Assessment of the external validity of a predictive score for blood transfusion in liver surgery

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Abstract

Background: Perioperative bleeding is a predictor of morbidity following liver resection. The transfusion-related score (TRS), which is derived from five variables (cirrhosis, preoperative haemoglobin level, tumour size, vena cava exposure and associated extraliver surgical procedure), has been proposed to predict the likelihood of transfusion in liver resection.

Objective: The purpose of this observational study was to evaluate the external validity of the TRS.

Methods: In a retrospective, monocentre, observational cohort study of patients undergoing elective liver resection surgery, data for transfused and non-transfused patients were compared by univariate analysis. The TRS was calculated for each patient. The frequency of transfusion was calculated for each score level. The accuracy of the TRS was evaluated using the area under the receiver operator characteristic curve (AUC).

Results: A total of 205 patients submitted to liver resection were included. Of these, 48 (23.4%) patients received a blood transfusion. There was no significant difference between transfused and non-transfused patients in age, American Society of Anesthesiologists (ASA) score or cirrhosis. The AUC for the TRS was 0.68 (95% confidence interval 0.59–0.77). Among TRS items, only vena cava exposure and associated surgical procedures were significantly associated with risk for transfusion.

Conclusions: In the present population, the TRS appeared to serve as a weak predictor of perioperative transfusion. This study confirms that the external validity of the transfusion predictive score should be subject to further investigation before it can be implemented in clinical use.

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Introduction

Despite improvements in surgical and anaesthetic techniques, postoperative morbidity following liver resection remains high.1–5 Perioperative bleeding is one of the major predictors of morbidity4–6 and blood transfusion is required in 10–38% of patients undergoing liver resection.7,8 Preoperative assessment of the risk for transfusion is useful for enhancing the information given to patients and in the development of a perioperative strategy to minimize the risk.5–11

The transfusion-related score (TRS) was proposed by Pulitanò et al to predict the likelihood of transfusion in liver resection.4 The score was found to have good overall accuracy, but was developed in a retrospective and monocentre study. The present authors hypothesized that the TRS might be used to accurately predict units of red blood cell (RBC) transfusion at the study liver surgery centre. The purpose of this study was to evaluate the external validity of the TRS in a different population of patients undergoing liver resection.
Materials and methods

According to French legislation for the regulation of clinical research, requirements for the provision of informed consent were waived because the present study was retrospective and observational.

Patients

A retrospective, monocentre, observational cohort study in consecutive patients submitted to elective liver resection during 2008 and 2009 was performed. Standard anaesthesia monitoring was applied peroperatively. A radial arterial catheter and venous central catheter were placed for major hepatectomy. Anaesthesia was induced and maintained at the discretion of the attending anaesthesiologist. Haemoglobin blood levels were repeatedly estimated using a HemoCue Hb 201+ (HemoCue France, Meaux, France). Transfusion criteria followed the American Society of Anesthesiologists (ASA) Task Force and Agence Française de Sécurité Sanitaire recommendations for 7–10 g/dl according to cardiovascular status. A haemodynamic strategy with fluid restriction during hepatic resection was applied.

All elective liver surgeries were performed by any of five senior hepatobiliary surgeons. Major liver resection was defined as the resection of three or more hepatic segments. Liver parenchymal transection was conducted using an ultrasonic dissector (Dissectron; Laboratoire Integra Neurosciences, Saint Priest, France), the Kelliclasie technique or bipolar coagulation. Intermittent pedicular clamping was performed using a protocol of 15 min of clamping followed by 5 min of non-clamping. Inferior vena cava clamping was performed when necessary. The hanging manoeuvre was used to facilitate the anterior approach in major liver resections.

Transfusion-related score

The TRS is derived from five variables: cirrhosis; preoperative haemoglobin level of ≤12.5 g/dl; tumour size of ≥4 cm; need for inferior vena cava exposure, and associated extraliver surgical procedure. Each variable can be assigned 1 point and the sum of these points establishes the TRS.

Data collection

The following data were collected from medical records: demographic data, including patient age, sex, body mass index, ASA score, malignant or benign nature of the tumour, and presence of cirrhosis, cardiopulmonary disease and diabetes; surgical data, including the number of resected segments, tumour size, perioperative vena cava exposure, any associated surgical procedure (bilioenteral anastomosis, associated colorectal, pancreatic or renal resections) and duration of surgery; preoperative haemoglobin blood levels, and the number of units of RBC transfused intraoperatively and until postoperative day 5.

