A Multicenter Evaluation of Adherence to 4 Major Elements of the Baveno Guidelines and Outcomes for Patients With Acute Variceal Hemorrhage

Elliot B. Tapper, MD, Jennifer Friderici, MS,† Zachary A. Borman, MD,‡ Jacob Alexander, MD,§ Alan Bonder, MD,* Nabiha Nuruzzaman, BA,‖ Sheryl Ramdass, MD,¶ and Rony Ghaoui, MD§*

Goals: To determine the rate of and outcomes associated with guideline adherence in the care of acute variceal hemorrhage (AVH).

Background: Four major elements of high-quality care for AVH defined by the Baveno consensus (VI) include timely endoscopy ($\leq$12 h), antibiotics, and somatostatin analogs before endoscopy and band ligation as primary therapy for esophageal varices.

Study: We retrospectively evaluated 239 consecutive admissions of 211 patients with AVH admitted to 2 centers in Massachusetts from 2010 to 2015. The primary outcome was 6-week mortality; secondary outcomes included treatment failure (shock, hemoglobin drop by 3 g/dL, hematemesis, death $\leq$5 d), length of stay, and 30-day readmission.

Results: Guideline adherence was variable: endoscopy $\leq$12 hours (79.9%), antibiotics (84.9%), band ligation (78.7%), and somatostatin analogs (90.8%). However, only 150 (62.8%) received care that was adherent to all indicated criteria. The 6-week mortality rate was 22.6%. Treatment failure occurred in 50 (21.0%) admissions. Among the 198 patients who survived to discharge, 41 (20.7%) were readmitted within 30 days. Octreotide before endoscopy was associated with a reduction in 30-day readmission (18.4% vs. 42.1%; $P = 0.03$), whereas banding of esophageal varices was associated with a reduced risk of treatment failure (15.0% vs. 50.0%; $P \leq 0.001$). However, adherence to quality metrics did not significantly reduce the risk of death within 6 weeks.

Conclusions: Adherence to quality metrics may not reduce the risk of mortality but could improve secondary outcomes of AVH. Variation in practice should be addressed through quality improvement interventions.

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From the *Division of Gastroenterology, University of Michigan, Ann Arbor MI; Departments of †Epidemiology; ¶Medicine; §Division of Gastroenterology, Baystate Medical Center, Springfield; ‡Department of Medicine; and ‖Division of Quality and Safety, Beth Israel Deaconess Medical Center, Boston, MA.

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The authors declare that they have nothing to disclose.

Address correspondence to: Elliot B. Tapper, MD, Division of Gastroenterology, University of Michigan, 3912 Taubman, 1500 E Medical Center Dr, Ann Arbor, MI 48109 (e-mail: etapper@umich.edu).

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Acute variceal hemorrhage (AVH) is a devastating complication of portal hypertension and cirrhosis. In the United States, there are 4000 discharges annually for the principal diagnosis of AVH, 500 to 600 of which occur in the north-east.[1] Advances in supportive care, pharmacotherapy (including somatostatin analogs/terlipressin and antibiotics) and highly effective first-line therapies (eg, band ligation) have markedly improved our patients' outcomes.[2–5] These advances have become standards as articulated in the Baveno consensus guidelines, which lay out an approach to the care and study of patients with AVH.[4] Since their first iteration in 1990 (Baveno I), in-hospital mortality for patients with AVH has fallen from 42.6% to 14.5% in 2000.[2] Data are limited, however, regarding the rates and impact of adherence to Baveno guidelines in clinical practice.

The most recent Baveno consensus document (VI) was released in 2015.[4] These guidelines reaffirmed several aspects of high-quality care including timely ($\leq$12 h) endoscopy, preprocedure provision of octreotide and antibiotics, and primary use of band ligation. Beyond that, new directions for research were defined. These include the use of 6-week mortality as a primary endpoint in clinical trials with additional endpoints, namely, salvage therapy, transfusion requirements, and length of stay (LOS) as well a redefinition of 5-day treatment failure without respect to blood product requirement.

Herein, we describe the rate and impact of adherence to Baveno VI quality criteria on patient outcomes at 2 tertiary referral centers in the Northeastern United States.

