paracentesis and care of patients with ascites, and resident self-efficacy in paracentesis and caring for patients with ascites. Data on resident medical knowledge and self-efficacy were obtained before, after and 6-mo after the intervention as appropriate. Data on resident medical knowledge and paracentesis self-efficacy were obtained at the beginning of each 4-wk rotation in the control group.

### Statistical analysis

Continuous variables are presented as mean (SD) and categorical variables as percentages as appropriate. Differences between groups were assessed using

**Table 1** Quality indicators for ascites

Refractory ascites
Diagnostic paracentesis in a timely manner
Aspirated fluid sent for cell count, differential and culture
Management with diuretics and sodium restriction in patients with normal renal function

independent student's *t*-test and Chi-square tests for continuous and categorical variables, respectively. Relative risks (RR) for clinical outcomes were adjusted for age, sex and the presence at admission of coronary artery disease (CAD), model for end-stage liver disease score (MELD score) and if hepatology consult was requested or not. Statistical significance was set at a *P* value of 0.05. SAS version 9.3 (SAS Institute Inc., Cary, NC) was used for all statistical analysis.

## RESULTS

### Demographics

Over the six-month study period, there were 85 admissions (60 individual patients) satisfying the inclusion criteria: 46 admissions in the intervention group and 39 admissions in the control group. 37 admissions (43.5%) were female. The mean (SD) age of the cohort was 53.5 (11.2) years. With regard to etiology of liver disease, 44 admissions (51.8%) were for alcoholic cirrhosis. Mean (SD) MELD-Na score of the cohort was 25.8 (7.04). There were no differences observed between the intervention and control groups for gender, age, MELD-Na score at admission, etiology of liver disease or the presence of coronary artery disease (CAD), diabetes, HIV or portal vein thrombosis. There was a significantly higher proportion of admissions with chronic kidney disease (CKD) in the intervention arm compared to the control arm (39 *vs* 25 admissions, *P* = 0.03). A hepatology consult was obtained in 30 admissions in the intervention group compared to 22 admissions in the control group (65.2% *vs* 56.4%, *P* = 0.4) (Table 2). No significant differences were observed between the two groups with regard to laboratory values at the time of admission (Supplement 2).

### Primary outcome

Forty-seven (52.3%) admissions met criteria (adherence to 3/3 quality indicators) for the primary outcome of quality care. For the primary outcome, no significant difference was observed between the intervention group and the control group (25/46 admissions (54.4%) *vs* 22/39 admissions (56.4%), *P* = 0.9). Of the 38 admissions not meeting criteria for quality care, 16 (18.8%) admissions adhered to 0/3 quality indicators; 12 (14.1%) admissions adhered to 1/3 quality indicators, and 10 (11.8%) admissions adhered to 2/3 quality indicators (Table 3).

With regard to adherence to specific quality indicators, timely paracentesis was performed in 49/85 (57.6%) admissions; appropriate testing was sent on ascitic fluid in 66/85 (77.6%) admissions, and management with sodium restriction and diuretics (when appropriate) occurred in 57/85 (67%) admissions.

In the intervention group, timely diagnostic paracentesis was performed in 24/46 (52%) admissions; appropriate studies were ordered on ascitic fluid in 31/46 (67%) admissions and appropriate management of ascites occurred in 26/46 (56.5%) admissions. In the control group, timely diagnostic paracentesis was performed in 25/39 (64%) admission; appropriate ascitic fluid studies ordered in 35/39 (90%) admissions and appropriate management of ascites in 31/39 (79%) admissions.

### Secondary outcomes

**Length of stay:** The mean (SD) length of stay did not differ between the intervention and control groups [8.95 (12.8) *vs* 11.1 (10.9) d, *P* = 0.4] (Table 3). However, on multivariate analysis-after adjustment for age, gender, presence of CKD, MELD-Na score at admission and hepatology consult- the relative risk for a length of hospital stay of > 6 d was 10% higher in the intervention group (RR = 1.10, 95% CI: 0.69-1.74, *P* = 0.1) (Table 4).

