ORIGINAL ARTICLE

Quality improvement initiative increases total paracentesis and early paracentesis rates in hospitalised cirrhotics with ascites

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Received 8 February 2019
Revised 27 March 2019
Accepted 12 April 2019
Published Online First 29 April 2019

To cite: Jesudian A, Barraza L, Steel P, *et al*. *Frontline Gastroenterology* 2020;**11**:22–27.

ABSTRACT

Objective Early paracentesis (EP) for rapid diagnosis of spontaneous bacterial peritonitis is considered best practice in the care of admitted patients with cirrhosis and ascites, but inpatient paracentesis is frequently not performed or delayed. We developed a quality improvement (QI) initiative aimed at increasing the proportion of admitted patients with cirrhosis who undergo paracentesis and EP.

Design Pre–post study of a QI initiative.

Setting A tertiary care hospital in a major metropolitan area.

Patients Hospitalised patients with cirrhosis and ascites.

Interventions We targeted care providers in the emergency department (ED) by raising awareness of the importance of EP, developing criteria to identify patients at highest risk of SBP who were prioritised for EP by ED providers and restructuring the ED environment to enable timely paracentesis.

Results 76 patients meeting inclusion criteria were admitted during the postintervention 9-month study period. Of these, 91% (69/76) underwent paracentesis during admission versus 71 % (77/109) preintervention (p=0.001). 81% (56/69) underwent EP within 12 hours of presentation or after a predefined acceptable reason for delay versus 48% (37/77) preintervention (p=0.001). There were no significant differences in in-hospital mortality or length of stay before and after intervention.

Conclusion A multidisciplinary QI intervention targeting care in the ED successfully increased the proportion of patients with cirrhosis and ascites undergoing diagnostic paracentesis during admission and EP within 12 hours of presentation.

Significance of this study

What is already known on this topic

- Spontaneous bacterial peritonitis (SBP) is common in hospitalised patients with cirrhosis and ascites and is associated with high mortality.
- Paracentesis and early paracentesis (EP) are essential to diagnosing and treating SBP in a timely manner in this population, but both are often neglected in practice.

What this study adds

- A multidisciplinary quality improvement initiative targeting care provided in the emergency department significantly improved paracentesis and EP in admitted patients with cirrhosis and ascites.

How might it impact on clinical practice in the foreseeable future

- These findings may lead to improvement in adherence to the quality metrics of paracentesis and EP during admission and thereby improve inpatient cirrhosis outcomes.

INTRODUCTION

Patients with decompensated cirrhosis are a population at high risk of hospitalisation, readmission and short-term mortality.[1] These poor outcomes can be partially explained by the existence of a quality gap between evidence-based guidelines for cirrhosis management and implementation of these guidelines.[2] Therefore, the development of feasible and sustainable

quality improvement (QI) programmes to address deficiencies in cirrhosis care is of utmost importance.

Spontaneous bacterial peritonitis (SBP) is a life-threatening infection of ascites fluid that is reported to occur in 10%–30% of hospitalised patients with cirrhosis and is associated with significant mortality.[3–5] Prompt recognition of SBP and initiation of antibiotic therapy is critical to optimising outcomes in this population. To diagnose SBP, consensus guidelines recommend diagnostic paracentesis in all inpatient patients with cirrhosis and ascites, regardless of presenting symptoms.[6] Those patients who undergo paracentesis have improved survival compared with those who do not.[7 8] Early paracentesis (EP), defined as occurring within 12 hours of presentation, has been shown to improve short-term survival and lower length of stay (LOS) compared with late paracentesis after 12 hours.[9] However, up to 60% of hospitalised patients with cirrhosis and ascites do not undergo paracentesis for diagnosis of SBP.[10 11]

Few QI programmes have targeted EP in hospitalised patients with cirrhosis and none within 12 hours of presentation. Published interventions have included educational programmes targeting members of the admitting team or co-management with a specialist.[12 13] However, inpatients increasingly spend extensive time in the ED secondary to hospital overcrowding and subsequent boarding of admitted patients.[14 15] To date, no specific QI intervention has targeted ED providers and care to improve the timeliness of diagnostic paracentesis in hospitalised patients with cirrhosis and ascites.

We designed, implemented and studied a multidisciplinary QI intervention targeting care in the ED to improve the proportion of patients with cirrhosis and ascites undergoing paracentesis during admission and EP within 12 hours. The project aim was to achieve diagnostic paracentesis in at least 90% of eligible hospitalised patients with cirrhosis and ascites with EP performed within 12 hours in at least 75% of eligible patients.

