Comparison of computed tomography findings with clinical risks factors for endoscopic therapy in upper gastrointestinal bleeding

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Several risk scoring systems exist for acute upper gastrointestinal bleeding (UGIB). The clinical Rockall score (clinical RS) and the Glasgow-Blatchford score (GBS) are major risk scores that consider only clinical data. Computed tomography (CT) findings are equivocal in non-variceal UGIB. We compared CT findings with clinical data to predict mortality, rebleeding and need for endoscopic therapy in non-variceal UGIB patients. This retrospective, single-center study included 386 patients admitted to our emergency department with diagnosis of non-variceal UGIB by urgent endoscopy between January 2009 and March 2015. Multivariable logistic regression analysis was used to investigate CT findings and risk factors derived from clinical data. CT findings could not significantly predict mortality and rebleeding in non-variceal UGIB patients. However, upper gastrointestinal hemorrhage in CT findings better predicted the need for endoscopic therapy than clinical data. The adjusted odds ratios were 10.10 (95% CI 5.01–20.40) for clinical RS and 10.70 (95% CI 5.08–22.70) for the GBS. UGI hemorrhage in CT findings could predict the need for endoscopic therapy in non-variceal UGIB patients in our emergency department. CT findings as well as risk score systems may be useful for predicting the need for endoscopic therapy.

Key Words: acute upper gastrointestinal hemorrhage, risk assessment, computed tomography

A acute upper gastrointestinal (UGI) bleeding is the most common medical emergency in gastroenterology, with an incidence of 50–150 per 100,000 of the population per year and a mortality rate of approximately 11–14% (1,2). The American Gastroenterology Association recommends that urgent UGI endoscopy be carried out within 12 h of admission (3).

The two most widely used systems for evaluating risk based on clinical data are the Rockall score (RS) and the Glasgow-Blatchford score (GBS) (4,5). The RS aims to predict mortality in patients with UGI bleeding (UGIB) and requires a prior UGIB procedure (Table 1). The clinical RS is derived from only clinical data by fitting the data in a multivariable logistic regression analysis, although the complete RS includes endoscopic findings. Several studies have shown that a clinical RS cutoff of 0 can be used to identify no mortality in UGIB. Other studies have reached the same conclusion by using the complete RS. However, the rebleeding rate among UGIB patients varies among previous reports (6,7).

The GBS has been proven to be superior in predicting the need for endoscopic therapy and patient mortality and in identifying patients with low-risk UGIB who require no intervention (Table 2). (8–11) The GBS may help identify patients with UGIB who are at low risk for adverse events and, thus, amenable to outpatient care. An ideal scale for identifying high-risk patients must be highly sensitive.

Risk scoring systems for patients with UGIB are easy to use because they rely on simple clinical data and require no urgent endoscopic therapy. However, most UGIB patients are still assessed based on the experience of the attending physician in the emergency department (ED), and therefore, assessments vary

Table 1. The clinical and complete Rockall score

| Risk markers | Scale score |
|--------------|-------------|
| Age          |             |
| <60          | 0           |
| 60–79        | 1           |
| ≥80          | 2           |
| Shock (systolic blood pressure; SBP) | |
| No shock: SBP≥100, pulse<100 | 0 |
| Tachycardia: SBP≥100, pulse≥100 | 1 |
| Hypotension: SBP<100 | 2 |
| Comorbidity  |             |
| No major comorbidity | 0 |
| Cardiac failure, ischemic heart disease, any major comorbidity | 2 |
| Renal failure, liver failure, disseminated malignancy | 3 |
| Complete (post-endoscopy) Rockall score; same as clinical Rockall score plus | |
| Endoscopic diagnosis | |
| Mallory-Weiss tear or no lesion observed | 0 |
| Pelvic ulcer disease, erosive esophagitis | 1 |
| Malignancy of upper gastrointestinal tract | 2 |
| Stigmata of recent hemorrhage | |
| Clean-based ulcer, flat pigmented spot | 0 |
| Blood in upper gastrointestinal tract, clot, visible vessel, bleeding | 2 |

|Clinical, laboratory and endoscopic variables considered and score for each range of values.