**Complications:** Twenty-one (45.7%) admissions in the intervention group encountered complications: 5 admissions with mild/non-life-threatening complications; 5 admissions with moderate/possibly life-threatening complications and 7

**Table 2** Baseline characteristics, *n* (%)

Groups	Control ( <i>n</i> = 39)	Intervention ( <i>n</i> = 46)	<i>P</i> value
Female	18 (46.2)	19 (41.3)	0.7
Age, yr	51.9 (11.4)	54.9 (10.9)	0.2
Hepatology consult	22 (56.41)	30 (65.22)	0.4
MELD-Na score	25.5 (6.2)	26.1 (7.7)	0.7
Comorbidities			
CAD	3 (7.69)	4 (8.7)	0.9
CKD	25 (64.1)	39 (84.78)	0.03
DM	11 (28.21)	17 (36.96)	0.4
HD	11 (28.21)	16 (34.78)	0.5
HIV	3 (7.69)	0 (0)	0.06
PVT	5 (12.82)	6 (13.04)	1
Etiology of cirrhosis			0.3
ETOH	23 (58.97)	21 (45.65)	
Hepatitis C	1 (2.56)	5 (10.87)	
ETOH/Hep C	3 (7.69)	2 (4.35)	
Hepatitis B	3 (7.69)	1 (2.17)	
NASH	4 (10.26)	8 (17.39)	
Other	5 (12.82)	9 (19.57)	

MELD-Na: Model of end-stage liver disease-sodium; CAD: Coronary artery disease; CKD: Chronic kidney disease; DM: Diabetes mellitus; HD: Hemodialysis; HIV: Human immunodeficiency virus; PVT: Portal vein thrombosis; ETOH: Alcohol; NASH: Non-alcoholic steatohepatitis.

admissions with severe/life-threatening complications. 17 (43.6%) admissions in the control group had complications: 3 admissions with mild complications; 8 admissions with moderate complications and 10 admissions with severe complications. No difference was observed in the proportion of complications seen in the intervention group compared to the control group (45.7% *vs* 43.6%, *P* = 0.9) (Table 3).

**30-d readmissions:** Re-admission to hospital within 30 days of discharge was seen in 14 admissions in the intervention group compared to 19 admissions in the control group (35% *vs* 52.8%, *P* = 0.1) (Table 3). The relative risk of 30-day admissions was 38% lower in the intervention group after adjustment for age, gender, CKD, MELD-Na score and hepatology consult (RR = 0.62, 95%CI: 0.39-1.00, *P* = 0.05) (Table 4).

**Mortality:** Three admissions in the intervention group concluded with in-hospital death compared to 3 admissions in the control group (13% *vs* 7.7%, *P* = 0.4). 3 admissions in the intervention group died within 30 d of admission to hospital compared to 4 admissions in the control group (7.5% *vs* 11.1%, *P* = 0.6). With regard to overall mortality, there were 15 deaths at the end of follow-up in the intervention group compared to 12 deaths in the control group (32.6% *vs* 30.8%, *P* = 0.9) (Table 3).

### Educational outcomes

Overall, 46 residents participated in the study. The composition of resident teams caring for patients was identical between groups. Educational outcomes have been reported in full elsewhere.

Overall mean resident score in the medical knowledge assessment on paracentesis and care of patients with ascites increased from 50% pre-intervention to 59.2% post-intervention (*P* = 0.07). Satisfaction with paracentesis training improved from 19.4% pre-intervention to 28.6% immediately post-intervention and 66.7% six-months post-intervention (*P* < 0.05). Mean self-efficacy score in performing paracentesis with indirect supervision increased from 2.5/4 (on a 4-point Likert scale) pre-intervention to 2.9/4 immediately post-intervention and 3.4/4 six-months post-intervention (*P* = 0.08).

## DISCUSSION

Quality care remains suboptimal for patients admitted to hospital with cirrhosis and



**Table 3 Adherence to quality care and clinical outcomes, n (%)**

Groups	Control (n = 39)	Intervention (n = 46)	P value
Quality care	22 (56.41)	25 (54.35)	0.9
Length of stay, d	8.95 (12.8)	11.1 (10.9)	0.4
Complications	17 (43.59)	21 (45.65)	0.9
30-d readmission	19 (52.78)	14 (35)	0.1
In-hospital mortality	3 (7.69)	6 (13.04)	0.4
30-d mortality	4 (11.11)	3 (7.5)	0.6
Total mortality	12 (30.77)	15 (32.61)	0.9

ascites. In our study, 52.3% of admissions received quality care, which is consistent with figures reported in other studies<sup>[8-11]</sup>. In our cohort, only 61.2% of admissions received a hepatology consult which may explain the relatively low proportion of patients receiving quality care. One study showed reduced inpatient mortality, hospital length of stay and readmission rates in patients with cirrhosis who received gastroenterology consult when admitted to hospital in VA system<sup>[16]</sup>.