METHODS

We performed a prospective study of a QI initiative at NewYork-Presbyterian Hospital-Weill Cornell Medicine (NYPH-WCM), an 862 bed tertiary academic medical centre in New York City. NYPH-WCM is a major regional referral centre for patients with complex liver disease. Urgent evaluation of patients with cirrhosis is undertaken by emergency medicine (EM) personnel and many are subsequently admitted to an internal medicine (IM) team. The primary care of the patient can be transitioned between EM and IM providers while the patient remains physically located in the ED. Hepatology consultation is available to either EM or IM providers at all times.

The design and analysis in this study was conducted to be consistent with the Standards for Quality Improvement Reporting Excellence guidelines.[16] The study was performed in accordance with the Declaration of Helsinki, Good Clinical Practice and applicable regulatory requirements.

Interventions

The new EP protocol for patients with cirrhosis was jointly developed by the hepatology, EM and IM services. During the 3 months preceding intervention, the multidisciplinary team conducted a gap analysis utilising focus groups with EM and IM providers to identify educational, workflow and environmental barriers to timely paracentesis. Resulting feedback was used to develop novel QI interventions. The protocol development period lasted from 1 July 2016 to 30 September 2016 and was excluded from analysis.

Focus groups identified a major barrier to EP among ED providers to be limitations on the time and personnel required to perform paracentesis amidst other competing clinical demands. In response, the novel, primary intervention by the multidisciplinary team was the formulation of criteria to identify patients with characteristics most concerning for SBP. This subset of patients could then be targeted for EP by ED providers who appreciated the urgency of paracentesis in this context. We created the 'BASIC' criteria to identify higher risk patients, which consisted of any one of: *B*ilirubin>3 mg/dL, *A*bdominal distension or pain, *S*igns of infection, *I*mpaired mental status, *C*reatinine >2 mg/dL (BASIC). Abdominal distension as well as signs of infection, including but not limited to fever, hypothermia, tachycardia, leucocytosis or leucopenia were interpreted at the discretion of the treating provider. The 'BASIC' criteria were designed to encapsulate possible indicators of SBP in the cirrhotic patient as are described in the American Association for the Study of Liver Disease and European Association for the Study of the Liver practice guidelines for ascites and SBP management.[6 17] Patients meeting no 'BASIC' criteria were deferred to the admitting team with clear, verbal communication by the ED team regarding the need for timely paracentesis even in the absence of these characteristics. EM and IM providers as well as EM nurses were in-serviced in the new protocol with multiple presentations. Posters depicting the protocol process map were displayed in clinical provider areas (figure 1). In addition, the intervention phase included four educational sessions each for EM and IM providers regarding the importance of prompt diagnosis of SBP in patients with cirrhosis and ascites as well as procedural training in bedside ultrasound and paracentesis technique when indicated. ED nurse management involvement in the initiative ensured that appropriate patients were promptly relocated to an area of the ED equipped for bedside procedures. Finally, a new diagnostic paracentesis kit of necessary equipment (syringes, needles, lidocaine, sterile drape,

