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Article

Real-World Outcomes of Acute Variceal Bleeding Across a UK Tertiary Multi-Centre Network

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Abstract

Aims/Background: Gastroesophageal acute variceal bleeding (AVB) is a lethal complication of portal hypertension. This service evaluation aimed to describe the real-world management and outcomes of AVB in patients who underwent endoscopic assessment across a UK tertiary hospital network. The primary outcome was 30-day all-cause mortality; 1-year all-cause mortality was a secondary outcome. **Methods:** This retrospective multi-centre service evaluation used electronic health records from three hospitals in one UK tertiary network (January 2019–December 2024), with follow-up to 31 December 2025. Continuous variables were compared by the Mann–Whitney U test and categorical variables by chi-squared or Fisher's exact test. Pre-specified Firth penalised logistic regression modelled baseline and in-hospital predictors of 30-day mortality separately. Survival was compared by Kaplan–Meier analysis with the log-rank test. **Results:** A total of 191 patients presented with AVB (median age 55 years; 68.1% male). Alcohol-related liver disease was the predominant aetiology (56.0%), and 88.4% had Child-Pugh class B or C disease. Haemodynamic instability was present in 57.1%, and 25.1% required intensive therapy unit (ITU) admission. Endoscopy was performed within 12 hours in 47.1%, achieving band ligation in 90.1% and initial haemostasis in 88.0%. Rescue therapies included balloon tamponade (7.3%), transjugular intrahepatic portosystemic stent-shunt (TIPSS; 6.3%), and endoscopic ultrasound (EUS)-guided coiling (2.6%). 30-day and 1-year all-cause mortality were 19.9% and 41.4%, respectively. Non-survivors had significantly higher Child-Pugh and Model for End-Stage Liver Disease (MELD) scores. On multivariable analysis, Child-Pugh score was the only independent baseline predictor of 30-day mortality (odds ratio [OR] 1.69 per point, 95% CI 1.39–2.06, $p < 0.001$); MELD performed equivalently (OR 1.18, 95% CI 1.10–1.27, $p < 0.001$). Haemodynamic instability, ITU admission, intubation and early endoscopy were not independently associated with mortality after adjustment for liver disease severity. Failure to achieve initial haemostasis was the exception (OR 0.30 for haemostasis achieved, 95% CI 0.10–0.89, $p = 0.027$). ITU admission stratified overall survival on Kaplan–Meier analysis (log-rank $p = 0.011$). **Conclusion:** AVB continues to carry high early and late mortality. Outcomes were most strongly associated with liver disease severity, with failure to achieve initial haemostasis the only in-hospital factor still associated with 30-day mortality after adjustment.

Keywords: esophageal and gastric varices; portal hypertension; liver cirrhosis; gastrointestinal hemorrhage; hospital mortality; endoscopy

1. Introduction

Acute upper gastrointestinal bleeding (UGIB) is a major medical emergency with an estimated incidence of approximately 134 per 100,000 population per year in the United Kingdom [1]. Gastroesophageal acute variceal bleeding (AVB) accounts for approximately 5–10% of all UGIB episodes but carries substantially greater morbidity and mortality than non-variceal causes, owing to the underlying burden of portal hypertension, hepatic dysfunction, and associated coagulopathy [2]. In the UK, national audit data have confirmed that AVB remains associated with inpatient mortality rates of 10–20%, with figures substantially higher in patients with decompensated chronic liver disease [3]. Standardisation of care has been a major focus of national and international bodies. The British Society of Gastroenterology (BSG) has published guidelines on the management of variceal haemorrhage in cirrhotic patients in 2015 [4].

A subsequent BSG position statement has since appraised the 2023 American Association for the Study of Liver Diseases (AASLD) practice guidance in the UK context [5]. Subsequent international consensus from the Baveno VIII (2026), the European Society of Gastrointestinal Endoscopy (ESGE), and the European Association for the Study of the Liver (EASL) has further refined recommendations on endoscopic, pharmacological, and radiological interventions, including risk stratification, antibiotic prophylaxis, vasoactive therapy, and the use of transjugular intrahepatic portosystemic shunt (TIPSS) [6,7,8]. Prior studies of AVB outcomes originated from single-

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centre settings, with relatively small sample sizes and variable follow-up. Contemporary UK data from the 2022 BSG audit have highlighted ongoing variability in adherence to the bundle-based care and a persistent early mortality [3]. Whether outcomes at individual high-volume centres are consistent with national standards, and which clinical variables independently predict early mortality remains a clinically important question.

The Baveno consensus also introduced updated definitions of acute haemorrhage, failure to control bleeding, and early rebleeding, which have practical implications for the categorisation of high-risk events and the timing of rescue interventions such as pre-emptive TIPSS [6]. Additionally, evidence from the PREDESCI trial has renewed interest in the role of non-selective beta-blockers in preventing decompensation in compensated cirrhosis with clinically significant portal hypertension, yet the influence of pre-existing beta-blocker therapy on outcomes at the time of AVB remains debated [9]. Notably, PREDESCI evaluated prevention of a first decompensating event, and an individual participant data meta-analysis by Villanueva et al. [10] found that, among patients with high-risk varices and no previous bleeding, non-selective beta-blockers improved survival compared with endoscopic variceal ligation in compensated cirrhosis, with no difference between therapies in decompensated patients.

We undertook a retrospective service evaluation across a large UK tertiary hospital network with the primary aim to describe the real-world management of AVB, including the use of guideline-recommended therapies, and to identify independent clinical predictors of 30-day mortality. Secondary aims were to characterise 1-year survival, explore the role of intensive therapy unit (ITU) escalation and of advanced portal hypertension therapies.

2. Methods

2.1 Study Design and Setting

University Hospitals Birmingham (UHB) NHS Foundation Trust is one of the largest teaching hospital trusts in England, serving a regional, national and international population. UHB collectively sees and treats more than 2.2 million people every year across its sites. This was a retrospective service evaluation that included patients admitted with AVB between 1 January 2019 and 31 December 2024, a period spanning six calendar years. Patients were identified through a search of the electronic endoscopy databases, which record upper gastrointestinal endoscopy performed at the participating hospitals. The sampling frame was therefore the endoscopy record, and the cohort consists of patients who underwent endoscopy during the index admission. The service evaluation was registered and approved internally by UHB prior to data collection (reference: CARMS-22038). The service evaluation was conducted across three of the acute hospitals within UHB: Queen Elizabeth Hospital Birmingham (QEHB), Birmingham Heartlands Hospital (BHH), and Good Hope Hospital (GHH).

2.2 Outcome and Follow-Up

The primary outcome was 30-day all-cause mortality from the date of the index admission; 1-year all-cause mortality was a secondary outcome. Mortality was ascertained from the electronic patient record, which is linked to regional community demographic data. Follow-up ended on 31 December 2025. Although admissions were eligible up to 31 December 2024, the last index admission occurred on 22 November 2024, so the minimum potential follow-up was 404 days; the median was 1160 days (IQR 818–1533). Every patient therefore had at least one complete year of potential observation. Survival time ran from the date of admission to death or 31 December 2025, whichever came first. The Baveno consensus recommends 6-week mortality as the standard short-term endpoint in acute variceal bleeding [6]. Thirty-day all-cause mortality was adopted here because it was the interval recorded in the service evaluation dataset, and it is widely reported in the national audit and cohort literature with which our results are compared. The two intervals describe the same early high-risk period after variceal bleeding, and we do not regard the difference as material to the clinical message. Thirty-day and one-year mortality status was recorded as a binary outcome during data collection and is the basis for the mortality figures reported in Tables 1,2 and for both multivariable models, whereas survival time for the Kaplan–Meier analysis was calculated from the recorded dates of admission and death; in a small number of patients the recorded date of death fell a few days outside the corresponding binary outcome window, so a Kaplan–Meier estimate at a given time point may differ slightly from the crude proportion.