METHODS

We performed a retrospective cohort study of all patients aged 18 and above with AVH presenting to Baystate Medical Center (BMC, Springfield, MA) and Beth Israel Deaconess Medical Center (BID, Boston, MA) from June 2010 to 2015, identified using billing codes consistent with variceal hemorrhage (ICD-9 456.X). All charts were reviewed to confirm the validity of inclusion. A standardized data collection form was developed for use by both centers and data were entered into each institution's RedCap database (grant number UL1TR001064), hosted by Tufts Clinical and Translational Science Institute (BMC)

and BID. Patients were excluded if index endoscopy was performed elsewhere or the cause of bleeding was nonvariceal, from ectopic varices, or postligation ulcers. Patients were followed for up to 6 weeks after discharge. The study's protocol was approved by the Institutional Review Boards at both centers.

In accordance with Baveno recommendations, the primary outcome was 6-week mortality. Secondary outcomes included treatment failure as defined in the Baveno VI document (a composite of either: a 3 g/dL drop in hemoglobin, fresh hematemesis, or death within 5 d), LOS, and 30-day readmission. The primary exposure variable was complete adherence to 4 of the principal elements of high-quality care: endoscopy within 12 hours of admission; preprocedure provision of octreotide and antibiotics; and primary use of band ligation when indicated. We chose easily measurable features that were shared with the prior Baveno V consensus. Admissions were dichotomized as fully adherent (quality score = 1) versus less than fully adherent. To adjust for demographics and disease severity, candidate covariates included age (continuous), sex, English fluency, race (white, black/African American, Hispanic, Other); clinical features including liver disease etiology, Charlson comorbidity index,[6] listing for liver transplantation, model for endstage liver disease score,[7] cirrhotic complications at presentation (ascites, hepatic encephalopathy, hepatorenal syndrome), acute on chronic liver failure (ACLF) as defined by the Chronic Liver Failure Consortium (CLIF),[8] and bleeding characteristics (location of varices, active bleeding at the time of endoscopy). Mediating factors included endotracheal intubation, transfusions, use of proton-pump inhibitors, transjugular intrahepatic portosystemic shunting (TIPS).

Statistical Analysis

Descriptive analyses were generated using means ± SDs and n (%). Univariate analyses, comparing baseline, and clinical characteristics by adherence groups were performed using the Fisher exact test (proportions), and Kruskal-Wallis equality-of-populations rank test (ordinal or continuous). Outcome models were developed based on adherence to each of the 4 selected Baveno standards. The dependent variable LOS was examined as a function quality metrics using competing risks regression,[9,10] indicated when 1 outcome (eg, death) prevents observation of the desired outcome (discharge), precluding censoring. The incidence rate ratio for 30-day readmission was explored using robust Poisson regression, restricted to patients who survived to discharge. Six-week mortality was examined among patients who survived to discharge using Cox proportional hazards regression. Mortality was confirmed by review of medical records and by a validated search of the Social Security Death Index.[11] All tests of statistical significance were performed with a criterion significance level of 2-tailed $P < 0.05$. Stata 14.0 was used for all analyses.

RESULTS

A total of 239 hospitalizations for AVH occurred during the study period (Table 1). Of these, 28 hospitalizations represent repeat admissions. The mean + SD age at admission was 57.5 ± 11.2 years, and both two-thirds male and white. In total, 11.7% (n = 28) required a translator. Payers included Medicaid/MassHealth (n = 81, 33.9%), Medicare (n = 67, 28.0%), and private insurance (n = 65, 27.2%). The median/interquartile range (IQR) presenting model for endstage liver disease was 14.0 IQR (11.4 to 21.0), and 66 (27.6%) met criteria for ACLF. Most observations (n = 221, 92.5%) presented with esophageal variceal hemorrhage (EVH) and 5.9% (n = 14) with gastric varices. Among admissions presenting with EVH, 24.0% (n = 53) were actively bleeding at the time of endoscopy. Few individual demographic or clinical characteristics were statistically associated with increased adherence to the quality metrics, save for alcoholic liver disease and insurance status.