Statistical analysis

Data for transfused and non-transfused patients were compared by univariate analysis using Fisher’s exact test or the Mann–Whitney test as appropriate. The plasma haemoglobin level associated with risk for transfusion was investigated using the Mann–Whitney test with different cut-off values. The frequency of transfusion at each score level was calculated. The accuracy of the TRS was evaluated using the area under the receiver operator characteristic (ROC) curve (AUC).

Results

A total of 205 consecutive patients submitted to scheduled liver surgery during the study period were included. Forty-eight (23.4%) patients were transfused; they received a median of 2 units (IQR: 2–4 units) of RBC. Demographic and surgical data for transfused and non-transfused patients are displayed in Table 1.

Discussion

The current study was designed to evaluate the external validity of the TRS in predicting perioperative transfusion during liver resection. Of the original TRS items, only intraoperative inferior vena cava exposure and associated surgical procedure were significantly associated with perioperative RBC transfusion in the present study population. The discriminating power of the TRS in this population was moderate and does not allow for the reliable prediction of RBC transfusion.

Preoperative haemoglobin level is a consistent predictor of transfusion, regardless of the type of surgery, but the thresholds cited vary among studies. For example, in liver surgery, Itamoto et al. found preoperative haemoglobin level at a threshold value of 11 g/dl to be the only predictor of intraoperative
transfusion, whereas Cockbain et al. identified a threshold value of 12.5 g/dl. In the present population, risk for transfusion was not significantly associated with a preoperative haemoglobin level of <12.5 g/dl, but was significantly associated with a preoperative haemoglobin level of <12.3 g/dl. This may reflect variability in transfusion practices. However, even with a threshold of 12.3 g/dl, the ROC AUC for the TRS remained moderate.

Cirrhosis is a well-known risk factor for transfusion during liver surgery. However, patients with cirrhosis in the present study displayed only a non-significant trend towards increased

Table 1 Demographic and surgical data for patients undergoing liver resection

<table>
<thead>
<tr>
<th></th>
<th>All patients (n = 205)</th>
<th>Transfused patients (n = 48)</th>
<th>Non-transfused patients (n = 157)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, years, median (IQR)</td>
<td>58 (17–80)</td>
<td>59 (23–80)</td>
<td>58 (17–80)</td>
<td>0.267</td>
</tr>
<tr>
<td>ASA class of ≥3, n (%)</td>
<td>13 (6.3%)</td>
<td>5 (10.4%)</td>
<td>8 (5.1%)</td>
<td>0.189</td>
</tr>
<tr>
<td>Aetiology, n (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Metastasis</td>
<td>92 (44.9%)</td>
<td>23 (47.9%)</td>
<td>69 (43.9%)</td>
<td>0.740</td>
</tr>
<tr>
<td>Hepatocellular carcinoma</td>
<td>42 (20.5%)</td>
<td>6 (12.5%)</td>
<td>36 (22.9%)</td>
<td>0.153</td>
</tr>
<tr>
<td>Cholangiocarcinoma</td>
<td>19 (9.3%)</td>
<td>5 (10.4%)</td>
<td>14 (8.9%)</td>
<td>0.778</td>
</tr>
<tr>
<td>Other reasons*</td>
<td>52 (25.4%)</td>
<td>14 (29.2%)</td>
<td>38 (24.2%)</td>
<td>0.570</td>
</tr>
<tr>
<td>Major liver resection, n (%)</td>
<td>102 (49.8%)</td>
<td>32 (66.7%)</td>
<td>70 (44.6%)</td>
<td>0.008</td>
</tr>
<tr>
<td>Preoperative Hb &lt;12.5 g/dl, n (%)</td>
<td>101 (57.4%)</td>
<td>30 (68.2%)</td>
<td>71 (53.8%)</td>
<td>0.114</td>
</tr>
<tr>
<td>Cirrhosis, n (%)</td>
<td>15 (7.4%)</td>
<td>5 (10.4%)</td>
<td>10 (6.4%)</td>
<td>0.354</td>
</tr>
<tr>
<td>Tumour size of &gt;4 cm, n (%)</td>
<td>100 (52%)</td>
<td>22 (53.7%)</td>
<td>78 (51.7%)</td>
<td>0.861</td>
</tr>
<tr>
<td>IVC exposure, n (%)</td>
<td>83 (40.5%)</td>
<td>27 (56.2%)</td>
<td>56 (35.7%)</td>
<td>0.012</td>
</tr>
<tr>
<td>Associated surgical procedures* n (%)</td>
<td>113 (55.7%)</td>
<td>33 (70.2%)</td>
<td>80 (51.3%)</td>
<td>0.029</td>
</tr>
<tr>
<td>Death at day 30, n (%)</td>
<td>6 (2.9%)</td>
<td>6 (12.5%)</td>
<td>0</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>