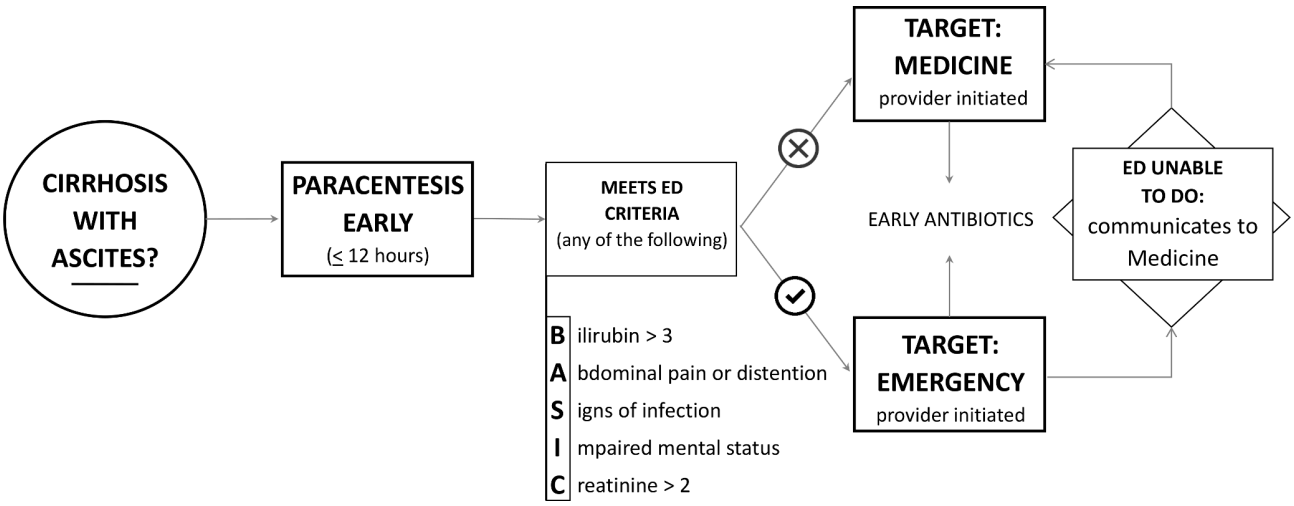

Figure 1 Process map of quality improvement intervention.

specimen tubes) was assembled and made readily available in the ED.

Rapid improvement cycles using the plan-do-study-act model were applied at 3-month intervals to identify barriers and areas for process improvement following feedback from involved providers.[18] In-person feedback to EM and IM providers by members of the multidisciplinary team was also reported in 3-month intervals by reviewing protocol adherence rates.

Analysis

We retrospectively analysed our centre data from July 2014 to June 2015 to establish preplanning and intervention baseline incidence of paracentesis during admission and EP within 12 hours. The proportions of patients undergoing paracentesis and EP postintervention were compared with those of the preintervention control group, as were in-hospital mortality, LOS and complications. The postintervention study period of 9 months lasted from 1 October 2016 to 30 June 2017.

Measures

All patients with cirrhosis and ascites (identified by International Classification of Diseases, Tenth Revision, Clinical Modification K70.30, K70.31, K74.60, K74.69 and R18.8, respectively) admitted to our centre between 1 October 2016 and 30 June 2017 were screened for inclusion. Patients were included in the analysis after electronic medical record review confirmed the diagnosis of cirrhosis (through a combination of history, laboratory assessment, radiographic appearance and/or histology when available), ascites present in sufficient quantity to undergo paracentesis and the absence of documented metastatic cancer or a contraindication to paracentesis (confirmed or suspected bowel perforation, abdominal wall cellulitis or pregnancy). In-patients with delayed (>12 hours) paracentesis, acceptable reasons for delay were unstable and/or critically ill, insufficient ascites for bedside paracentesis or patient refusal of bedside paracentesis as documented by the medical provider. Patients with an acceptable reason for delay were excluded from the delayed paracentesis group during data analysis. Timing of first physician encounter was determined by the time stamp of first physician documentation in the electronic medical record. Time of paracentesis was determined by time stamp in the medical record of ascites fluid being received for analysis in the laboratory.

The primary outcomes were proportion of patients who underwent paracentesis during admission and proportion of patients who underwent either EP or paracentesis after 12 hours with an acceptable reason for delay. The secondary outcomes were in-hospital mortality and LOS. Balancing measures were complications of paracentesis as documented in the medical record, namely intestinal perforation, haemoperitoneum and abdominal wall haematoma.

Statistical analysis

Statistical analysis was performed using Stata. Student's t-tests were used to compare continuous variables such as LOS between the early and delayed paracentesis cohorts. χ^2 tests and where appropriate Fisher's exact tests were used to compare categorical variables such as mortality between the early and delayed paracentesis groups.

RESULTS

Preintervention

From July 2014 to June 2015, 109 patients with cirrhosis and ascites were admitted, of which 77 (71%) underwent paracentesis during admission. Of those, 37/77 (48%) underwent EP during the first 12 hours after presentation. Five patients were diagnosed with SBP, one in the EP group and four in the delayed paracentesis group.

Inpatient deaths occurred in 12/109 (11%): 2/32 (6%) who did not undergo paracentesis during

Table 1 Preintervention and postintervention outcomes

Outcome	Preintervention	Postintervention	P value
Paracentesis (%)	71	91	0.001
Within 12 hours* (%)	48	81	0.001
After 12 hours (%)	52	19	0.001
Median LOS (days)	5.78	8.14	0.378
Mortality (%)	11.0	6.6	0.305

*Acceptable delay.
LOS, length of stay.

admission and 10/77 (13%) who underwent paracentesis during admission, including 5/37 (14%) who underwent EP and 5/40 (13%) who underwent paracentesis after 12 hours.

In those discharged, average LOS was 5.8 days in those who did not undergo paracentesis and 11.5 days in those who underwent paracentesis during admission. In analysis restricted to patients who underwent paracentesis, LOS was 8.7 days in the EP group and 14.2 days in the late paracentesis group (p=0.06).

