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Effect of hospital-admission volume on outcomes following acute non-variceal upper gastrointestinal bleeding

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ABSTRACT

INTRODUCTION: Treatment-requiring acute non-variceal upper gastrointestinal bleeding (NVUGIB) is a common, potentially life-threatening emergency. This study investigated whether hospital admittance volume of patients with NVUGIB was associated with reduced mortality, reduced lasting failure of haemostatic procedures defined as rate of re-endoscopy with repeated haemostasis intervention (ReWHI), transfusion requirements and conversion to surgery.

METHODS: Data on Danish nationwide admissions of patients with acute NVUGIB from 2011-2013 were analysed to estimate 30-day mortality, re-bleeding (ReWHI), transfusion rates and rates of conversion to surgery. Data were analysed by regression modelling while controlling for confounders including age, admission haemoglobin, the American College of Anesthesiologists score, comorbidities and the Forrest classification.

RESULTS: A total of 3,537 patients with acute non-variceal upper gastrointestinal bleeding were included in the study. The hospital admission volume of patients with NVUGIB was positively associated with a significant increase in ReWHI with an odds ratio of 1.27; p = 1.91 × 10–6. There was no significant association between admission volume and conversion to surgery, 30-day mortality or transfusion rates.

CONCLUSIONS: A positive association between admission volumes of patients with NVUGIB and ReWHI was identified. No association between admission volumes and 30-day mortality or other failure of haemostasis events could be identified.

FUNDING: none.

TRIAL REGISTRATION: not applicable.
version (ICD10) codes indicating a diagnosis of hypertension, diabetes, previous myocardial infarction, atrial fibrillation as well as chronic liver or renal disease.

From the Danish Clinical Register of Emergency Surgery (Akut Kirurgi Databasen) [7], data on American Society of Anesthesiologists (ASA) score, admission haemoglobin and haemorrhage stigmata were collected. Transfusion information was extracted from the Danish National Transfusion Database, whereas time of death was collected from the Danish Cause of Death Registry.

**Statistical analysis**

Statistical analysis was performed using “R” [8]. Hospitals were stratified into quartiles based on their annual volume of NVUGIB admissions. Data were analysed using logistical or linear regression as appropriate. Multiple regression models, associating outcomes with hospital NVUGIB admission volumes, were used and controlled for confounders, including age, sex, admission haemoglobin, ASA score, presence of comorbidities, as defined above, and haemorrhage stigmata defined as a compound grade based on the Forrest classification [9]. Grade 1 equals Forrest grades I-IIb, grade 2 equals Iic and above.

Dichotomous outcomes such as need for ReWHI, conversion to surgery and 30-day mortality are presented as percentages and odds ratios (OR) with 95% confidence intervals (CI), whereas continuous outcomes are reported as medians with interquartile range and as β-coefficients with standard error.

**Trial registration:** not applicable.

**RESULTS**

A total of 3,537 patients with treatment-requiring acute NVUGIB were included. Basic demographics are presented in Table 1.

The quantitative frequencies of the study endpoints are shown in Table 2. Re-bleeding occurred in 20% of cases, resulting in either ReWHI (16.8%) or conversion to surgery (2.9%). RPCs were frequent with a median use of four (2-7) units per patient. Fresh frozen plasma (FFP) and pooled platelets (PLT) were rarely employed with a median use of zero instances and an interquartile use of (0-2) and (0-0), respectively.

**Table 1**

<table>
<thead>
<tr>
<th>Basic demographics.</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, yrs, median (IQR)</td>
<td>74 (65-83)</td>
</tr>
<tr>
<td>Male gender, %</td>
<td>56.7</td>
</tr>
<tr>
<td>Hypertension, %</td>
<td>53.2</td>
</tr>
<tr>
<td>Atrial fibrillation, %</td>
<td>25.7</td>
</tr>
<tr>
<td>Diabetes, %</td>
<td>17.1</td>
</tr>
<tr>
<td>Renal disease, %</td>
<td>11.0</td>
</tr>
<tr>
<td>Liver disease, %</td>
<td>6.5</td>
</tr>
<tr>
<td>Prior myocardial infarction, %</td>
<td>12.5</td>
</tr>
<tr>
<td>ASA score, median (IQR)</td>
<td>3 (2-3)</td>
</tr>
<tr>
<td>Admission haemoglobin, mmol/l, median (IQR)</td>
<td>5.1 (4.2-6.1)</td>
</tr>
<tr>
<td>Haemorrhage stigmata*, median (IQR)</td>
<td>1 (1-1)</td>
</tr>
</tbody>
</table>

ASA = American College of Anesthesiologists; IQR = interquartile range.