For each of the 4 quality metrics, adherence was uniformly high, ranging from 80% for endoscopy within 12 hours, to 90.8% for octreotide before endoscopy (Fig. 1). However, 37.2% of admissions (n = 89) missed at least 1 indicated metric. The number of indicated metrics received did not seem to increase with LOS (Spearman $\rho = 0.04$; $P = 0.54$), reducing the likelihood that immortal time bias impacted observed associations (or lack thereof). Of the 203 patients receiving prophylactic antibiotics, 66.0% received a third-generation cephalosporin, 34 received a fluoroquinolone and 33 received piperacillin-tazobactam. Among the patients without a 12-hour endoscopy, the time to endoscopy was 22.1 hours (IQR, 16.3 to 40.0). Of the 34 patients with esophageal AVH who did not receive band ligation, 27 received no endoscopic therapy, 4 received balloon-tamponade and TIPS, and 3 received sclerotherapy alone.

Details of concurrent clinical management are presented in Table 2. Intensive care unit utilization (84.0% vs. 56.2%), endotracheal intubation (61.3% vs. 32.6%), and sucralfate administration (49.3% vs. 21.4%) were each significantly greater in the full-adherence group. Otherwise processes of care such as transfusion, administration of erythromycin, vasopressor use, Blakemore tube placement, and postprocedure nonselective β-blocker use were statistically comparable between groups. Of the 58 patients with active hemorrhage at the time of endoscopy, 28 received >1 unit of packed red blood cell, 18 received a unit of platelets, and 8 received a unit of cryoprecipitate. Early or salvage TIPS was used in 12 (5%) admissions. Overall, 167 (75.6%) received adjuvant nonselective β-blockers.

Overall, outcomes associated with AVH were poor. Nearly 1 in 4 patients (n = 54, 22.6% (95% CI, 17.7-28.4)) died within 6 weeks of their index admission. One in 5 [n = 41, 17.2% (95% CI, 12.9-22.5)] died during their index hospitalization. Among the 198 admissions where the patient survived to discharge, 41 or 20.7% (95% CI, 15.6-27.0) were readmitted to the discharging hospital within 30 days. Treatment failure occurred in 50 (21.0%; 95% CI, 16.2-26.6) of all admissions.

Table 3 demonstrates the effect of adherence to each individual Baveno guideline on clinical outcomes. Octreotide before endoscopy and banding of esophageal varices showed significant, protective effects related to 30-day readmission, and Baveno failure, respectively. The impact of each metric on the primary outcome (mortality) was evaluated individually; however, no significant associations were detected (Table 4). Furthermore, adherence to all 4 Baveno of the selected guidelines combined was also not associated with incremental improvements in clinical outcomes.(Supplementary Table 1, Supplemental Digital Content 1, http://links.lww.com/JCG/A320) The impact of band ligation on the components of treatment failure was

TABLE 1. Clinical Characteristics of Patients Hospitalized With Acute Variceal Hemorrhage With and Without Full Adherence to Baveno Guidelines

	Full Adherence to Baveno Guidelines where Indicated [n (%)]			
Clinical Variable	**Overall (N = 239)**	**No (N = 89)**	**Yes (N = 150)**	***P****
Age (mean ± SD) (y)	57.5 ± 11.2	57.3 ± 12.0	57.4 ± 9.0	0.94
% Male	158 (66.1)	55 (61.8)	103 (68.7)	0.32
White	187 (78.2)	75 (84.3)	112 (74.7)	0.11
English-speaking	211 (88.3)	75 (91.5)	126 (85.7)	0.29
Payer				
Private	65 (27.2)	21 (23.6)	44 (29.3)	0.001
Medicare	67 (28.0)	28 (31.5)	39 (26.0)	
MassHealth	53 (22.2)	9 (10.1)	44 (29.3)	
Medicaid	28 (11.7)	15 (16.9)	13 (8.7)	
Self-pay/other	26 (10.9)	16 (18.0)	10 (6.7)	
Etiology				
Alcohol	107 (44.8)	34 (38.2)	73 (48.7)	0.03
Hepatitis C	46 (19.3)	17 (19.1)	29 (19.3)	
Hepatitis B	6 (2.5)	1 (1.1)	5 (3.3)	
NAFLD	17 (7.1)	9 (10.1)	8 (5.3)	
Cryptogenic	8 (3.4)	7 (7.9)	1 (0.7)	
Other	13 (5.4)	3 (3.4)	10 (6.7)	
Multiple	42 (17.6)	18 (20.2)	24 (16.0)	
Transplant listed	17 (7.1)	5 (5.6)	12 (8.0)	0.61
Complications at admission				
Ascites	104 (43.5)	32 (36.0)	72 (48.0)	0.08
Hepatic encephalopathy	72 (30.1)	20 (22.5)	52 (34.7)	0.06
Hepatorenal syndrome	8 (3.4)	3 (3.4)	5 (3.3)	1.00
ACLF	66 (27.6)	21 (23.6)	45 (30.0)	0.30
HCC	21 (8.8)	7 (8.0)	14 (9.3)	0.82
Admission hemoglobin [median (IQR)]	9.7(8.1-11.5)	9.6(7.5-11.0)	9.8(8.2-11.7)	0.19
Admission platelet count (mean ± SD)	106 ± 74	113 ± 77	102 ± 72	0.24
Admission MELD score [median (IQR)]	14 (11-21)	14 (11-18)	15 (11-22)	0.22