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among hospitals. Urgent endoscopic therapy is not available in many hospitals, such as in remote hospitals located on islands. Our ED receives many critical cases of acute UGIB not only from the neighborhood area but from remote island areas. The decision to prescribe urgent endoscopy is often difficult based on the limited information available for UGIB patients who are admitted from distant, remote islands. Therefore, clinical data are very important, and risk scoring systems are useful in making the decision to transport a critical patient.

For better validation of predicting UGIB, several studies have suggested modified or alternative risk scoring systems to predict UGIB more accurately than conventional risk scoring systems. In addition, Farooq et al. compared risk scores with the clinical triage decisions of ED doctors.

The significance of the computed tomography (CT) findings of patients with acute UGIB is equivocal despite the fact that CT exams are widely available and non-invasive. Several studies have shown that CT exams are useful for patients with acute lower gastrointestinal bleeding (LGB); however, little is known about the usefulness of CT findings for patients with acute UGIB. In our hospital, the CT data of patients from remote islands are available within several minutes through CT data sharing system and can be evaluated by more than two doctors. However, CT findings are subjective compared with clinical data. Therefore, we hypothesized that combining CT data and clinical data would be more useful for predicting UGIB than clinical data alone.

Here, our objective was to evaluate risk scores and the clinical usefulness of CT findings in patients with non-variceal UGIB. In addition, we used multivariable logistic regression analysis to compare risk factors derived from clinical data and CT findings.

### Materials and Methods

#### Ethics.

The study was conducted in accordance with the principles of the Declaration of Helsinki. The study protocol was approved by the Ethics Committee of Tokyo Metropolitan Hiroo Hospital.

#### Study design.

This was a retrospective, single-center study based at Tokyo Metropolitan Hiroo Hospital in Japan.

#### Subjects.

Inclusion criteria were as follows: All adults 18 years of age or older presented to the ED with acute UGIB between January 2009 and March 2015. Acute UGIB was defined as observed hematemesis, melena, or nasogastric aspirate containing gross or altered blood or recent history of hematemesis or melena. All patients underwent endoscopy and were admitted. Exclusion criteria were patients diagnosed with variceal bleeding and patients with no CT exam.

#### CT procedures and definition of CT findings.

A CT exam was performed before endoscopy in all patients. The patients were scanned with either a 16- or 64-detector CT with the following parameters: 120 kV and 7 mm collimation. A contrast-enhanced CT was added to a plain CT when the decision to use the contrast agent was determined by the treating physician. For the contrast-enhanced CT, a total of 90 ml iopamidol was power-injected intra-venously. CT findings were reviewed for the following two points by two experts, however they were blind to clinical data (Fig. 1): UGI hemorrhage in CT exam (yes or no); and UGI wall findings on CT exam (presence of concavity or hypertrophy). CT findings were defined by the agreement of two experts; that is, we defined insufficient significant CT findings when there was the disagreement of two experts.

#### Pre-endoscopy treatment.

At our hospital it is standard to start all patients with UGIB on an intravenous proton pump inhibitor (PPI) or histamine-2 blocker in the emergency room. Intravenous 10 mg omeprazole or 20 mg famotidine drip is started on all patients. Blood transfusions were used in patients with a hemoglobin level below 10 g/dl and hemodynamic instability despite fluid resuscitation though the decision to transfuse blood was determined by the treating physician.

#### Endoscopic procedures.

All patients underwent urgent esophagogastroduodenoscopy. When esophagogastroduodenoscopy revealed active UGIB, endoscopic hemostasis was performed. The decision to perform endoscopic hemostasis was at the discretion of individual endoscopist. The endoscopic hemostasis procedure involved a combination of the following: clipping with a hemoclip, injection of epinephrine solution or ethanol, coagulation using hemostatic devices. Peptic ulcers with signs of recent hemorrhage (i.e., Forrest classification 1, 2a, and 2b lesions) were treated. The decision to perform endoscopic hemostasis for ulcers without signs of active bleeding (i.e., Forrest classification 2c and 3 lesions) was at the discretion of individual endoscopist, as the case may be.

#### Post-endoscopy treatment.

The patients with endoscopic therapy were taken intravenous PPI drip or oral PPI within the hospitalization period.