*a) Compound score based on the Forrest classification: grade 1 ≈ grades I-IIb, grade 2 ≈ ≥ Iic.*

**Table 2**

Quantitative frequency of the study endpoints (n = 3,537).

| Failure of haemostasis and mortality, % | Need for re-endoscopy | 16.8 |
| Conversion to surgery | 2.9 |
| 30-day mortality | 7.2 |
| Transfusion requirements/patient, median (IQR) | 4 (2-7) |
| Packed red blood cells, U | 0 (0-2) |
| Fresh frozen plasma, instances | 0 (0-0) |
| Pooled platelets, instances | 0 (0-0) |

IQR = interquartile range.

**Table 3**

The effect of hospital admission volume of non-variceal upper gastrointestinal bleeding on study endpoints.

<table>
<thead>
<tr>
<th></th>
<th>Unadjusted model</th>
<th>Adjusted model</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OR (95% CI)</td>
<td>β-coefficient (± SE)</td>
</tr>
<tr>
<td>Need for re-endoscopy</td>
<td>1.06 (1.03-1.09)</td>
<td>–</td>
</tr>
<tr>
<td>Conversion to surgery</td>
<td>0.75 (0.66-0.98)</td>
<td>–</td>
</tr>
<tr>
<td>30-day mortality</td>
<td>1.01 (0.91-1.13)</td>
<td>–</td>
</tr>
<tr>
<td>Packed red blood cells transfused</td>
<td>–</td>
<td>-0.14 (± 0.14)</td>
</tr>
<tr>
<td>Fresh frozen plasma transfused</td>
<td>–</td>
<td>-0.12 (± 0.09)</td>
</tr>
<tr>
<td>Pooled platelets transfused</td>
<td>–</td>
<td>0.02 (± 0.03)</td>
</tr>
</tbody>
</table>

CI = confidence interval; OR = odds ratio; SE = standard error.
The effect of NVUGIB hospital admission volume on study end points is presented in Table 3 and graphically depicted in Figure 1. There was no significant association between hospital admission volume and 30-day mortality, conversion to surgery or volume of RBCs transfused (Table 3).

Hospital admission volume stratification was positively associated with a significant increase in ReWHI with an OR of 1.28 (95% CI: 1.16-1.42); p = 2.09 × 10^-6.

Subgroup analysis revealed no associations between comorbidities and risk of ReWHI, although atrial fibrillation showed a trend towards and increased risk (OR = 1.28 (95% CI: 1.16-1.42); p = 0.06). In contrast, age (p = 0.04), ASA score (p = 0.04) and Forrest classification (p < 0.01) were all associated with an increased risk of ReWHI.

**DISCUSSION**

This study found that hospital admission volume of treatment-requiring patients with NVUGIB was positively associated with a significant increase in ReWHI. In contrast, no association with mortality, blood product utilisation or conversion rates could be identified. These results suggest that ReWHIs were more frequent in hospitals with a high admission volume than in hospitals with a lower admission volume, which runs counter to the initial study hypothesis.

Before drawing conclusions, it is important to underline the difference between initial technical failure of haemostasis related to inadequate haemostasis during the index endoscopy, and late failure, which is often attributed to multiple confounding variables (fluid resuscitation strategies, patient comorbidities, adherence to proton pump inhibitor regimes, etc.).

The present study only investigated the association between NVUGIB admission volumes and the above-mentioned predefined outcomes, and the study setup does not allow for a conclusion on whether the observed differences were primarily due to primary haemostasis insufficiency, unnecessary re-endoscopies or late confounding effects. Furthermore, the level of adherence to guidelines mandating dual therapy modalities as well as mandatory proton inhibitor therapy cannot be assessed.

Theoretically, a variety of factors could, however, have had an impact on the observed results. The higher frequency of re-endoscopy with intervention may be driven by the availability of dedicated endoscopy units. In Denmark, hospitals with a high admission volume often have independent endoscopy units or dedicated operating room (OR) facilities to which patients can easily be transferred without having to compete for OR facilities with other patient groups. When faced with a patient exhibiting a continuous slow drop in haemoglobin levels without any signs of frank critical bleeding, the ease of referral to re-endoscopy may result in more rapidly performed re-endoscopies.

This again raises the question of whether a subgroup of subclinical NVUGIB re-bleedings (patients with a gradual drop in haemoglobin levels following their initial endoscopy) may actually be self-limiting, and suggests that a need exists for studies aimed at investigating the optimal criteria for NVUGIB re-endoscopy. Furthermore, it may be speculated that once the decision to perform re-endoscopy was made, the threshold to proceed to actual therapeutic intervention was lower. As such, the easier access to re-endoscopy in high-volume centres may facilitate additional endoscopies, which in turn leads to an increased number of interventions due to the threshold effect. Alternatively, confounding effects such as differences in fluid resuscitation strategies may also be of importance, although a recent study has indicated only a limited association between resuscitation strategy and outcomes following NVUGIB [10].