Postintervention

During the 9 month postintervention study period (October 2016–June 2017), 76 patients with cirrhosis and ascites met inclusion criteria. Of these, 69/76 (91%) underwent paracentesis during admission. When performed, paracentesis occurred within the first 12 hours of initial physician encounter or after 12 hours with an acceptable reason for delay as previously defined in 56/69 (81%, 43 within 12 hours and 13 acceptable delay). The proportion of patients undergoing both paracentesis during admission and EP improved significantly when compared with the preintervention period, 71% and 48%, respectively (p=0.001) (table 1).

A run chart of proportion of patients undergoing paracentesis during admission and EP following the QI intervention is depicted in figure 2. The proportion of patients undergoing paracentesis during admission and EP both increased significantly over time postintervention (p=0.004 and p=0.009, respectively). Patients were more likely to undergo EP if they met three or more of the 'BASIC' criteria (p=0.04) or if an EM provider performed the paracentesis (p=0.001).

A total of 2/69 (3%) patients who underwent paracentesis during the study period experienced a complication related to the procedure which was haemoperitoneum in both instances. Both complications resolved with transfusion alone, and both patients survived to discharge.

Among those who underwent paracentesis, 3/69 (4%) were diagnosed with SBP. One patient with SBP met three out of five 'BASIC' criteria at presentation while the remaining two patients met four out of five criteria. Of those with SBP, two underwent EP and 1 after 12 hours. Among the patients with SBP, 1/3 (33%) died during the hospitalisation. This patient

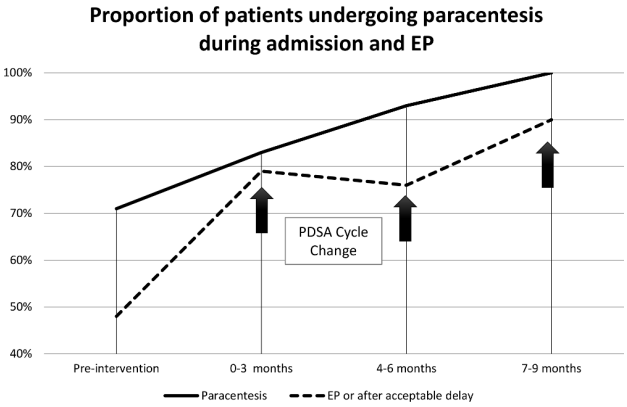

Figure 2 Run chart of proportion of patients who underwent paracentesis during admission and EP within 12 hours. The proportion of patients who underwent paracentesis during admission and EP within 12 hours of presentation (or acceptable delay) are depicted here, both preintervention and at 3-month intervals postintervention. Intervention adjustments by the multidisciplinary team occurred in 3-month intervals based on data from the preceding 3 months. Significant improvement over the preintervention period was observed during the course of the intervention. EP, early paracentesis, PDSA, plan-do-study-act.

had paracentesis performed after 12 hours. Of those without SBP, 2/66 (3%) met 1 'BASIC' criterion, 18/66 (27%) met two criteria, 27/66 (41%) met three criteria, 5/66 (8%) met four criteria and 0/5 (0%) met five criteria.

Finally, among all patients, inpatient mortality did not differ significantly between those who underwent paracentesis (7.2%) and those who did not (0%, p=0.461). Mortality also did not differ significantly between those who underwent EP (7.5%) and after 12 hours (15.4%, p=0.352). In those who were discharged, average LOS did not differ significantly in those who underwent paracentesis or did not (10.88 days vs 5.39 days, respectively, p=0.221) or in those who underwent EP or after 12 hours (11.67 days vs 8.00 days, respectively, p=0.179) (table 1).

DISCUSSION

Diagnostic paracentesis during hospitalisation is an explicit quality indicator in the care of patients with cirrhosis with or without concerning symptoms given the high incidence of SBP.[19] Unfortunately, widespread adherence to this and other cirrhosis quality metrics remains poor.[1] ED visits for patients with cirrhosis continue to increase, the majority of which result in admission.[20 21] Increasingly, inadequate inpatient bed capacity leads to prolonged ED boarding periods for admitted patients in hospitals that care for a high volume of sicker patients.[22] Given the management concerns unique to cirrhotics, specialist involvement in inpatient cirrhosis care has been advanced as a means of improving adherence to quality metrics.[13 23] However, prolonged stay in the ED can pose a barrier to timely and effective specialty consultation.[24]

Our study is the first reported QI programme targeting ED care to increase the proportion of patients with cirrhosis who undergo diagnostic paracentesis during admission and EP within 12 hours. We demonstrated that a multidisciplinary approach can significantly improve adherence to the best practice of early diagnostic paracentesis in all patients with cirrhosis and ascites admitted to the hospital. We were able to increase the proportion of patients with cirrhosis and ascites who underwent paracentesis during admission to 91% from 71% preintervention (p=0.001) and the proportion of patients who underwent EP within 12 hours (or after acceptable delay) to 81% from 48% preintervention (p=0.001).