2.3 Definitions

Acute variceal bleeding (AVB) was defined as haematemesis and/or melaena in a patient with portal hypertension in whom endoscopy demonstrated one or more of the following: (i) active spurting or oozing from a varix; (ii) a fibrin plug, white nipple sign or other stigmata of recent bleeding on a varix; or (iii) varices with blood in the stomach and no other identifiable bleeding lesion. All patients included underwent endoscopy. Haemodynamic instability at presentation was defined, in accordance with BSG guidance, as a systolic blood pressure <100 mmHg and/or a heart rate >100 beats per minute, and was derived directly from the physiological values recorded at presentation [4]. A previous history of varices was defined as documented endoscopic or radiological evidence of gastro-oesophageal varices recorded prior to the index admission, whether or not endoscopic variceal therapy had previously been undertaken. This is because the retrospective record did not reliably distinguish varices that had previously been banded from varices that had been diagnosed but not treated.

Table 1. Baseline characteristics, presentation, resuscitation, endoscopic management and outcomes (n = 191).

Characteristic	Value (n = 191)
Demographics	
Age, years	55.00 (43.50–62.00)
Sex	
Male	130 (68.1)
Female	61 (31.9)
Ethnicity	
White	149 (78.0)
Asian	19 (9.9)
Black	2 (1.0)
Any other ethnic group	21 (11.0)
Admission site	
Queen Elizabeth Hospital Birmingham	120 (62.8)
Birmingham Heartlands Hospital	43 (22.5)
Good Hope Hospital	28 (14.7)
Liver disease	
Aetiology	
Alcohol-related	107 (56.0)
MASLD	21 (11.0)
Autoimmune	20 (10.5)
Viral	15 (7.9)
Vascular	8 (4.2)
Cryptogenic	8 (4.2)
Other	12 (6.3)
Child-Pugh score, points	9.00 (7.00–11.00)
Child-Pugh class*	
Class A	22 (11.6)
Class B	95 (50.3)
Class C	72 (38.1)
MELD score†	17.00 (12.00–21.00)
Known varices prior to admission	113 (59.2)
Presentation	
Systolic blood pressure, mmHg	112.00 (100.00–125.00)
Diastolic blood pressure, mmHg	68.00 (58.50–75.00)
Heart rate, beats/min	97.00 (84.00–111.00)
Haemodynamic instability at presentation‡	109 (57.1)
Required ITU support on admission or at time of bleeding	40 (20.9)
Laboratory values at presentation	
Haemoglobin, g/L	84.00 (68.25–104.00)
Platelet count, $\times 10^9$/L	111.50 (76.00–158.75)
Haematocrit, ratio	0.259 (0.219–0.309)
Urea, mmol/L	9.10 (5.65–15.90)
Creatinine, µmol/L	70.00 (53.50–95.00)
Bilirubin, µmol/L	48.00 (24.50–82.50)
Alanine aminotransferase, U/L	29.00 (20.75–48.00)
Albumin, g/L	27.00 (22.00–31.00)
International normalised ratio	1.55 (1.30–2.00)
Medication and resuscitation	
Beta-blocker prior to admission	90 (47.1)
Anticoagulant or antiplatelet use	29 (15.2)
Terlipressin administered	154 (80.6)
Prophylactic antibiotics administered	158 (82.7)
Red blood cell transfusion	121 (63.4)
Units transfused, units§	1.00 (0.00–2.00)
Platelet transfusion	20 (10.5)
Units transfused, units§	0.00 (0.00–0.00)
Fresh frozen plasma transfusion	45 (23.6)
Units transfused, units§	0.00 (0.00–0.00)
Endoscopy	
Time from presentation to endoscopy, hours	12.00 (6.00–20.00)
Endoscopy within 12 hours of presentation	90 (47.1)
Endotracheal intubation at the time of endoscopy	49 (25.7)
Findings at index endoscopy	
Actively bleeding varix	53 (27.7)
Varix with stigmata of recent bleeding	123 (64.4)
Varices without stigmata, no alternative source	15 (7.9)
Grade of oesophageal varices	
Grade 1	12 (6.3)
Grade 2	93 (48.7)
Grade 3	86 (45.0)
Number of oesophageal variceal columns, n	3.00 (3.00–4.00)
Gastric varices present	18 (9.4)
Band ligation performed	172 (90.1)
Number of bands applied, n	4.00 (3.00–5.00)
Thrombin or glue injection	5 (2.6)
Initial haemostasis achieved	168 (88.0)
Number of endoscopy sessions, n	1.00 (1.00–1.00)
Rescue and advanced interventions	
Balloon tamponade (Sengstaken–Blakemore tube)	14 (7.3)
Covered oesophageal stent (Danis)	2 (1.0)
EUS-guided coiling	5 (2.6)
TIPSS	12 (6.3)
BRTO/PARTO	1 (0.5)

Table 1. Continued.

Characteristic	Value (n = 191)
Outcomes	
ITU admission during hospital episode	48 (25.1)
Died during admission	36 (18.8)
30-day all-cause mortality	38 (19.9)
1-year all-cause mortality	79 (41.4)

Data are median (interquartile range) for continuous variables and n (%) for categorical variables. *Child-Pugh class could not be assigned in two patients (one with insufficient component data and one without chronic liver disease); percentages are of 189. †MELD was calculable in 188 patients. ‡Systolic blood pressure <100 mmHg and/or heart rate >100 beats per minute at presentation. §Patients who did not receive a transfusion are included as zero units. BRTO, balloon-occluded retrograde transvenous obliteration; EUS, endoscopic ultrasound; GHH, Good Hope Hospital; ITU, intensive therapy unit; MASLD, metabolic dysfunction-associated steatotic liver disease; MELD, Model for End-Stage Liver Disease; PARTO, plug-assisted retrograde transvenous obliteration; TIPSS, transjugular intrahepatic portosystemic stent-shunt.

2.4 Inclusion and Exclusion Criteria

All upper gastrointestinal endoscopies performed at the three participating hospitals during the study period were screened from the electronic endoscopy databases, and the records of patients with suspected AVB were matched to their electronic patient records. Because the sampling frame was the endoscopy record, patients who did not undergo endoscopy could not be identified from it and are therefore not represented in this cohort; the implications of this are addressed in the Discussion.

Inclusion criteria were: (1) presentation directly to one of the three participating hospitals with suspected AVB between 1 January 2019 and 31 December 2024; (2) endoscopy performed during that admission; and (3) endoscopic findings meeting the predefined diagnostic criteria for AVB.

Exclusion criteria were: (1) endoscopic findings that did not meet the predefined diagnostic criteria for AVB; and (2) patients transferred into the network from other hospitals specifically for tertiary interventional radiology input, who had not presented directly to one of the three participating sites. The network is a tertiary referral centre for interventional radiology, and this evaluation was confined to patients presenting directly to the three participating hospitals; patients in this cohort who subsequently required TIPSS or other interventional radiology procedures during their admission were therefore retained and are reported in the Results.

Where a patient had more than one admission with AVB during the study period, only the first (index) admission was included, so that each of the 191 patients contributes one observation; repeat endoscopy performed during the same admission was not counted as a separate bleeding episode. Of 445 suspected AVB episodes screened, 191 unique patients met the criteria above and were included in the analysis. **Supplementary Fig. 1** illustrates the patient selection flow diagram.