#### Outcome.

Mortality was defined as death during the hospitalization. Rebleeding was defined as a new episode of bleeding within the hospitalization period, after the initial bleeding had stopped. The primary endpoint was the odds ratio of risks scores based on clinical data and CT findings for predicting mortality in patients with non-variceal UGIB. Secondary endpoints were the odds ratios for predicting rebleeding and need for endoscopic therapy.

#### Statistical methods.

We conducted multivariable logistic regression analysis by combining the CT findings with the risk score factors. However, there were no patients with hepatic disease and a major comorbidity, and thus, we excluded these variables. First, the variables considered in the CT-modified clinical RS models were age (continuous), pulse (continuous), and other markers such as plasma urea, hemoglobin, systolic blood pressure, and other markers as shown in Table 2.

### Table 2. The Glasgow-Blatchford score

| Risk markers | Scale score |
|--------------|-------------|
| Plasma urea (mg/dl) | |
| ≥18.2, <22.4 | 2 |
| ≥22.4, <28 | 3 |
| ≥28, <70 | 4 |
| ≥70 | 6 |
| Hemoglobin (g/dl) | |
| Men | |
| ≥12.0, <13.0 | 1 |
| ≥10.0, <12.0 | 3 |
| <10 | 6 |
| Women | |
| ≥10, <12.0 | 1 |
| <10.0 | 6 |
| Systolic blood pressure (mmHg) | |
| 100–109 | 1 |
| 90–99 | 2 |
| <90 | 3 |
| Other markers | |
| Pulse: ≥100 | 1 |
| Presentation with melena | 1 |
| Presentation with syncope | 2 |
| Hepatic disease | 2 |
| Cardiac failure | 2 |

Clinical and laboratory variables considered and score for each range of values.

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systolic blood pressure (continuous), cardiac failure (categorical), ischemic heart disease (categorical), disseminated malignancy (categorical), UGI hemorrhage on CT findings (categorical) and UGI wall change on CT findings (categorical). Variables considered in the CT-modified GBS models were systolic blood pressure (continuous), hemoglobin (continuous), plasma urea (continuous), pulse (continuous), presentation with melena (categorical), presentation with syncope (categorical), cardiac failure (categorical), UGI hemorrhage on CT findings (categorical) and UGI wall change on CT findings (categorical). We based the sample size on an estimated 9 or 10 variables for the multivariable logistic regression analysis. For reliable analysis, we required at least 10 events of the primary outcome measure per variable, that is, 90 or 100 events for 9 or 10 variables. We obtained a reliable sample size regarding the need for endoscopic therapy; however, the sample size was too small to avoid overfitting for mortality and rebleeding. Multicollinearity was assessed by using the variance inflation factor. A variance inflation factor exceeding 10 is regarded as indicating severe multicollinearity. All statistical analyses were performed with EZR (Saitama Medical Center, Jichi Medical University, Saitama, Japan), which is a graphical user interface for R (The R Foundation for Statistical Computing, Vienna, Austria). More precisely, it is a modified version of R software designed to add statistical functions frequently used in biostatistics.\(^{(18)}\)

Results

Patient characteristics. A total of 386 patients with non-variceal UGIB were enrolled in this study. A plain CT was performed in all patients. A contrast-enhanced CT was performed in 159 patients. The clinical features of these patients are presented in Table 3. Endoscopic therapy was performed in 295 patients (76.4%). There were no significant differences in the baseline characteristics between the two groups. The mortality rate was 1.0% (4/386), and the rebleeding rate was 1.8% (7/386) in all patients. The agreement of two experts about UGI hemorrhage was admitted in 378 patients (97.9%) and UGI hemorrhage on CT findings was detected in 180 patients (46.6%). The agreement of two experts about UGI wall change was admitted in 79 patients (20.5%). UGI hemorrhage on CT findings has a sensitivity of 57.3% and a specificity of 88.0% for predicting the need for endoscopic therapy. UGI hemorrhage on CT findings has a sensitivity of 54.5% and a specificity of 87.7% in plain CT group and a sensitivity 60.8% and a specificity of 86.2% in enhanced CT group for predicting the need for endoscopic therapy. UGI wall change on CT findings has a sensitivity of 13.9% and a specificity of 82.2% in plain CT group and a sensitivity 26.9% and a specificity of 65.5% in enhanced CT group for predicting the need for endoscopic therapy.