*Unpaired *t* test (Gaussian), Wilcoxon rank-sum (non-Gaussian), or the Fisher exact (categorical).

ACLF indicates acute on chronic liver failure; HCC, hepatocellular carcinoma; IQR, interquartile range; MELD, model for endstage liver disease; NAFLD, nonalcoholic fatty liver disease.

examined in Supplementary Table 2, Supplemental Digital Content 2, http://links.lww.com/JCG/A321. There was an inverse association between the use of band ligation for esophageal varices and postprocedure hemetemesis, hemoglobin drop, and shock but not death within 5 days.

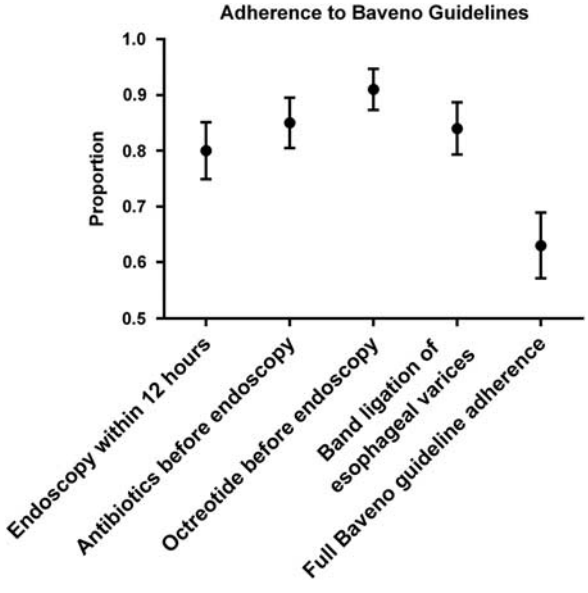

FIGURE 1. Adherence to Baveno guidelines. All estimates are presented with 95% confidence intervals.

DISCUSSION

Although the outcomes of AVH have improved over time,[2] there is still room for improvement. Beyond the technological advances of AVH care (band ligation, somatostatin analogs, and antibiotics), there is an important role for guidelines, care standardization, and implementation science. Indeed, these data from 2 North American referral centers demonstrate that there is variation in the quality of care for patients with AVH and that high-quality care, when provided, is associated with improved outcomes.

These data extend the literature on AVH in 2 principal ways. First, we demonstrate real-world estimates of the effect on AVH outcomes when Baveno consensus guidelines are applied. Specifically, band ligation is a significantly protective factor against treatment failure and octreotide utilization is associated with reduced risk of 30-day readmission. Previous studies have established the benefits of the individual guideline components: antibiotic prophylaxis saves lives,[12,13] early somatostatin analog administration prevents rebleeding,[2,3,14] and band ligation is superior to its alternatives.[15–17] Timely endoscopy ($\leq$12 h) has been associated with improved 6-week rebleeding-free survival among Taiwanese patients presenting with hematemesis (all of whom also received antibiotics and vasoactive agents).[18]