2.5 Data Collection

Following identification of patients with AVB from available electronic endoscopy databases, the associated clinical data were further extracted from the electronic health records. Demographic information recorded included age at presentation, sex, ethnicity, and site of admission. Liver disease aetiology was categorised from clinical noting and, where available, liver biopsy, imaging or non-invasive fibrosis assessment.

Disease severity was categorised using the Child-Turcotte-Pugh (CTP) scoring system (classes A, B, and C) [11,12] and Model for End-Stage Liver Disease (MELD) score [13,14]. The Child–Turcotte–Pugh score was assigned from its five components recorded at the index presentation—serum bilirubin, serum albumin, the international normalised ratio (INR), and the presence and severity of ascites and of hepatic encephalopathy—each scored from 1 to 3, giving a total of 5 to 15 points and classes A (5–6), B (7–9) and C (10–15). Ascites and encephalopathy were taken from the contemporaneous clinical documentation and cross-sectional imaging reports. The score was analysed both as a continuous variable in points and by class. MELD was calculated from the bilirubin, INR and creatinine recorded at presentation using the original published formula. Values below the formula's lower limit of 1.0 (a bilirubin of 17.1 µmol/L or a creatinine of 88.4 µmol/L) were set to that limit, and creatinine was capped at 354 µmol/L (4.0 mg/dL). The calculated score was then bounded between 6 and 40, in line with the implementation used for transplant allocation; three patients had a calculated value above 40 and are reported as 40. Serum sodium was not consistently recorded, so MELD-Na and MELD 3.0 were not derived. The score used throughout is therefore the original MELD, calculated once for each patient from the first blood sample taken at presentation, before endoscopy. MELD was calculable in 188 of 191 patients (98.4%). It could not be calculated in three patients (1.6%) in whom the international normalised ratio had not been recorded; bilirubin and creatinine were available for all 191. These three patients are excluded from MELD-based analyses only, and all other analyses use the full cohort.

Presenting symptoms were recorded as haematemesis, melaena, or both. These were taken from the endoscopy request and admission documentation, which did not distinguish the two symptoms consistently or record their combination reliably; presenting symptoms are therefore described qualitatively and are not reported as frequencies. Physiological parameters at presentation were documented, including systolic and diastolic blood pressure, heart rate, and haemodynamic instability status. Smoking history and

Table 2. Univariable association of baseline and in-hospital characteristics with 30-day mortality*.

Variable	Survived to 30 days (n = 153)	Died within 30 days (n = 38)	Test statistic	*p* value
Continuous variables, median (IQR)				
Age, years	55.00 (43.00–62.00)	54.50 (45.00–61.75)	Z = –0.484	0.630
Child-Pugh score, points	8.00 (7.00–10.00)	11.50 (9.00–13.00)	Z = –5.389	<0.001
MELD score	16.00 (12.00–19.50)	23.00 (18.00–27.00)	Z = –4.926	<0.001
Systolic blood pressure, mmHg	114.00 (100.00–128.00)	105.00 (92.00–116.75)	Z = 2.561	0.010
Diastolic blood pressure, mmHg	69.00 (59.00–76.00)	65.00 (54.50–72.50)	Z = 1.761	0.078
Heart rate, beats/min	97.00 (85.00–111.00)	94.00 (81.75–107.00)	Z = 0.557	0.578
Haemoglobin, g/L	83.50 (67.00–101.25)	88.00 (72.25–110.00)	Z = –0.836	0.404
Platelet count, $\times 10^9$/L	111.50 (72.00–163.00)	108.00 (82.25–135.50)	Z = 0.331	0.742
Haematocrit, ratio	0.259 (0.217–0.310)	0.259 (0.234–0.276)	Z = –0.086	0.933
Urea, mmol/L	8.80 (5.40–14.30)	11.95 (6.15–19.02)	Z = –1.620	0.106
Creatinine, µmol/L	67.00 (53.00–88.00)	93.00 (67.50–128.25)	Z = –3.427	<0.001
Bilirubin, µmol/L	44.00 (22.00–69.00)	82.50 (41.50–273.00)	Z = –3.695	<0.001
Alanine aminotransferase, U/L	27.00 (19.50–45.00)	38.00 (25.00–86.00)	Z = –2.264	0.024
Albumin, g/L	28.00 (24.00–32.00)	22.00 (17.25–26.75)	Z = 4.404	<0.001
International normalised ratio	1.50 (1.30–1.90)	2.00 (1.60–2.30)	Z = –4.112	<0.001
Time to endoscopy, hours	13.00 (6.00–21.00)	8.00 (5.00–14.50)	Z = 2.317	0.021
Red blood cell units transfused	1.00 (0.00–2.00)	2.00 (0.00–3.00)	Z = –1.134	0.258
Platelet units transfused	0.00 (0.00–0.00)	0.00 (0.00–0.00)	Z = –1.349	0.178
Fresh frozen plasma units transfused	0.00 (0.00–0.00)	0.00 (0.00–1.00)	Z = –1.574	0.116
Number of variceal columns	3.00 (3.00–4.00)	3.00 (3.00–4.00)	Z = –0.503	0.616
Number of bands applied	4.00 (3.00–5.00)	3.00 (2.50–4.00)	Z = 1.546	0.123
Number of endoscopy sessions	1.00 (1.00–1.00)	1.00 (1.00–2.00)	Z = –2.345	0.019
Categorical variables, n (%)				
Male sex	104 (68.0)	26 (68.4)	χ^2 = 0.003	0.958
White ethnicity	124 (81.0)	25 (65.8)	χ^2 = 4.130	0.042
Child-Pugh class C	45 (29.8)	27 (71.1)	χ^2 = 21.907	<0.001
Known varices prior to admission	96 (62.7)	17 (44.7)	χ^2 = 4.086	0.043
Haemodynamic instability at presentation‡	87 (56.9)	22 (57.9)	χ^2 = 0.013	0.908
ITU support at admission or at bleeding	24 (15.7)	16 (42.1)	χ^2 = 12.832	<0.001
ITU admission during episode	28 (18.3)	20 (52.6)	χ^2 = 19.068	<0.001
Endotracheal intubation at the time of endoscopy	32 (20.9)	17 (44.7)	χ^2 = 9.057	0.003
Beta-blocker prior to admission	77 (50.3)	13 (34.2)	χ^2 = 3.173	0.075
Anticoagulant or antiplatelet use	22 (14.4)	7 (18.4)	χ^2 = 0.386	0.534
Terlipressin administered	124 (81.0)	30 (78.9)	χ^2 = 0.086	0.770
Prophylactic antibiotics administered	125 (81.7)	33 (86.8)	χ^2 = 0.563	0.453
Red blood cell transfusion	97 (63.4)	24 (63.2)	χ^2 = 0.001	0.978
Platelet transfusion	14 (9.2)	6 (15.8)	Fisher's exact	0.242
Fresh frozen plasma transfusion	33 (21.6)	12 (31.6)	χ^2 = 1.694	0.193
Endoscopy within 12 hours	65 (42.5)	25 (65.8)	χ^2 = 6.635	0.010
Actively bleeding varix at endoscopy	39 (25.5)	14 (36.8)	χ^2 = 1.957	0.162
Grade 3 oesophageal varices	65 (42.5)	21 (55.3)	χ^2 = 2.008	0.156
Gastric varices present	12 (7.8)	6 (15.8)	Fisher's exact	0.209
Band ligation performed	142 (92.8)	30 (78.9)	Fisher's exact	0.028

Table 2. Continued.