Validation of risk score. Clinical RS, with a cutoff>0, has a sensitivity of 100% to predict mortality, with a specificity of 13.1%. In addition, complete RS, with a cutoff>2, has a sensitivity of 100% to predict rebleeding, with a specificity of 4.3%. A GBS greater than 0 has a sensitivity of 98.6% and a specificity of 3.3% for detecting the need for endoscopic therapy. (A GBS greater than 2 has a sensitivity of 97.3% and a specificity of 11.8% for detecting the need for endoscopic therapy.

Comparison of CT findings with risks factors derived from clinical data. The adjusted ORs for mortality, rebleeding and the need for endoscopic therapy based on the multivariable logistic regression analysis are shown in Table 4 and 5. The CT findings were not significant in predicting mortality and rebleeding in patients with non-variceal UGIB. However, UGI hemorrhage on CT findings was more useful in predicting the need for endoscopic therapy than clinical data. Based on the clinical data, the adjusted odds ratios were 10.10 (95% CI 5.01–20.40) for the clinical RS and 10.70 (95% CI 5.08–22.70) for the GBS. On the other hand, UGI wall change on CT findings had no significance in predicting mortality, rebleeding or the need for endoscopic therapy.

![Fig. 1. The classification of computed tomography findings. (A) Upper gastrointestinal hemorrhage. (B) Upper gastrointestinal wall change (concavity). (C) Upper gastrointestinal wall change (concavity, enhanced computed tomography). (D) Upper gastrointestinal wall change (hypertrophy). (E) Neither upper gastrointestinal hemorrhage nor wall change.](image-url)
| Factor | Group | Endoscopic therapy (-) | Endoscopic therapy (+) | p value |
|--------|-------|------------------------|------------------------|---------|
| n      |       |                        |                        |         |
| Sex (%) | F     | 30 (32.3)              | 66 (22.4)              | 0.052   |
|        | M     | 61 (67.0)              | 229 (77.6)             |         |
| Age (%) | Young | <60                    | 18 (19.8)              | 102 (34.6) | 0.002 |
|        | Intermediate | 60–80                | 39 (42.9)              | 131 (44.4) |         |
|        | Old    | 80<                   | 34 (37.4)              | 62 (21.0)     |         |
| Pulse (%) | <100  | 64 (70.3)              | 164 (55.6)             |         |
|        | <100   | 27 (29.7)              | 131 (44.4)             |         |
| Systolic blood pressure (%) | <110   | 61 (67.0)              | 161 (54.6)             | 0.218   |
|        | 100–109 | 12 (13.2)           | 50 (16.9)              |         |
|        | 90–99   | 10 (11.0)              | 41 (13.9)              |         |
| <90    | 8 (8.8) |                       | 43 (14.6)              |         |
| Presentation with melena (%) | No     | 41 (45.1)              | 87 (29.5)              | 0.007   |
|        | Yes    | 50 (56.2)              | 208 (70.5)             |         |
| Presentation with syncope (%) | No     | 85 (93.4)              | 239 (81.0)             | 0.005   |
|        | Yes    | 6 (6.6)                | 56 (19.0)              |         |
| Cardiac failure (%) | No     | 86 (94.5)              | 289 (98.0)             | 0.14    |
|        | Yes    | 5 (5.5)                | 6 (2.0)                |         |
| Ischemic heart disease (%) | No     | 81 (89.0)              | 272 (92.2)             | 0.39    |
|        | Yes    | 10 (11.0)              | 23 (7.8)               |         |
| Renal failure (%) | No     | 87 (95.6)              | 289 (98.0)             | 0.255   |