TABLE 2. Management Strategies of Patients Hospitalized With Acute Variceal Hemorrhage With and Without Full Adherence to Baveno Guidelines

	Full Adherence to Baveno Guidelines Where Indicated [n (%)]			
Management Variable	**Overall (N = 239)**	**No (N = 89)**	**Yes (N = 150)**	***P***
Any ICU utilization	176 (73.6)	50 (56.2)	126 (84.0)	< 0.001
Transfusions				
Any PRBC	150 (62.8)	51 (57.3)	99 (66.0)	0.21
PRBC units [median (IQR)]	3 (2-4)	2 (2-4)	3 (2-4)	0.87
Any FFP	72 (30.1)	22 (24.7)	50 (33.3)	0.19
FFP units [median (IQR)]	2 (2–5)	3 (2–4)	2 (2-5)	0.44
Any platelets	35 (14.6)	12 (11.3)	23 (17.3)	0.34
Platelet units [median (IQR)]	1 (1-2)	1 (1-5)	1 (1-2)	0.77
Any cryoprecipitate	17 (7.1)	6 (6.7)	11 (7.3)	1.00
Erythromycin	3 (1.3)	2 (2.3)	1 (0.7)	0.56
Vasopressors	23 (9.6)	10 (11.2)	13 (8.7)	0.51
Intubation	121 (50.6)	29 (32.6)	92 (61.3)	< 0.001
Endoscopic management				
Band ligation if indicated [n/N (%)]	187/221 (84.6)	54/88 (61.4)	133/133 (100.0)	< 0.001
Sclerotherapy	6 (2.5)	4 (4.5)	2 (1.3)	0.41
Blakemore tube placed	13 (5.4)	7 (8.0))	6 (4.0)	0.24
TIPS	12 (5.0)	5 (5.6)	7 (4.7)	0.77
BRTO	3/12 (25.0)	1/9 (11.1)	2/3 (66.7)	NA
Nonselective β-blocker prescribed	117 (49.0)	42 (47.2)	75 (50.0)	0.69
Sucralfate prescribed	93 (38.9)	19 (21.4)	74 (49.3)	< 0.001

Antibiotics included fluoroquinolones, third-generation cephalosporins or β-lactams.

Tests of statistical significance included the Fisher exact test (categorical), Kruskal-Wallis equality-of-populations rank test (continuous or ordinal).

BRTO indicates balloon-occluded retrograde transvenous obliteration; FFP, fresh-frozen plasma; ICU, intensive care unit; IQR, interquartile range; NA, not applicable; PRBC, packed red blood cells; TIPS, transjugular intrahepatic portosystemic shunting.

Conversely, in a Western Canadian population where 70% received octreotide and 22% received prophylactic antibiotics, time to endoscopy was not associated with in-hospital mortality. Our data from 2 American centers delineates the independent effects of each quality measure (in contrast to the Taiwanese data which only looked at timely endoscopy) in the context of contemporary outcome measures such as treatment failure and 6-week mortality (in contrast to the Canadian data which only looked at in-hospital mortality). Our data also show no association between adherence and 6-week mortality, implying either that underlying disease severity (eg, portal pressure, Child class) or that unmeasured aspects of supportive care play a larger role in this outcome than periprocedureal management.

Second, we show that there is an unacceptable variation in clinical practice. A recent systematic review of quality care for AVH found that the pooled rates of prophylactic antibiotics during admission, octreotide, or terlipressin infusion during admission, band ligation or sclerotherapy at the time of endoscopy and timely (< 24 h) endoscopy were: 35.0%, 76.1%, 79.8%, and 77.9%, respectively.[19] Although our data reflect higher rates of quality indicators—as well as a higher standards for timely endoscopy (< 12 h) and medication provision (before endoscopy as opposed to anytime during endoscopy)—only 3 in 5 patients received care which was fully adherent with Baveno guidelines. The reasons are unclear though they likely relate to knowledge deficits among frontline clinicians (eg, housestaff, emergency ward clinicians) or non-specialized on-call gastroenterology staff.