Variable	Survived to 30 days (n = 153)	Died within 30 days (n = 38)	Test statistic	*p* value
Initial haemostasis achieved	142 (92.8)	26 (68.4)	Fisher's exact	<0.001
Balloon tamponade used	6 (3.9)	8 (21.1)	Fisher's exact	0.001
TIPSS performed	11 (7.2)	1 (2.6)	Fisher's exact	0.465

*Continuous variables were compared using the Mann–Whitney U test, a rank-based test that assumes no particular distribution; the Z value is the standardised test statistic, with a negative value indicating higher values among non-survivors and a positive value higher values among survivors. Categorical variables were compared using the chi-squared (χ^2) test, which quantifies the departure of the observed distribution from that expected under no association. Where any expected cell count was below five, Fisher's exact test was used instead; it calculates the probability directly and produces no test statistic, hence the absence of a χ^2 value in those rows. All tests were two-sided, unadjusted, and $p < 0.05$ was considered significant. All comparisons were performed on complete cases. Data were complete for 36 of the 45 variables collected. The number of patients with missing data was: Child-Pugh score and Child-Pugh class, 2 (1.0%); MELD score, international normalised ratio and alanine aminotransferase, 3 (1.6%) each; haematocrit, 2 (1.0%); haemoglobin and platelet count, 1 (0.5%) each; and number of bands applied, 11 (5.8%). Nineteen patients did not undergo ligation. Of these, nine recorded zero ligatures, and ten did not record the number of ligatures because ligation was not applicable. One patient underwent ligation, but the number of ligatures was not recorded. Therefore, a total of eleven patients did not have their ligature count recorded. Percentages in each group are of the patients with data available for that variable. ‡Systolic blood pressure <100 mmHg and/or heart rate >100 beats per minute at presentation.

current alcohol consumption at the time of admission were not consistently captured in electronic records and were therefore not analysed.

Laboratory investigations obtained at presentation included haemoglobin (g/L), platelet count ($\times 10^9$/L), haematocrit, urea (mmol/L), creatinine (µmol/L), bilirubin (µmol/L), alanine aminotransferase (alanine aminotransferase [ALT]; U/L), albumin (g/L), and INR. Aspartate aminotransferase was recorded in only 42 of 191 patients (22.0%) and was therefore not analysed.

Medication history prior to admission was recorded, including beta-blocker therapy, anticoagulant or antiplatelet use. Acute medical management of AVB was documented including administration of vasoactive therapy (terlipressin), prophylactic antibiotics, and blood product transfusion. Transfusion requirements prior to and during endoscopy were recorded: red blood cell (RBC) units, platelet units, and fresh frozen plasma (FFP) units. The time from initial hospital presentation to Oesophago-Gastro-Duodenoscopy (OGD) was recorded in hours. Performance of OGD within 12 hours of admission was used as a binary variable to facilitate multivariable modelling. Endotracheal intubation at the time of OGD and requirement for ITU stay during the hospital admission episode were both documented. Prior endoscopic variceal therapy is reported within the composite variable "previous history of varices" in Table 1, as defined above.

Endoscopic findings were systematically reviewed. The presence and grade of oesophageal varices (grades 1–3), the number of oesophageal variceal columns, and the presence of gastric varices were recorded. Endoscopic interventions included endoscopic variceal ligation (EVL; band ligation), injection therapy (thrombin or glue), and any adjunctive haemostatic agent. The number of bands applied at the index endoscopy was recorded. Achievement of initial haemostasis following the index endoscopy was recorded. Reasons for repeat OGD were categorised as re-look endoscopy for ongoing bleeding, concern regarding rebleed, and planned surveillance or further treatment.

Rescue and advanced interventions were recorded, including balloon tamponade with a Sengstaken-Blakemore tube, covered expandable oesophageal stent placement using a Danis stent, endoscopic ultrasound (EUS)-guided coiling, and transjugular intrahepatic portosystemic shunt (TIPSS). Balloon-occluded retrograde transvenous obliteration (BRTO), plug-assisted retrograde transvenous obliteration (PARTO), direct intrahepatic portocaval shunt (DIPS) and open surgical portosystemic shunting were also documented where performed.

2.6 Statistical Analysis

Analyses were initially performed using IBM SPSS Statistics version 30.0 (IBM Corp., Armonk, NY, USA). Further analyses were performed in Python version 3.11.15 (Python Software Foundation, Beaverton, OR, USA) using the NumPy 2.4.4, SciPy 1.17.1 and pandas 3.0.2 libraries (NumFOCUS, Austin, TX, USA) and the statsmodels 0.14.6 library (statsmodels developers; open-source software with no commercial manufacturer), with AI-assisted data processing (Claude Sonnet 4.6 and Claude Opus 5; Anthropic, PBC, San Francisco, CA, USA, last revisions of data analyses were completed on 24/08/2026).

The distribution of continuous variables was assessed using the Shapiro–Wilk test, to determine whether the continuous variables were normally distributed. Most continuous variables were non-normally distributed and non-parametric methods were therefore used throughout. Continuous variables are presented as median with interquartile range (IQR) and categorical variables as frequency with percentage. Between-group comparisons (30-day survivors vs non-survivors) were performed using the Mann–Whitney U test for continuous variables and the chi-squared

test or Fisher's exact test for categorical variables, the latter where any expected cell count was below five.

Because only 38 deaths occurred within 30 days, multivariable predictors were pre-specified on clinical grounds rather than selected by univariable screening, and their number was limited by the available events. Two separate models were fitted. Model A was a baseline prognostic model containing only variables available at or before endoscopy (age, sex, Child-Pugh score, and haemodynamic instability at presentation; four predictors, 9.5 events per variable). Model B examined the in-hospital course (ITU admission, endotracheal intubation, achievement of initial haemostasis, and endoscopy within 12 hours) adjusted for Child-Pugh score (five predictors, 7.6 events per variable) and is presented as descriptive of factors associated with mortality during the admission rather than as baseline prognostic factors. A parallel version of Model A substituting MELD for Child-Pugh score was also fitted; because the two scores are strongly correlated, they were never entered together. Child-Pugh score was pre-specified as the severity term in the principal model because it is the score used for risk stratification in the acute variceal bleeding guidelines followed in this network, and because it could be assigned in more patients (189 vs 188); MELD was therefore reported in a parallel model rather than omitted. No model contained MELD together with any of its own components (bilirubin, international normalised ratio or creatinine).

Both models were fitted using Firth penalised logistic regression, with inference by penalised likelihood ratio testing; unpenalised maximum likelihood estimates were computed for comparison (**Supplementary Table 1**).

Two sensitivity analyses were performed to test the robustness of Model A. In the first, the model was refitted with the cohort restricted to patients in whom active bleeding or stigmata of recent bleeding were seen at the index endoscopy, excluding those in whom varices were the only identified source without stigmata. In the second, because haemodynamic instability at presentation can be defined in more than one way, the model was refitted substituting each of five candidate definitions of instability in turn, with all other terms unchanged. No other variable was altered in either analysis.

Firth penalised logistic regression was used to assess the association between clinical factors and the outcome of interest in this study, because it provides more reliable estimates when the sample size is small. Results were reported as odds ratios. Multicollinearity was assessed before model fitting using the variance inflation factor, tolerance, and pairwise Spearman correlations [15,16,17,18,19].

Missing data were handled by complete-case analysis, with the number of patients analysed reported for each model. Kaplan-Meier survival curves were generated to compare overall survival between patients who required ITU admission and those who did not [20] and were compared using the log-rank test. A two-sided p value of <0.05 was considered statistically significant.