|        | Yes    | 4 (4.4)                | 6 (2.0)                |         |
| Disseminated malignancy (%) | No     | 88 (96.7)              | 285 (96.6)             | 1       |
|        | Yes    | 3 (3.3)                | 10 (3.4)               |         |
| Antithrombotic medication (%) | No     | 67 (73.6)              | 244 (82.7)             | 0.068   |
|        | Yes    | 24 (26.4)              | 51 (17.3)              | 0.07    |
| Anti-gastric acid medication (%) | No     | 74 (81.3)              | 263 (89.2)             |         |
|        | Yes    | 17 (18.7)              | 32 (10.8)              |         |
| Hemoglobin score (GBS, %) | No     | 20 (22.0)              | 28 (9.5)               | 0.012   |
|        | Yes    | 9 (9.9)                | 45 (15.3)              |         |
| Blood urea nitrogen score (GBS, %) | No     | 11 (12.1)              | 55 (18.6)              |         |
|        | Yes    | 6 (6.6)                | 167 (56.6)             |         |
| CT findings (the agreement of two experts) | Hemorrhage (%) | No | 80 (87.9) | 126 (42.7) | <0.001 |
|        |        | Yes                    | 11 (12.1)              | 169 (57.3) |         |
|        | Wall change (%) | No | 70 (76.9) | 237 (80.3) | 0.012 |
|        |        | Yes                    | 11 (12.1)              | 169 (57.3) |         |
|        | Concavity | 1 (1.1)   | 21 (7.1)              |         |
|        | Hypertrophy | 20 (22.0) | 37 (12.5) |         |
| Main diagnosis (%) | Gastric ulcer | 19 (20.9) | 173 (58.6) |         |
|        | Early gastric cancer | 0 (0.0) | 1 (0.3) |         |
|        | Advanced gastric cancer | 10 (11.0) | 15 (5.1) |         |
|        | Malignant lymphoma | 1 (1.1) | 2 (0.6) |         |
|        | Other gastric diseases | 9 (9.9) | 11 (3.7) |         |
|        | Reflux esophagitis | 17 (18.7) | 3 (1.0) |         |
|        | Mallory-Weiss Syndrome | 1 (1.1) | 33 (11.2) |         |
|        | Esophageal ulcer | 0 (0.0) | 1 (0.3) |         |
|        | Other esophageal diseases | 1 (1.1) | 1 (0.3) |         |
|        | Duodenal ulcer | 6 (6.6) | 51 (17.3) |         |
|        | Duodenal ulcer scar | 1 (1.1) | 0 (0.0) |         |
|        | Other duodenal diseases | 2 (2.2) | 0 (0.0) |         |
|        | Stomal ulcer | 0 (0.0) | 4 (1.4) |         |
|        | Pancreas cancer invasion | 1 (1.1) | 0 (0.0) |         |
|        | Tongue hemorrhage | 1 (1.1) | 0 (0.0) |         |
|        | Nasal hemorrhage | 1 (1.1) | 0 (0.0) |         |
|        | No finding | 21 (23.1) | 0 (0.0) |         |
| Forrest classification (ulcer group only), n = 254 | 1a | 0 | 28 | <0.001 |
|        | 1b | 0 | 46 |         |
|        | 2a | 1 | 142 |         |
|        | 2b | 4 | 6 |         |
|        | 2c | 3 | 2 |         |
|        | 3 | 17 | 5 |         |
| Therapy (includes multiple therapy) | Ethanol | 140 | |         |
|        | Hypertonic saline epinephrine (HSE) | 139 | |         |
|        | Clip | 212 | |         |
|        | Hot biopsy coagulation | 16 | |         |
|        | Argon plasma coagulation | 8 | |         |
|        | Other | Intervventional radiology | 4 | |         |
|        | Operation | 1 | |         |
|        | Polypectomy | 1 | |         |
|        | Mortality (%) | No | 88 (96.9) | 294 (99.7) | 0.042 |
|        | Yes | 3 (3.3) | 1 (0.3) |         |
| Rebleeding (%) | No | 89 (97.8) | 290 (98.3) | 0.67 |
|        | Yes | 2 (2.2) | 5 (1.7) |         |
| Hospitalization (days) | mean (SD) | 15.67 (16.25) | 13.70 (9.68) | 0.159 |

GBS, Glasgow-Blatchford score.
Combination of risk score systems and the CT findings.