In sum, on the basis of improvements in secondary outcomes in the setting of practice variation, these data support a role for programs to improve local adherence with Baveno guidelines. The ideal variceal bleed is promptly recognized, swiftly addressed with appropriate medical therapy and triaged to clinical locations where endoscopy may be performed without delay by endoscopists who are familiar with and competent in the contemporary management of AVH. Accordingly, the targets for any intervention that aims at this ideal include care-coordination, clinician education, consistently available clinical resources, and trained staff and mechanisms to standardize care.

Four prior studies have trialed programs to improve the outcomes of AVH—each of which has its merits. One potential intervention to reduce practice variation, as studied successfully in a small cohort of 46 Australian patients with AVH, is to deploy a dedicated nurse to facilitate quality care for all bleeding patients.[20] Johnson and colleagues studied a combination of interventions at an academic center in Wisconsin including an educational seminar for housestaff and a standardized paper order set to promote guideline-based care for patients with upper gastrointestinal hemorrhage.[21] Although these authors saw a decrease in 30-day readmissions, paper-based order sets are subject to variable adherence.[19] Mayorga and Rockey[22] studied an electronic order set that cued clinicians to provide the correct medications and doses along with free-text education regarding the underlying rationale. This invention improved process measures—time to medication provision—but not clinical outcomes. In addition, the uptake of their order set was limited to 50% of candidate patients indicating that interventions utilizing electronic order sets also require a mechanism to default the orders or cue clinicians. Finally, Ghaoui and colleagues examined the effect of mandatory gastroenterology consultation for patients with decompensated cirrhosis at BMC.[23] In this study, 2 gastroenterologists reviewed all admissions to the medical center for candidate patients to trigger a consult by a variable staff of consultants. The investigators were able

TABLE 3. The Impact of Adherence to Baveno Guidelines on Clinical Outcomes for Patients With Acute Variceal Hemorrhage

	6-Week Mortality*			Length of Stay			30-Day Readmission*			Treatment Failure		
Quality Metric	Metric Met [n/N (%)]	Metric Not Met [n/N (%)]	*P*	Metric Met (Median/IQR)	Metric Not Met (Median/IQR)	*P*	Metric Met [n/N (%)]	Metric Not Met [n/N (%)]	*P*	Metric Met [n/N (%)]	Metric Not Met [n/N (%)]	*P*
Endoscopy within 12 h	10/158 (6.3)	3/40 (7.5)	0.73	5.0 (3.3-8.6)	5.0 (3.6-8.6	0.81	30/158 (19.0)	11/40 (27.5)	0.28	40/191 (20.9)	10/48 (20.8)	1.00
Antibiotics before Endoscopy	11/165 (6.7)	2/33 (6.1)	1.00	5.0 (3.3-9.0)	4.7 (3.6-6.2)	0.41	33/165 (20.0)	8/33 (24.2)	0.64	46/203 (22.7)	4/36 (11.1)	0.18
Octreotide before endoscopy	11/179 (6.2)	2/19 (10.5)	0.36	5.0 (3.5-9.0)	3.7 (3.0-5.0)	0.009	33/179 (18.4)	8/19 (42.1)	0.03	46/217 (21.2)	4/22 (18.2)	1.00
Esophageal varices banded†	11/157 (7.0)	2/27 (7.4)	1.00	5.0 (3.3-8.6)	5.6 (3.3-8.0)	0.85	33/157 (21.0)	5/27 (18.5)	1.00	28/187 (15.0)	17/34 (50.0)	< 0.001
All 4 Quality Metrics	7/123 (5.7)	6/75 (8.0)	0.56	5.0 (3.2-9.0)	5.0 (3.5-7.2)	0.66	20/123 (16.3)	21/75 (28.0)	0.07	27/150 (18.0)	23/89 (25.8)	0.19

*Among 198 patients who survived index admission.
†Excluding patients with gastric variceal hemorrhage.