3. Results

3.1 Overview of the Study Cohort

Between 1 January 2019 and 31 December 2024, 191 patients presented with AVB across the three hospital sites (QEHB n = 120, 62.8%; BHH n = 43, 22.5%; GHH n = 28, 14.7%). The majority presented with melaena, haematemesis, or a combination of both; because these symptoms were captured from routine admission and endoscopy request documentation, which did not record them consistently, the numbers presenting with each symptom individually could not be determined reliably and are therefore not reported. The median age at presentation was 55 years. A total of 130 patients (68.1%) were male. Regarding ethnicity, 149 (78.0%) were of White background, 19 (9.9%) Asian, 2 (1.0%) Black, and 21 (11.0%) from any other ethnic group. Haemodynamic parameters at presentation included a median systolic blood pressure of 112 mmHg, median diastolic blood pressure of 68 mmHg, and median heart rate of 97 bpm. At presentation patients demonstrated a median haemoglobin of 84 g/L, and median platelet count of 111.5×10^9/L. Renal function showed a median urea of 9.1 mmol/L and median creatinine of 70 µmol/L. Liver function tests were at median bilirubin of 48 µmol/L, median ALT of 29 U/L, and median albumin of 27 g/L. The median INR was 1.55.

Alcohol-related liver disease (ArLD) was the most common aetiology, accounting for 107 patients (56.0%), followed by metabolic dysfunction-associated steatotic liver disease (MASLD; n = 21, 11.0%), autoimmune liver disease including primary biliary cholangitis, primary sclerosing cholangitis, and autoimmune hepatitis (n = 20, 10.5%), viral liver disease (n = 15, 7.9%), vascular liver disease including portal vein thrombosis and Budd-Chiari syndrome (n = 8, 4.2%), and cryptogenic cirrhosis (n = 8, 4.2%). Detailed documentation of active alcohol consumption at presentation was not consistently available across the electronic record system and was therefore not amenable to analysis. Most patients had advanced cirrhosis: 11.6% were classified as CTP class A, 50.3% as class B, and 38.1% as class C. A known history of prior varices was documented in 113 patients (59.2%).

Haemodynamic instability (systolic blood pressure <100 mmHg and/or heart rate >100 beats per minute) at presentation was documented in 109 patients (57.1%). Results about the transfusion details are shown in **Supplementary Table 2**. Forty patients (20.9%) required ITU support on admission or at the time of bleeding, a baseline characteristic distinct from admission to ITU during the hospital episode, which is reported under clinical outcomes in Table 1. A history of beta-blocker therapy prior to admission was recorded in 90 patients (47.1%), and 29 (15.2%) were on anticoagulant or antiplatelet therapy.

Terlipressin was administered to 154 patients (80.6%) and prophylactic antibiotics to 158 (82.7%). Red blood cell (RBC) transfusion was administered to 121 patients (63.4%), platelet transfusion to 20 (10.5%), and fresh frozen plasma (FFP) to 45 (23.6%).

A total of 90 patients (47.1%) underwent OGD within 12 hours of admission. Endotracheal intubation was required in 49 patients (25.7%). At first OGD, actively bleeding varices were identified in 53 patients (27.7%), varices with stigmata of recent bleeding in 123 (64.4%), and varices without bleeding stigmata but with no alternative source identified in 15 (7.9%). Gastric varices were present in 18 patients (9.4%). Regarding oesophageal varices, grade 1 varices were identified in 12 patients (6.3%), grade 2 in 93 (48.7%), and grade 3 in 86 (45.0%). Band ligation was performed in 172 patients (90.1%), with initial haemostasis achieved in 168 (88.0%) at first endoscopic attempt. Thrombin or glue injection was used in 5 patients (2.6%). No haemospray was used in this cohort. Many patients underwent a single OGD session (n = 148, 77.5%); 31 (16.2%) required two sessions, and 12 (6.3%) required three or more. Among the 43 patients who underwent more than one endoscopy, the indication for the repeat procedure was a re-look endoscopy for ongoing bleeding at the initial OGD in 9 (20.9%), concern regarding rebleeding in 20 (46.5%), and planned further treatment such as thrombin injection or further banding in 14 (32.6%).

Balloon tamponade with a Sengstaken-Blakemore tube was required in 14 patients (7.3%) as a bridge to definitive therapy. A Danis covered oesophageal stent was deployed in 2 patients (1.0%). EUS-guided coiling was performed in 5 patients (2.6%), predominantly for gastric varices where conventional injection or band ligation was not technically feasible. TIPSS was performed in 12 patients (6.3%), predominantly as a rescue procedure following failed or repeated endoscopic therapy. No pre-emptive TIPSS was included in this cohort. BRTO/PARTO was performed in 1 patient (0.5%). No patient underwent direct intrahepatic portocaval shunt (DIPS), another radiologically guided portosystemic shunting procedure, or open surgical portosystemic shunting.

3.2 Clinical Outcomes

ITU admission during the hospital episode was required in 48 patients (25.1%). All-cause mortality at 30 days was 19.9% (n = 38) and at one year was 41.4% (n = 79). Univariate analyses of the association between baseline and in-hospital characteristics and 30-day mortality are presented in Table 2. Key findings are summarised here. Non-survivors had significantly higher Child-Pugh score (median 11.50 vs 8.00, Z = –5.389, $p < 0.001$), MELD score (23.00 vs 16.00, Z = –4.926, $p < 0.001$), creatinine ($p < 0.001$), bilirubin ($p < 0.001$), INR ($p < 0.001$) and ALT ($p = 0.024$), and lower albumin ($p < 0.001$) and systolic blood pressure ($p = 0.010$), compared with survivors. Non-survivors were also more likely to require ITU admission (52.6% vs 18.3%, $p < 0.001$), endotracheal intubation (44.7% vs 20.9%, $p = 0.003$), and balloon tamponade (21.1% vs 3.9%, $p = 0.001$), and were less likely to achieve initial haemostasis (68.4% vs 92.8%, $p < 0.001$). Earlier time to OGD was associated with increased 30-day mortality ($p = 0.021$), consistent with the sicker phenotype requiring urgent intervention rather than a direct effect of endoscopy. Age, sex, diastolic blood pressure, heart rate, haemoglobin, platelet count, haematocrit, urea, haemodynamic instability at presentation, transfusion requirements, variceal grade and the number of variceal columns did not differ significantly between survivors and non-survivors.

3.3 Multivariable Models

Two pre-specified multivariable models were fitted. In the baseline prognostic model (Model A; Table 3), Child-Pugh score was the only independent predictor of 30-day mortality, each additional point increasing the odds of death by 69% (odds ratio [OR] 1.69, 95% CI 1.39–2.06, $p < 0.001$). Age (OR 1.03, 95% CI 0.99–1.06, $p = 0.126$), male sex (OR 0.89, 95% CI 0.38–2.08, $p = 0.784$) and haemodynamic instability at presentation (OR 1.09, 95% CI 0.48–2.44, $p = 0.842$) were not independently associated with mortality. Substituting MELD for Child-Pugh score gave an equivalent result (OR 1.18 per point, 95% CI 1.10–1.27, $p < 0.001$; **Supplementary Table 3**), confirming that the choice of severity score did not alter the conclusion. Unpenalised maximum likelihood estimates were closely similar to the penalised estimates for every term. All variance inflation factors in the final models were below 3; MELD carried a variance inflation factor of 9.9 in the candidate variable set and correlated strongly with Child-Pugh score (Spearman $\rho = 0.76$), bilirubin ($\rho = 0.84$) and INR ($\rho = 0.82$), and was therefore never entered alongside these variables (**Supplementary Tables 4,5**).