We did not find any significant difference between the intervention and control groups with regard to the primary outcome of quality care. The lack of a significant difference in the primary outcome may be related to the content of the educational intervention, which focused largely on the practical aspects of paracentesis. Analysis of adherence to individual quality indicators showed that diagnostic paracentesis was performed in a timely manner in only 57.6% of admissions. Whilst medical knowledge improved after the educational intervention, this difference was not statistically significant, and increased focus on the pedagogical aspect of the intervention could improve this figure. This quality indicator remains an ideal target for improvement as two recent studies have demonstrated a relationship between inpatient mortality and timely paracentesis<sup>[14,15]</sup>.

It is also possible that the lack of involvement of the night float admitting residents contributed to the negative primary outcome. Our center uses a night float system when admitting patients to the hospitalist service after hours, a system that is commonplace in hospital medicine nowadays. The rotating night float resident was not captured in the educational intervention but the patients they admitted during intervention months would have been counted towards the intervention group. On review, 15 admissions in the intervention group were admitted by the night float resident. This issue may be addressed in the future with the use of online learning modules accessible to all at any time of day. Similar initiatives have been used to deliver educational material in laparoscopic cholecystectomy techniques to surgical trainees and in the education of all trainees in chronic kidney disease<sup>[17,18]</sup>.

We did find a trend towards reduced 30-d readmission rates in the intervention group before and after adjustment for differences in age, gender, MELD-Na score and CKD with the control group. Whilst quality of care would not explain this finding, it is possible that our educational intervention altered behavior in another way or engendered a heightened awareness of the complexity of patients with cirrhosis. It is also worth noting that the rate of 30-d readmissions in the control group was relatively high compared to previous studies, likely reflecting our sicker study population<sup>[19,20]</sup>. Reducing 30-d readmissions has significant financial implications for hospitals and payers as admissions to hospital for cirrhosis-related complications increase, and as health care costs in the United States continue to rise: chronic liver disease accounted for over \$3.3 billion in health care expenditure in 2012<sup>[5,21]</sup>.

Our study is the first to evaluate if medical education can improve quality care in patients admitted to hospital with cirrhosis and ascites. Previous studies have used checklists and order sets to improve quality in patients with cirrhosis<sup>[13,19,22]</sup>. Medical education has been shown to reduce surgical complications by orthopedics residents; increase screening rates for hepatitis C by primary care residents and reduce inappropriate ordering of echocardiograms by internal medicine residents<sup>[23-25]</sup>. We noted improved self-efficacy with regard to paracentesis in residents after the educational intervention. Self-efficacy with paracentesis also persisted over time demonstrating the durability of our educational intervention.

Previous studies have measured the proportion of adherence to quality indicators when evaluating delivery of care in patients with cirrhosis and have failed to demonstrate an improvement in mortality<sup>[8-10]</sup>. Our study differs from previous work by using an all-or-nothing definition of quality care with regard to adherence to quality indicators. Furthermore, we evaluated patient admissions, as opposed to

**Table 4 Adjusted relative risk for clinical outcomes related to intervention group**

	Intervention [RR (95%CI)]	P value
Length of stay > 6 d	1.10 (0.69, 1.74)	0.1
Complications	0.93 (0.58, 1.50)	0.8
30-d readmission	0.62 (0.39, 1.00)	0.05
30-d mortality	0.95 (0.30, 2.99)	0.7
Total mortality	1.07 (0.54, 2.13)	0.8

individual patients, as admissions were viewed as opportunities for quality care.

A disconnect currently exists between medical education and clinical outcomes. Educational research has traditionally focused purely on learner outcomes but should be focusing on the synchronization of learning and clinical outcomes. Patients with cirrhosis are an ideal population to expand this research due to their limited heterogeneity. Furthermore, SBP could be a key disease for study due to its clear diagnostic criteria and well-validated quality measures<sup>[26]</sup>. This would promote study in residency programs across institutions allowing mutual learning and improvements in clinical care. One study has shown that maternal complications in obstetrics patients were associated with the obstetrician's residency program<sup>[27]</sup>. Improving residency education therefore has the potential to affect quality of care and patient outcomes on thousands of patients in the future.