TABLE 4. Unadjusted and Adjusted Risk of Death Within 6 Weeks of Admission Among Patients With Acute Variceal Hemorrhage*

	Risk of Death Within 6 wk of Admission	
	Unadjusted Models†	Adjusted Models‡
Principal Predictor	Incidence Rate Ratio (95% CI)	Incidence Rate Ratio (95% CI)
Model 1: endoscopy within 12 h	0.81 (0.44-1.48)	0.97 (0.47-1.97)
Model 2: antibiotics before endoscopy	1.43 (0.60-3.38)	1.07 (0.50-2.89)
Model 3: octreotide before endoscopy	0.84 (0.37-1.88)	1.04 (0.45-2.40)
Model 4: esophageal varices banded if indicated§	0.70 (0.37-1.32)	0.70 (0.37-1.32)
Model 5: all 4 quality metrics	0.79 (0.48-1.32)	0.75 (0.45-1.25)

*Excludes 4 liver transplant patients.
†All models are adjusted for study center (BID vs. BMC).
‡Adjusted for study center as well as additional covariates: model 1—active variceal bleeding and number of packed RBC transfusions before endoscopy; model 2—ascites, admission MELD, and fresh-frozen platelets; model 3—payer; model 4—no additional covariates identified in bivariable screening; model 5—hepatic encephalopathy.
§Restricted to 217 nontransplant patients with active or suspected esophageal variceal bleeding.
BID indicates Beth Israel Deaconess Medical Center; BMC, Baystate Medical Center; CI, confidence interval; MELD, model for endstage liver disease; RBC, red blood cell.

to improve the rate of endoscopy within 24 hours but not endoscopic therapy, antibiotics, or somatostatin analogs, potentially because there was no set AVH protocol aside from the consult itself. Finally, specialized centers with dedicated variceal bleeding units have demonstrated substantially improved outcomes over time suggesting that regionalization of care is a promising if untested approach.[2]

The implications of our data must be interpreted in the context of the study design. First, the application of high-quality care varied across the population for reasons that cannot be completely explained in this retrospective study, but may be related to variables such as the individual treating physicians and unmeasured patient factors. Indeed, patients who did not receive quality metrics tended to be sicker. This is particularly important when evaluating the significant association between band ligation and reduced treatment failure. Potential explanations could include failure to band when varices were nonbleeding and decompressed, discomfort with banding for inexperienced operators or failure to visualize varices in the setting of massive bleeding. In addition, there were differences in the rate of guideline adherence for patients with various insurance types and the presence of alcoholic liver disease, though it is unclear how these factors could affect adherence. For this reason, these data do not reflect on the efficacy of the Baveno standards but may indicate limits in their effectiveness. Second, this study took place in the Northeastern United States at 2 centers which care for high volumes of patients with decompensated cirrhosis[24,25] and may not be generalizable to other regions or other types of facilities. Indeed, 1 in 3 patients presented with a history of

hepatic encephalopathy and 1 in 4 with ACLF, suggesting that the overall severity of illness in our cohort was high. Finally, terlipressin is often preferred over somatostatin analogs but is not available in the United States.

In conclusion, variation in the care of patients presenting with AVH is an important target for quality improvement. Although adherence to quality metrics may not improve 6-week mortality, it may improve important secondary outcomes. Programs to implement AVH guideline-based care are warranted. Efforts to standardize management using checklists or order sets,[21,22] bleeding nurse-coordinators,[20] or even centers of excellence with dedicated variceal hemorrhage units[2] are reasonable approaches. Further study is needed to confirm these findings in a larger cohort and to further elucidate the reasons for guideline noncompliance.