In the in-hospital model (Model B; Table 4), Child-Pugh score again predicted 30-day mortality (OR 1.54, 95% CI 1.25–1.88, $p < 0.001$), and failure to achieve initial haemostasis was associated with increased mortality (OR 0.30 for haemostasis achieved, 95% CI 0.10–0.89, $p = 0.027$). After adjustment for baseline liver disease severity, ITU admission (OR 1.69, 95% CI 0.53–5.34, $p = 0.363$), endotracheal intubation (OR 0.95, 95% CI 0.31–2.95, $p = 0.931$) and endoscopy within 12 hours (OR 1.38, 95% CI 0.57–3.32, $p = 0.466$) were no longer associated with 30-day mortality, indicating that their univariable associations reflected disease severity rather than an independent effect. Ethnicity was not entered into either model, as the number of deaths in non-White groups was too small to permit estimation (Black, n = 2). In a sensitivity analysis restricted to the 176 patients with active bleeding or stigmata of recent bleeding at endoscopy, Child-Pugh score remained the only independent predictor (OR 1.72, 95% CI 1.39–2.13, $p < 0.001$; **Supplementary Table 6**).

Table 3. Baseline prognostic model for 30-day mortality (Model A): Firth penalised multivariable logistic regression (n = 189; 38 events; 9.5 events per variable)*.

Variable	Reference	β	SE	Wald χ^2	OR (95% CI)	*p* value
Age, per year	Not applicable	0.025	0.017	2.267	1.03 (0.99–1.06)	0.126
Male sex	Female	–0.118	0.433	0.075	0.89 (0.38–2.08)	0.784
Child-Pugh score, per point	Not applicable	0.527	0.100	27.612	1.69 (1.39–2.06)	<0.001
Haemodynamic instability at presentation	No instability	0.082	0.413	0.039	1.09 (0.48–2.44)	0.842

*β, regression coefficient; CI, confidence interval; OR, odds ratio; SE, standard error. The odds ratio is the coefficient expressed on a familiar scale (OR = e^β) and is the figure to read clinically: values above 1 indicate higher odds of 30-day death, values below 1 lower odds, applied per one-unit increase for continuous variables or against the stated reference category. The standard error determines the width of the confidence interval, and an interval excluding 1 indicates statistical significance. The Wald χ^2 is the coefficient relative to its standard error, with larger values indicating stronger evidence. *p* values are from penalised likelihood ratio tests, which are more reliable than Wald tests when outcome events are few. Coefficients, standard errors and Wald statistics are given to three decimal places and odds ratios with confidence intervals to two.

Table 4. Factors associated with 30-day mortality during the hospital admission (Model B): Firth penalised multivariable logistic regression adjusted for baseline severity (n = 189; 38 events; 7.6 events per variable).

Variable	Reference	β	SE	Wald χ^2	OR (95% CI)	*p* value
Child-Pugh score, per point	Not applicable	0.430	0.104	17.216	1.54 (1.25–1.88)	<0.001
ITU admission during episode	No ITU admission	0.524	0.587	0.798	1.69 (0.53–5.34)	0.363
Endotracheal intubation at the time of endoscopy	Not intubated	–0.049	0.577	0.007	0.95 (0.31–2.95)	0.931
Initial haemostasis achieved	Haemostasis not achieved	–1.218	0.562	4.688	0.30 (0.10–0.89)	0.027
Endoscopy within 12 hours	Endoscopy after 12 hours	0.323	0.448	0.520	1.38 (0.57–3.32)	0.466

β, regression coefficient; CI, confidence interval; ITU, intensive therapy unit; OR, odds ratio; SE, standard error. The factors in this model arise during the hospital admission itself and are influenced by how unwell the patient already is. Sicker patients are more likely to receive these interventions, so the associations shown here describe what happened during the admission rather than identifying factors present at presentation that predict outcome.

3.4 Sensitivity Analysis: Definition of Haemodynamic Instability

Because haemodynamic instability can be defined in more than one way, Model A was refitted substituting each of five candidate definitions in turn, with all other terms unchanged and each model adjusted for age, sex and Child-Pugh score (**Supplementary Table 7**).

Three definitions were not associated with 30-day mortality. The definition stated in the Methods—systolic blood pressure <100 mmHg and/or heart rate >100 beats per minute—was met by 109 patients (57.1%; OR 1.09, 95% CI 0.48–2.44, $p = 0.842$). Requiring both criteria simultaneously identified 23 patients (12.0%; OR 1.28, 95% CI 0.43–3.83, $p = 0.657$), and lowering the systolic blood pressure threshold to <90 mmHg identified 93 patients (48.7%; OR 1.39, 95% CI 0.62–3.14, $p = 0.420$).

Two definitions were associated with 30-day mortality. A shock index (heart rate divided by systolic blood pressure) greater than 1 was present in 58 patients (30.4%; OR 2.83, 95% CI 1.21–6.64, $p = 0.015$); unlike the definitions above, this uses a continuous ratio of the two measurements rather than a fixed cut-off for either. Instability as recorded during the original data collection, which took account of receipt of ITU support in addition to the presenting observations, applied to 77 patients (40.3%; OR 4.05, 95% CI 1.72–9.57, $p < 0.001$). This variable was assigned at the time of data collection rather than derived by applying a fixed threshold to the recorded physiological values, and the criteria used were not documented in a form that can be reconstructed retrospectively; it is therefore not a superset of any of the threshold-based definitions above, and the number of patients it identifies is not necessarily larger. It is the only definition that draws on care delivered after admission rather than on physiology recorded at presentation. Both of these definitions are considered further in the Discussion.

3.5 Survival Analysis

Kaplan-Meier analysis demonstrated that ITU requirement was a significant stratifier of overall survival (log-rank $\chi^2 = 6.45$, $p = 0.011$). Patients requiring ITU admission had markedly lower survival probability from the outset, with the survival curves diverging early after admission and remaining separated throughout follow-up (Fig. 1). Thirty-day survival among patients who did not and did require ITU admission was 87.4% (125 of 143) and 58.3% (28 of