Our study has several limitations. First, this is a single center study so certain practices and culture at our institution, *e.g.*, hospital-based model of inpatient care, may not be generalizable to other medical centers. The pilot nature of our study meant that it was underpowered to fully evaluate differences in readmissions, mortality, complications and transfer to the ICU. A multi-center study would address both issues. Third, our intervention was directed at medical residents. The applicability of our medical educational intervention to medical students, advanced practice providers and staff physicians is unknown. Fourth, it is not possible to capture true readmission rates as patients may re-present to different hospitals. To mitigate this, we only included admissions presenting *via* UMMC ER, and excluded those transferred from other institutions. Finally, the nature of residency training made it impossible to prevent cross-fertilization of knowledge between the intervention and control groups despite best efforts. The impact of this however would have been softened by the rotation of residents between the three teaching hospitals affiliated with the University of Minnesota for their inpatient rotations.

In summary, a gap remains in the provision of quality care for patients admitted to hospital with decompensated cirrhosis. The use of medical education to improve quality care in this population remains a novel and relatively unproven idea with the potential to improve clinical outcomes particularly hospital readmission rates. Given the low cost and reproducible nature of our intervention, a larger scale study is justified particularly as medical education research transitions towards evaluating patient-oriented outcomes.

## ARTICLE HIGHLIGHTS

### Research background

The prevalence of cirrhosis in the United States is increasing with an increasing burden placed on the health care system. In 2010, a set of quality indicators were developed to provide a framework for the delivery of quality care in patients with cirrhosis. Despite this, the proportion of patients with cirrhosis receiving quality care remains relatively modest. Timely diagnostic paracentesis has been shown to be a quality indicator that is repeatedly missed in patients with cirrhosis admitted to hospital. Previous studies have shown that mandatory gastroenterology consultation, the use of standardized order sets and utilization of the electronic health record can improve quality care in patients with cirrhosis. To date, no studies have looked at the use of medical education to improve the quality of care provided to patients with cirrhosis.

### Research motivation

Medical education has traditionally focused on learner outcomes. We developed an educational intervention delivered to medical residents with the intention of demonstrating that medical education could improve clinical outcomes. If proven, medical education could be a cheap and easily reproducible tool to improve quality care and other clinical outcomes in patients with cirrhosis. This is particularly relevant at a time when health care costs are rising in the United States.

### Research objectives

Our main objective was to determine if an educational intervention can improve quality of care in cirrhotic patients admitted to hospital with ascites. Achieving this objective would provide one tool in addressing the deficit in quality care provided to patients with cirrhosis and stimulate further study into the use of medical education to do so.

### Research methods

We conducted a pilot prospective cohort study using time-based randomization. An educational intervention was delivered to medical residents caring for patients with cirrhosis in the hospital. The control group comprised medical residents on alternate months who did not receive the educational intervention. Quality care- defined as complete adherence to all evidence-based quality indicators- was compared between the two groups. Clinical outcomes including complications, transfer to the intensive care unit, length of hospital stay, 30-d readmission and inpatient mortality were also compared.

### Research results

We found that there remains a deficit in the provision of quality care in patients admitted to the cirrhosis with ascites. We found no difference in quality care between the two groups. We did find a lower rate of 30-d readmission in the intervention group that persisted after adjustment for age, gender and MELD-Na score.

### Research conclusions

In this pilot study, although provision of quality care was not different between the intervention and control group, there was a reduction in 30-d readmission seen in the intervention group. There remains a deficit in quality care provided to patients with cirrhosis but the use of medical education shows potential as a cheap, effective tool to improve clinical outcomes in this population.

### Research perspectives

Medical education has the potential to improve clinical outcomes in patients admitted to hospital with cirrhosis and ascites. Further refinement of our educational intervention implemented over a longer period of time may demonstrate sustained improvements in clinical outcomes in this population. Future research should look at the use of medical education to improve clinical outcomes in other patient populations such as heart failure and chronic kidney disease.

## ACKNOWLEDGEMENTS

We would like to thank Gretchen Sieger of the Clinical and Translational Science Institute at the University of Minnesota for her invaluable help with data collection and organization.

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