REFERENCES

1. HCUPnet Statistics for Acute Variceal Hemorrhage Discharges. Healthcare Cost and Utilization Project (HCUP). 2013. Agency for Healthcare Research and Quality, Rockville, MD. http://hcupnet.ahrq.gov/. Accessed May 5, 2016.
2. Carbonell N, Pauwels A, Serfaty L, et al. Improved survival after variceal bleeding in patients with cirrhosis over the past two decades. *Hepatology*. 2004;40:652–659.
3. Tripathi D, Stanley AJ, Hayes PC, et al. UK guidelines on the management of variceal haemorrhage in cirrhotic patients. *Gut*. 2015;64:1680–1704.
4. de Franchis R, Faculty BV. Expanding consensus in portal hypertension: report of the Baveno VI Consensus Workshop: stratifying risk and individualizing care for portal hypertension. *J Hepatol*. 2015;63:743–752.
5. Garcia-Tsao G, Bosch J. Varices and variceal hemorrhage in cirrhosis: a new view of an old problem. *Clin Gastroenterol Hepatol*. 2015;13:2109–2117.
6. Deyo RA, Cherkin DC, Ciol MA. Adapting a clinical comorbidity index for use with ICD-9-CM administrative databases. *J Clin Epidemiol*. 1992;45:613–619.
7. Kamath PS, Wiesner RH, Malinchoc M, et al. A model to predict survival in patients with end-stage liver disease. *Hepatology*. 2001;33:464–470.
8. Moreau R, Jalan R, Gines P, et al. Acute-on-chronic liver failure is a distinct syndrome that develops in patients with acute decompensation of cirrhosis. *Gastroenterology*. 2013;144 :1426–1437. e9.
9. Fine JP, Gray RJ. A proportional hazards model for the subdistribution of a competing risk. *J Am Stat Assoc*. 1999; 94:496–509.
10. Berry SD, Ngo L, Samelson EJ, et al. Competing risk of death: an important consideration in studies of older adults. *J Am Geriatr Soc*. 2010;58:783–787.
11. Hauser TH, Ho KK. Accuracy of on-line databases in determining vital status. *J Clin Epidemiol*. 2001;54: 1267–1270.
12. Bernard B, Grangé JD, Khac EN, et al. Antibiotic prophylaxis for the prevention of bacterial infections in cirrhotic patients with gastrointestinal bleeding: a meta-analysis. *Hepatology*. 1999;29:1655–1661.
13. Fernández J, del Arbol LR, Gómez C, et al. Norfloxacin vs ceftriaxone in the prophylaxis of infections in patients with advanced cirrhosis and hemorrhage. *Gastroenterology*. 2006; 131:1049–1056.
14. Calès P, Masliah C, Bernard B, et al. Early administration of vapreotide for variceal bleeding in patients with cirrhosis. *N Engl J Med*. 2001;344:23–28.
15. Lo G-H, Lai K-H, Cheng J-S, et al. A prospective, randomized trial of sclerotherapy versus ligation in the management of bleeding esophageal varices. *Hepatology*. 1995;22:466–471.
16. Sarin SK, Lamba GS, Kumar M, et al. Comparison of endoscopic ligation and propranolol for the primary prevention of variceal bleeding. *N Engl J Med*. 1999;340:988–993.
17. Stiegmann GV, Goff JS, Michaletz-Onody PA, et al. Endoscopic sclerotherapy as compared with endoscopic ligation for bleeding esophageal varices. *N Engl J Med*. 1992;326: 1527–1532.
18. Chen P-H, Chen W-C, Hou M-C, et al. Delayed endoscopy increases re-bleeding and mortality in patients with hematemesis and active esophageal variceal bleeding: a cohort study. *J Hepatol*. 2012;57:1207–1213.
19. Tapper EB. Building effective quality improvement programs in liver disease: a systematic review of quality improvement initiatives. *Clin Gastroenterol Hepatol*. 2016;14:1256–1265.
20. Wundke R, Altus R, Sandford J, et al. Improving management of oesophageal varices in patients with cirrhosis. *Qual Saf Health Care*. 2010;19:536–541.
21. Johnson EA, Spier BJ, Leff JA, et al. Optimising the care of patients with cirrhosis and gastrointestinal haemorrhage: a quality improvement study. *Aliment Pharmacol Ther*. 2011;34: 76–82.
22. Mayorga CA, Rockey DC. Clinical utility of a standardized electronic order set for the management of acute upper gastrointestinal hemorrhage in patients with cirrhosis. *Clin Gastroenterol Hepatol*. 2013;11:1342–1348.
23. Ghaoui R, Friderici J, Desilets DJ, et al. Outcomes associated with a mandatory gastroenterology consultation to improve the quality of care of patients hospitalized with decompensated cirrhosis. *J Hosp Med*. 2015;10:236–241.
24. Ghaoui R, Friderici J, Visintainer P, et al. Measurement of the quality of care of patients admitted with decompensated cirrhosis. *Liver Int*. 2014;34:204–210.
25. Tapper EB, Finkelstein D, Mittleman MA, et al. A quality improvement initiative reduces 30-day rate of readmission for patients with cirrhosis. *Clin Gastroenterol Hepatol*. 2016;14:753–759.