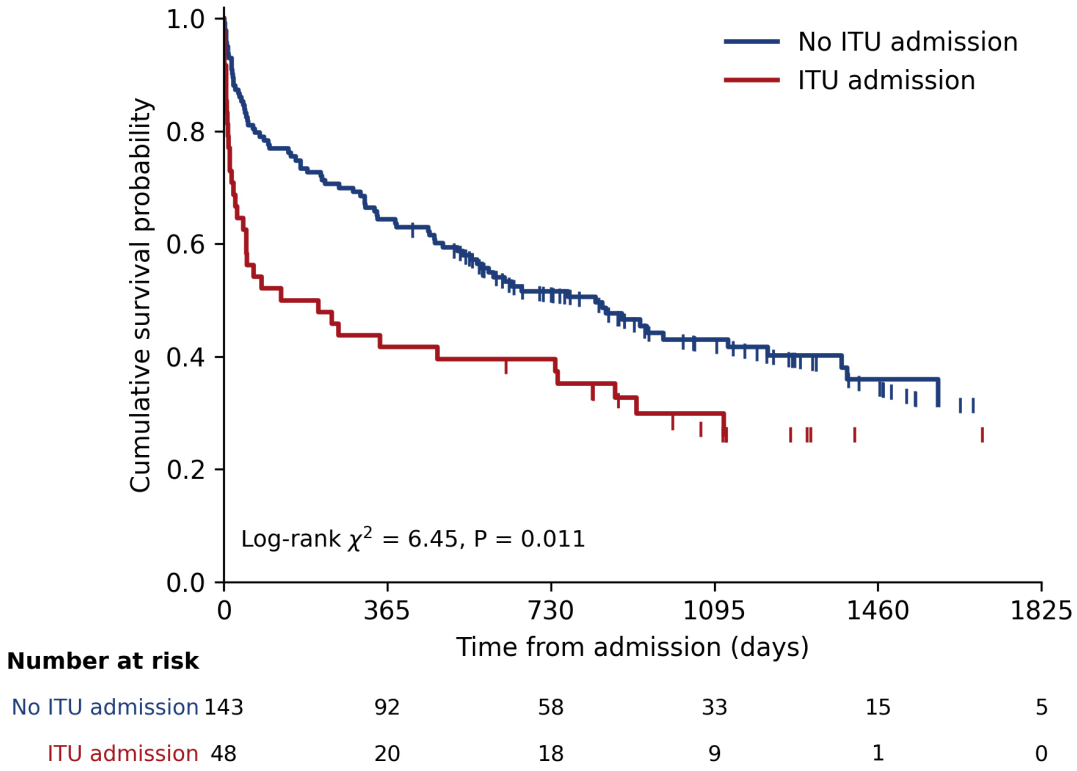


Fig. 1. Kaplan-Meier survival curves stratified by requirement for ITU admission. The x-axis represents survival time in days following the index hospital admission, and the y-axis shows cumulative overall survival. The blue curve represents patients who did not require ITU admission and the red curve those who did. Vertical tick marks denote censored observations. The number of patients at risk in each group is shown beneath the curves. Follow-up was censored/ended on 31 December 2025. Groups were compared using the log-rank test ($\chi^2 = 6.452$, $p = 0.011$). ITU, intensive therapy unit. Survival probabilities are derived from the recorded dates of admission and death and may differ slightly from the crude proportions reported in Table 2.

48) respectively, as reported in Table 2. Kaplan–Meier estimates of longer-term survival were 64.3% vs 41.7% at one year and 43.1% vs 29.9% at three years.

4. Discussion

This service evaluation represents a contemporaneous six-year analysis of AVB outcomes across a large, multi-site UK tertiary network. Our principal findings are that mortality remains high; approximately one in five patients died within 30 days, and two in five within one year, and that outcomes were most strongly associated with the severity of underlying hepatic dysfunction rather than with presenting haemodynamics or the intensity of subsequent supportive care. Among factors arising during the admission, failure to achieve initial haemostasis was the exception, remaining associated with 30-day mortality after adjustment for baseline severity.

Our 30-day mortality of 19.9% is broadly consistent with national audit findings and with the broader international literature, which has reported in hospital mortality of up to 20% depending on the proportion of patients with decompensated cirrhosis [3,21,22]. Notably, 88.4% of our cohort had CTP class B or C disease, a figure that likely reflects the tertiary referral pattern of University Hospitals Birmingham and the urban catchment population, in which alcohol related liver disease is the predominant aetiology (56.0% of patients). The one-year mortality of 41.4% highlights the ongoing high-risk trajectory that follows a first or recurrent variceal bleed, underscoring the importance of effective secondary prophylaxis, continued surveillance, and consideration of liver transplant evaluation in eligible patients.

Detailed documentation of active alcohol consumption at the time of admission was not systematically available in our dataset, this remains an important confounding variable in outcome analyses, particularly given the physiological trajectory of those who continue to consume alcohol, a significant factor in liver disease progression.

Terlipressin was given to 80.6% of patients and prophylactic antibiotics to 82.7%, so BSG/British Association for the Study of the Liver (BASL) bundle-based care reached most but not all patients, leaving scope to improve the consistency with which it is delivered. The absence of an association between these therapies and mortality in our data does not imply that they are ineffective. It reflects in-

stead the well-recognised limitations of retrospective observational analyses in which nearly all patients received the same therapies, leaving insufficient variation in the exposed group to detect an effect. The biological plausibility and randomised trial evidence supporting both terlipressin and antibiotic prophylaxis in AVB remain robust and unaffected by our observational findings [4,6].

Approximately 47.1% of patients were on beta-blockers at the time of presentation. Beta-blockers reduce portal pressure, and in compensated cirrhosis with clinically significant portal hypertension the PREDESCI trial showed that they reduce decompensation, a benefit driven mainly by a lower incidence of ascites rather than by reduced bleeding [9]. The benefit of beta-blockers in modifying outcomes once an acute bleed has occurred is less certain, and our data do not allow conclusions about beta-blocker use, dosage, or compliance. The individual participant data meta-analysis by Villanueva et al. [10] found the survival advantage of non-selective beta-blockers over endoscopic ligation to be confined to compensated cirrhosis, with no difference in decompensated patients. Neither study speaks directly to a cohort such as ours, in which every patient had already bled and most were decompensated, which limits what can be inferred here about pre-admission beta-blocker therapy.

Our study showed haemodynamic instability at presentation was not independently associated with 30-day mortality once liver disease severity was accounted for (OR 1.09, 95% CI 0.48–2.44, p = 0.842), and it did not differ between survivors and non-survivors on univariable testing (56.9% vs 57.9%, p = 0.908). This suggests that, in a cohort of predominantly decompensated cirrhosis, the prognostic signal lies in hepatic reserve rather than in the haemodynamic response to bleeding. The result was not an artefact of one threshold: instability was not associated with mortality under three of the five definitions tested. Of the two that were associated, the original coding included receipt of ITU support and therefore reflected escalation of care as much as presenting physiology. The shock index combines heart rate and blood pressure in a single ratio and may detect circulatory compromise more sensitively than either threshold alone. We regard this as an observation from a retrospective cohort, and it highlights the need for prospective study to establish whether haemodynamic instability alone carries prognostic weight in acute variceal bleeding.

ITU admission remained a powerful stratifier of overall survival on Kaplan-Meier analysis (log-rank p = 0.011), but this too lost independence after adjustment for Child-Pugh score, indicating that it identifies rather than causes the high-risk phenotype. Whether earlier or more liberal ITU escalation would improve outcomes merits prospective evaluation.

Early endoscopy within 12 hours was associated with higher mortality on univariable testing (65.8% of non-survivors vs 42.5% of survivors, p = 0.010) but not after adjustment for baseline severity (OR 1.38, 95% CI 0.57–3.32, p = 0.466), consistent with this association reflecting confounding by severity rather than harm attributable to the procedure: sicker patients are appropriately prioritised for urgent endoscopy. An OGD rate within 12 hours of 47.1% is consistent with the practical constraints of an out-of-hours emergency endoscopy service in a large NHS trust. Band ligation was performed in 90.1%, and initial haemostasis was achieved in 88.0%, figures that align with published standards [4,6]. Failure to achieve initial haemostasis was the only in-hospital factor that remained independently associated with 30-day mortality (OR 0.30 for haemostasis achieved, 95% CI 0.10–0.89, p = 0.027), a clinically coherent finding that reinforces the importance of effective first endoscopic therapy. The number of bands applied did not differ between survivors and non-survivors (p = 0.123) and was not carried into the multivariable models.

Rescue interventions were used in a minority of patients: 14 patients (7.3%) required balloon tamponade, 12 (6.3%) underwent TIPSS, and 5 (2.6%) underwent EUS-guided coiling. TIPSS was predominantly deployed as a rescue procedure following failed endoscopic haemostasis. The utility of EUS-guided coiling for gastric varices in cases where conventional injection therapy is technically challenging is an emerging area supported by growing case series data, and our centre's experience adds to this evidence base; dedicated expert guidance on the management of bleeding gastric varices is also available and supports this approach [23].