UGI hemorrhage on CT findings or a clinical RS=0, has a sensitivity of 90.8% and a specificity of 4.4% for detecting the need for endoscopic therapy. UGI hemorrhage on CT findings or a GBS=0, has a sensitivity of 98.6% and a specificity of 3.3% for detecting the need for endoscopic therapy. UGI hemorrhage on CT findings or a GBS>2, has a sensitivity of 98.0% and a specificity of 12.1% for detecting the need for endoscopic therapy. UGI hemorrhage on CT findings or a GBS>0, has a sensitivity of 98.6% and a specificity of 3.3% for predicting mortality and rebleeding. A GBS of 0 or a GBS>2, has a sensitivity of 97.3% and a specificity of 11.8% for detecting the need for endoscopic therapy. (A GBS>2 has a sensitivity of 100% for predicting mortality and rebleeding. A GBS>0 has a sensitivity of 98.6% and a specificity of 3.3% for predicting the need for endoscopic therapy.) In other words, a GBS of 0 or a GBS>2 indicates no need for endoscopic therapy. These results are in agreement with those of prior studies in the literature; however, we observed a highly variable specificity. The mortality and rebleeding rates among the included patients with non-variceal UGIB were much lower than those reported in the study of Vreeburg et al. This difference is likely because of the improvements that have been made in endoscopic techniques.

In addition to these results, we validated the odds ratio individually for factors of risk scores and CT findings by fitting the data by multivariable logistic regression analysis. Rebleeding affects UGIB patient outcomes and is considered a risk factor for mortality. We expect that CT findings can substitute the endoscopic findings of the complete RS. However, none of the factors, including the CT findings, had a significant odds ratio for predicting mortality and rebleeding. This may be explained by our limited sample size with low mortality and rebleeding rates, as stated above.

On comparison between plain and enhanced CT, both UGI hemorrhage and wall change on CT findings in plain CT group has a little lower sensitivity than in enhanced CT group. It can be inferred that enhanced CT is more likely to detect UGI hemorrhage and wall change than plain CT, however it is necessary to avoid enhanced CT in patients with contrast agent allergy, asthma, and renal function deterioration. In our study, UGI hemorrhage could be detected in both plain and enhanced CT groups and it was inferred that enhanced CT is more likely to detect UGI hemorrhage and wall change than plain CT, however it is necessary to avoid enhanced CT in patients with contrast agent allergy, asthma, and renal function deterioration. In our study, UGI hemorrhage could be detected in both plain and enhanced CT groups and it was considered to be useful for predicting the need of endoscopic therapy by multivariable logistic regression analysis.

For predicting the need for endoscopic therapy, some clinical factors such as “presentation of melena” corresponded to significant odds ratios. Furthermore, UGI hemorrhage on CT findings had a higher odds ratio for predicting the need for endoscopic therapy than risk factors derived from clinical data. We believe that UGI hemorrhage on CT findings can predict a certain amount of UGIB and the need for endoscopic therapy.

Several methods have been investigated for predicting the need for endoscopic therapy, other authors have confirmed that nasogastric aspiration is useful for predicting the need for endoscopic therapy in acute UGIB cases. Nasogastric aspiration
has a high specificity of 82–91% in acute UGIB cases with a highly variable sensitivity of 42–84%. They claimed that positive nasogastric aspiration indicates probable acute UGIB due to high specificity; however, negative nasogastric aspiration does not rule out acute UGIB due to low sensitivity. The authors suggested that duodenal ulcers can produce false-negative nasogastric aspiration results because the pyloric sphincter impedes the passage of a tube. We hypothesized that UGI hemorrhage on CT findings would be useful for noninvasively predicting UGIB as well as nasogastric aspiration, as it had a sensitivity of 57.3% and a specificity of 88.0% in our study.

The combination of risk score systems and UGI hemorrhage on CT findings had higher sensitivity than validation only by UGI hemorrhage on CT findings, however we observed a lower specificity. It was similar to validation only by risk score systems in that it has a high sensitivity and a low sensitivity. In the analysis excluding cases with low risk score, validation of UGI hemorrhage on CT findings has a little higher sensitivity while keeping high specificity.

UGI wall change on CT findings had no significance in predicting mortality, rebleeding or the need for endoscopic therapy. The complete RS can detect high- or low-risk patients with UGIB for mortality, and endoscopic findings are as important as clinical data in identifying patients who require intensive care to improve their outcomes.