Another potential aspect may be the fact that high-volume centres often also serve as academic teaching institutions, which may result in an increased ratio of trainee endoscopists, junior attendings or even resident physicians on call. Within the field of colorectal cancer surgery, surgeon volume has been found to improve outcomes with a reduction in 30-day mortality, five-year survival, recurrence, anastomotic leak, hospital stay, operating time and hospital expenses compared with surgeons with a low volume of operations [5].
It may be speculated that these associations to some degree also apply when treating patients with NVUGIB. While data on the experience level of the endoscopist would have been interesting, unfortunately such data were not available.

It may also be speculated that patients in high-volume hospitals are preselected and more severely ill and therefore more likely to undergo re-endoscopy during admission than patients in hospitals with lower volumes. Including comorbidities and ASA classification in the multivariate model did, however, not underpin this.

These findings contradict previous studies in the field. One study found a significant correlation between hospitals with low admission volume and a negative outcome in high-risk patients with NVUGIB measured on continuous bleeding after treatment, re-bleeding during admission, the need for surgical/other re-treatment and death within 30 days following endoscopy [11]. Choi et al pointed out that these findings may be caused by the difference in the number of clips used, and that administration of post-endoscopy proton pump inhibitors was different in the two groups. While we cannot rule out this effect, it is important to note that Danish national guidelines mandate combination therapy, including a minimum of two modalities [12] (e.g., epinephrine injections, cauterisation, clips, etc.) as well as administration of post-endoscopy high-dose proton pump inhibitors. Previous reports have suggested a high degree of adherence to these protocols [3, 4]. Furthermore, these reports do not indicate significant differences in adherence to protocols in high-versus low-volume hospitals.

Although this study does not provide adequate information to assess this, other aspects of haemostasis should be considered when interpreting the results: Novel haemostatic methods are currently under investigation in order to reduce the number of re-bleedings and re-endoscopies in patients with NVUGIB. One study found that the use of haemostatic spray may be appropriate in high-risk patients with a peptic ulcer after adrenaline injection, when other haemostatic measures may not be technically suitable, or as an adjunct to conventional dual therapy in order to achieve primary haemostasis [13]. Other factors like transfusion of PRBC was found to be associated with an increased rate of re-endoscopy as well as conversion to surgery and in-hospital mortality in one study [10]. Furthermore, the timing of surgery has been found to be crucial in lowering in-hospital mortality. Laursen et al found that the optimal timing of endoscopy in haemodynamically stable patients with an ASA-score of 3-5 is 12-36 hours post admission and that haemodynamically unstable patients should undergo endoscopy within three hours following admission [14]. Factors like comorbidity, but not stigmata of the bleeding, have been found to be associated with a decrease in long-term survival [15].

Several studies point out and suggest predictors for re-bleeding after initial endoscopic interventions. One meta-analysis concluded that major predictors of re-bleeding among patients with peptic ulcer bleeding include haemodynamic instability, active bleeding at endoscopy, large ulcer size, ulcer location, haemoglobin value and the need for transfusion [16]. As such, several of the above-mentioned factors could have confounded the observed results.

Regardless of the underlying reason, it is interesting to note that these factors were associated neither with mortality nor with transfusion requirements. As such, even though patients at high-volume centres required more ReWHIs, haemostasis (as measured by blood product utilisation) was unaffected. If the initial endoscopic attempt was unsuccessful, one would also have expected higher rates of blood product utilisation. In contrast, blood product utilisation was not associated with hospital admission volumes. These findings might suggest that the ReWHIs performed were, to some extent, unnecessary, which highlights the need for further studies investigating the optimal indications and procedures for re-endoscopy following NVUGIB.

A number of limitations should be acknowledged in this study. As is the case for any retrospective study, the quality of the data relies solely on the quality of the input data. Furthermore, we can only determine associations and not conclude on causal associations.

We adjusted the model for relevant confounders, but we cannot exclude that unidentified confounders may be relevant to this study. Disease severities may not be completely captured by diagnosis codes or ASA classifications. Information regarding anticoagulant use, re-endoscopy without intervention, skill level of the endoscopist as well as timing of endoscopy would have been relevant. Also, access to interventional radiology could be a factor, although referral would theoretically be easier from high-volume centres. Finally, this cohort is representative of patients with upper GI haemorrhage. As such, results may differ if only massive bleeders were analysed.

Further prospective studies are relevant in order to assess the true causation between hospital volume and outcomes of NVUGIB.

**CONCLUSIONS**

This study found that hospital admission volume was positively associated with a significant increase in the need for re-endoscopy with intervention. This study found no significant association between hospital admission volume and conversion to surgery transfusion blood product administered or 30-day mortality.
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LITERATURE