The use of BRTO/PARTO remained rare (n = 1), consistent with current practice in UK centres where dedicated interventional radiology expertise for these procedures is limited. It is noted that the latest BSG position statement advises that pre-emptive TIPSS currently be confined to a research setting; the number of patients in our cohort who formally met pre-emptive TIPSS criteria, as distinct from those who ultimately received TIPSS, was not systematically captured and represents a target for future data extraction. UHB is currently recruiting patients to answer this question [5,24].

Ethnicity was not included in the multivariable models. Although White ethnicity was less common among non-survivors on univariable testing (65.8% vs 81.0%, p = 0.042), the number of deaths in non-White groups was too small to support stable estimation, with only two Black patients in the cohort. Any apparent effect of ethnicity in a model of this size would be uninterpretable, and we have therefore reported ethnicity descriptively only. The relationship between ethnicity and outcomes after variceal bleeding warrants investigation in larger, ethnically diverse cohorts.

5. Limitation

Several limitations should be acknowledged. First, the retrospective design introduces the possibility of selection bias, incomplete data ascertainment, and residual con-

founding. Because patients were identified from electronic endoscopy databases and then matched with electronic patient records, those with suspected AVB who did not undergo endoscopy, including any who died before endoscopy could be performed, are not represented. The cohort therefore describes real-world outcomes among patients with AVB who underwent endoscopic assessment rather than the entire real-world spectrum of AVB, and the mortality reported here is likely to understate that of the unselected population, since the patients excluded on this basis include some of the most critically ill. Patients transferred into the network solely for tertiary interventional radiology input were also excluded, so the cohort reflects presentations to the three participating hospitals rather than the network's full tertiary referral workload. Second, data on active alcohol consumption, smoking status, functional status, and comorbidity index were not systematically available. Third, with 38 deaths within 30 days the number of predictors that could be modelled reliably was limited, and a variable showing no independent association in our study may still carry a real but smaller effect that a cohort of this size could not detect.

Fourth, the granular data required to apply Baveno consensus failure-to-control-bleeding definitions retrospectively were not available in all cases. Fifth, the haemodynamic instability definition reported here is derived solely from presenting physiology. Sixth, presenting symptoms were not recorded consistently and are therefore described qualitatively rather than reported as frequencies. Seventh, we analysed 30-day rather than the 6-week mortality recommended by the Baveno consensus, because 30 days was the interval recorded in the dataset—an interval that captures the same early high-risk period.

Finally, the Kaplan–Meier analysis stratifies patients by ITU admission during the hospital episode, an exposure that may occur after follow-up begins; the comparison is therefore susceptible to time-related (immortal time) bias, since a patient must survive long enough to reach intensive care. The timing of ITU admission relative to the index bleed was not captured in the retrospective extract, so a time-dependent analysis could not be performed. The multivariable models, in which ITU admission was not independently associated with mortality, are the basis for our interpretation. What the curves do show is clinically meaningful in its own right—the patients escalated to intensive care were those with substantially worse survival, reflecting accurate recognition of the sickest patients by the clinical teams rather than any effect of intensive care itself. However, despite these limitations, this service evaluation provides valuable contemporaneous real-world data on AVB outcomes from a large UK tertiary centre network, with a sample size substantially larger than most published single-centre series.

6. Conclusion

AVB continues to carry high early and late mortality. Clinical outcomes were most strongly associated with the severity of underlying liver disease, with Child-Pugh score the only independent baseline predictor of 30-day mortality identified in this cohort. Markers of acute physiological compromise and of subsequent escalation of care identified high-risk patients but were not associated with mortality independently of hepatic reserve. Among factors arising during the admission, failure to achieve initial haemostasis at the index endoscopy remained associated with 30-day mortality after adjustment for baseline severity. Early identification of patients with advanced liver disease, prompt bundle-based resuscitation, effective first-time endoscopic haemostasis, and timely access to advanced portal hypertension therapies including TIPSS remain the key priorities for managing AVB patients.

Key Points

• In this retrospective service evaluation of acute variceal bleeding across three hospitals in a large UK tertiary network, early and late mortality remained high, with 19.9% of patients dying within 30 days and 41.4% within one year.

• Outcomes were most strongly associated with liver disease severity, with Child-Pugh score the only independent baseline predictor of 30-day mortality and failure to achieve initial haemostasis the one in-hospital factor that remained associated with mortality after adjustment for baseline severity.

• Vasoactive therapy (80.6%) and prophylactic antibiotics (82.7%) reached most but not all patients, indicating scope to improve the consistency with which acute bundle-based care is delivered.

• Alcohol-related liver disease was the commonest aetiology, indicating the need for meaningful investment in public health strategy aimed at reducing alcohol consumption.

• Research is needed to advance critical care management pathways to determine whether mortality in AVB can be reduced through earlier intervention, including pre-emptive transjugular intrahepatic portosystemic stent-shunt (TIPSS).

Availability of Data and Materials

Anonymised data were collected as part of a registered service evaluation at University Hospitals Birmingham (UHB) NHS Foundation Trust (reference: CARMS-22038). Data are not publicly available owing to information governance restrictions on routinely collected patient data but may be obtained from the corresponding author on reasonable request and subject to UHB approval/data sharing policies.

Author Contributions

AB conceived and designed the study. PP, NAD, OE, GS and KE contributed to data collection. AB performed the statistical analysis. AB and PP drafted the original manuscript. AB, PT, MAB and DT reviewed and edited the manuscript, assessed data quality, developed the re-analysis plan in response to peer review, and evaluated the results and their interpretation. All authors critically revised the manuscript and approved the final version to be published. All authors have participated sufficiently in the work and agreed to be accountable for all aspects of the work.

Ethics Approval and Consent to Participate

This was a retrospective service evaluation approved by the University Hospitals Birmingham (UHB) NHS Foundation Trust audit committee prior to data collection (reference: CARMS-22038). The service evaluation was conducted in strict accordance with the ethical principles for medical research involving human subjects outlined in the Declaration of Helsinki. The service evaluation involved only the retrospective analysis of anonymised data collected during routine clinical care. The requirement for individual informed consent was waived as per the UHB policy. No identifiable patient information is presented in this manuscript.

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Conflicts of Interest

DT has received speaker fees from W. L. Gore & Associates and research funding from AstraZeneca, Boehringer Ingelheim, and the National Institute for Health and Care Research (NIHR). All other authors declare no conflicts of interest pertaining to this manuscript.

Declaration of AI and AI-Assisted Technologies in the Writing Process

Artificial intelligence (AI) tools were used in preparing this manuscript. For the original submission, Claude Sonnet 4.6 (Anthropic, PBC, San Francisco, CA, USA) executed author-specified analytical code to verify the statistical output independently, and assisted with grammar and language editing. Following peer review, Claude Opus 5 (Anthropic, PBC, San Francisco, CA, USA) executed author-specified code to re-analyse the dataset in full in order to address methodological points raised by the reviewers: recalculation of the descriptive and univariable analyses, refitting of the multivariable models using Firth penalised logistic regression, assessment of multicollinearity, and repetition of the survival analysis with log-rank testing. All results reported in this manuscript derive from that re-analysis. The authors defined the analysis plan, specified the variables and models, reviewed and edited all AI-generated content, and checked the outputs against the primary source data. No AI tool was used to generate primary data or to draft the manuscript, and no AI tool is listed as a co-author. The authors take full responsibility for the content of this publication.

Supplementary Material

Supplementary material associated with this article can be found, in the online version, at https://doi.org/10.31083/BJHM56279.

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