In our experience, partnership between EM providers and admitting and consulting teams is crucial to the success of this intervention. In our planning phase, focus groups revealed that EM providers understood the importance of early paracentesis but were concerned about detractions from the care of other urgent patients. This led us to the creation of the 'BASIC' criteria which identified those patients with features most concerning for SBP at presentation, whom EM providers agreed should be prioritised for EP while under their care. By involving admitting and consulting teams in the planning and execution of the initiative, we were able to implement prioritisation of patients not meeting 'BASIC' criteria for early paracentesis, even when not performed by the ED team. Among those patients meeting 'BASIC' criteria, our data suggest that 3–4 criteria on presentation might identify a population at particularly high risk for SBP. This association warrants further investigation.

Additionally, broad publicity and repetitive education of the initiative through in-service presentations and reminder posters contributed to the project's sustainability. As is clear from our data, it took 3 months from project start for providers to be fully aware of the protocol and able to consistently adhere to targets for early paracentesis and paracentesis during admission. Reviewing protocol adherence rates via group presentations as well as individual feedback discussions with involved providers were useful in identifying problem areas with the initiative and soliciting feedback with which to adjust future interventions via plan-do-study-act cycles.

Since NYPH-WCM is a large urban medical centre with a large liver transplant and hepatology programme, it is possible that the success of our intervention might not be generalisable across all institutions. However, the high number of cirrhosis-related admissions during the study period supports the feasibility of implementing a similar initiative in centres with fewer such patients without impacting the care of other urgent patients. Additionally, hepatology staff were not involved in the supervision or performance of the procedures, indicating that both IM and EM providers can perform paracenteses safely and with ease.

Our study has some additional noteworthy limitations. First, the sample size of 76 patients is small, and all patients were admitted to a single centre. The QI initiative was conducted as a year-long hospital-sponsored project, and all patients meeting inclusion criteria during the 9 months following the initial 3-month planning period were included in the analysis. The small sample size and/or outpatient prophylaxis against SBP may be reasons for the incidence of SBP being lower than anticipated during our study period. As the mortality and LOS benefit of EP is largely observed in patient populations with higher rates of SBP, it follows that we were unable to draw firm conclusions regarding these secondary outcomes. Nonetheless, SBP continues to be recognised as a significant concern in hospitalised patients with cirrhosis with extremely high mortality in the absence of early diagnosis and treatment.[25] Expanding our QI initiative to multiple centres and calculating an appropriate sample size in a forthcoming study will allow us to validate the findings of this initial study and determine whether our intervention is able to improve outcomes in patients with SBP. Finally, we were unable to determine the reasons for no or delayed paracentesis in the preintervention group as these were rarely documented in the medical record.

In terms of balancing measures, 3% of patients experienced the complication of haemoperitoneum related to paracentesis. While a higher risk than previously reported, this is likely the result of small sample size and potentially a sicker inpatient population.[5] Neither patient required an invasive procedure to control bleeding, an outcome that is consistent with existing evidence supporting the safety of diagnostic paracentesis.

In summary, we successfully implemented an ED-focused, multidisciplinary QI intervention to increase the proportion of patients with cirrhosis and ascites undergoing paracentesis during admission and EP within 12 hours of presentation. This intervention was accomplished without noticeable impact on the care of other patients in the ED and without significant adverse events in the patients undergoing paracentesis. We believe that with widespread implementation, this initiative has the potential to dramatically increase the quality of care delivered to hospitalised patients with cirrhosis and ascites and improve outcomes in this vulnerable patient population.

Contributors AJ is responsible for the overall content as guarantor and contributed to the drafting of the manuscript. LB, NS, SD and YS contributed to the statistical analysis. RS, RSB and JIL contributed to the study supervision. All authors contributed to the study concept and design, acquisition of data; analysis and interpretation of data and critical revision of the manuscript.

Funding The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests None declared.

Patient consent for publication Not required.

Ethics approval The Weill Cornell Medicine Institutional Review Board approved the study protocol (no. 1512016841).

Provenance and peer review Not commissioned; externally peer reviewed.

Data sharing statement Data are available upon reasonable request.

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