Table 5 shows multivariable logistic regression analysis. SBP, systolic blood pressure; CT, computed tomography; UGI, upper gastrointestinal; Hb, hemoglobin; N/A, not applicable: there is no case.

| Score | Odds ratio (95% CI) | p value |
|-------|---------------------|---------|
| SBP (mmHg) |                      |         |
| >110  | 12.90 (0.23–720.00) | 0.21    |
| 100–109 | 2.40 (0.34–17.00)  | 0.38    |
| 90–99  | 8.02 (0.11–57.00)   | 0.34    |
| <90    | 16.30 (0.18–1380.00)| 0.22    |
| Hemoglobin (g/dl) |              |         |
| ≥13 (men), ≥12 (females) | 1.43 (0.48–4.26) | 0.52 |
| 12≤Hb<13 (men), 10≤Hb<12 (females) | N/A |         |
| 10≤Hb<12 (men) | 2.09 (0.76–5.75) | 0.16    |
| Hb<10  | 1.64 (0.71–3.82)   |         |
| Blood urea (mg/dl) |                   |         |
| <18.2 | N/A                 |         |
| ≥18.2, <22.4 | 0.87 (0.25–3.07) | 0.83    |
| ≥22.4, <28 | 2.48 (0.94–6.60) |         |
| ≥28, <70 | 1.95 (0.92–4.15) |         |
| ≥70    | 1.35 (0.71–3.82)   |         |
| Pulse  | ≥100  | 1.47 (0.44–4.14) | 0.19    |
| ≥100   | 1.88 (0.14–25.40) | 0.64    |
| Presentation with melena |                   |         |
| 1      | 0.20 (0.02–2.54)  | 0.22    |
| Presentation with syncope |                   |         |
| 2      | 3.53 (0.18–71.20) | 0.41    |
| Cardiac failure |                   |         |
| 2      | 36.50 (0.82–1630.00)| 0.06    |
| CT findings |                   |         |
| UGI hemorrhage | 0.11 (0.01–2.22) | 0.15    |
| UGI wall change | 1.30 (0.07–25.10)| 0.84    |
study showed no significant relation between UGI wall change on CT findings and predicting UGIB according to the multivariable logistic regression analysis.

In summary, risk scoring systems based on clinical data are useful for ruling out UGIB because of their high sensitivities. On the other hand, UGI hemorrhage on CT findings may predict the need for endoscopic therapy because of its high specificity and high odds ratio according to the multivariable logistic regression analysis.

There are several limitations of this study. First, our study was a single-center retrospective study. Although our ED receives many critical cases of acute UGIB, not only from the local area, but also from remove island areas, other prospective multi-center studies are needed.

Another limitation is that variceal patients were excluded, and thus, the calculated GBS was lower than that for patients with hepatic disease. We excluded variceal bleeding in the present study because most variceal bleeding is critical, and endoscopic therapy is more difficult to administer for variceal bleeding (such as EVL or EIS) than for non-variceal bleeding. Furthermore, variceal bleeding depends on liver damage such as albumin, prothrombin time, hepatic coma and ascites. These factors have little relevance to this study.

Third, our study was limited to inpatients and did not include outpatients; hence, the proportion of patients with no need for endoscopic therapy might increase if outpatients are included.

Finally, information regarding the last meal time was not added to the CT findings. However, most patients had an empty stomach on ED admission due to poor health. Therefore, further studies would be necessary to confirm the usefulness of CT findings in non-variceal UGIB patients.

In conclusion, we investigated CT findings and risks scores derived from clinical data for non-variceal UGIB patients. UGI hemorrhage on CT findings is a significant factor for predicting the need for endoscopic therapy according to multivariable logistic regression analysis.

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Author Contributions

Study concept and design; FJ, HI, KF, MK, KK, KO, TN, TI, AK, AN, SK, AN and MI. Acquisition of data; FJ, AN and SK. Analysis and interpretation of data; FJ and HI. Drafting of the manuscript; FJ, HI, KF and MI. Critical revision of the manuscript for important intellectual content; FJ, HI, KF and MI. Statistical analysis; FJ and HI. Obtained funding; KF, MK, AN and MI.

Administrative, technical, or material support; FJ and HI. Study supervision; AN, SK, AN and MI.

Abbreviations

CT computed tomography
ED emergency department
EIS endoscopic injection sclerotherapy
EVL endoscopic variceal ligation
GBS Glasgow-Blatchford score
PPI proton pump inhibitor
RS Rockall score
UGIB upper gastrointestinal bleeding

Conflict of Interest

No potential conflicts of interest were disclosed.

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