*Other reasons: adenoma, hepatic polycystosis.
*Colorectal resections, biloenteral anastomosis, pancreatic, spleen or renal resection.
ASA, American Society of Anesthesiologists; Hb, haemoglobin; IQR, interquartile range; IVC, inferior vena cava.

Table 2 Transfusion data according to the transfusion-related score (TRS) in patients undergoing liver resection

<table>
<thead>
<tr>
<th>TRS</th>
<th>Patients, n = 163</th>
<th>Patients transfused, n = 38</th>
<th>RBC, units, median (IQR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>15 (9.2%)</td>
<td>1 (6.7%)</td>
<td>2 (2–2)</td>
</tr>
<tr>
<td>1</td>
<td>35 (21.5%)</td>
<td>3 (8.6%)</td>
<td>2 (2–7)</td>
</tr>
<tr>
<td>2</td>
<td>44 (27.0%)</td>
<td>11 (25.0%)</td>
<td>2 (1–5)</td>
</tr>
<tr>
<td>3</td>
<td>47 (28.8%)</td>
<td>13 (27.7%)</td>
<td>2 (1–2)</td>
</tr>
<tr>
<td>4</td>
<td>21 (12.9%)</td>
<td>9 (42.9%)</td>
<td>2 (2–5)</td>
</tr>
<tr>
<td>5</td>
<td>1 (0.6%)</td>
<td>1 (100%)</td>
<td>1 (1–1)</td>
</tr>
</tbody>
</table>

IQR, interquartile range; RBC, red blood cells n (%).

Figure 1 Frequencies of transfusion of red blood cell units in patients undergoing liver resection (n = 205)

Figure 2 Transfusion rates according to transfusion-related scores in the Pulitanò et al. population (n = 320) and the present population (n = 163) of patients undergoing liver resection

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need for transfusion. This result may be related to the fact that the number of patients with cirrhosis in the present study was relatively low, which may imply insufficient power to detect this small difference. An additional explanation may refer to the severity of cirrhosis in resected patients. In accordance with current practices, elective liver surgery was performed in highly selected patients with cirrhosis (i.e. those with Child–Pugh class A status or very selected patients of Child–Pugh class B status) to limit the risk for haemorrhage related to portal hypertension or coagulation disorders.\(^8,10\)

Tumour size has been proposed as an item contributing to the TRS because of tumour rich vascularization and parenchymal congestion.\(^6,10\) However, this item was not significantly associated with transfusion in the present study. This discrepancy may refer to the fact that the difficulty of the surgery seems to relate to tumour localization more than it does to tumour size.\(^9\) Moreover, improvements in surgical and perioperative management may also explain this result. In the current study, among the original TRS items, inferior vena cava exposure and concomitant extrahepatic procedures were the only surgical factors to be consistently confirmed, as significantly associated with need for RBC transfusion in liver surgery.

Finally, the varied case mix, different surgical techniques and skills used and varied transfusion practices, in combination, are likely to have impacted on the present results. All of these factors are subject to significant variability among surgical teams and thus it can be hypothesized that a universally reliable predictive score is likely to be very difficult to establish.

The present study is subject to some limitations that must be acknowledged. This was a retrospective study and lacks data justifying the delivery of transfusion for each patient (perioperative blood loss and haemoglobin value at the time of transfusion). Moreover, the present study population (n = 205) was smaller than that in the study by Pulitanò et al.\(^8\) (n = 320), and the frequency of cirrhosis was lower [15 patients (7.3%) versus 82 (25.6%) patients]. Nevertheless, before any prognostic model can be extended to other populations, external validation is necessary\(^7\) and should ideally be performed in a population other than that of the initial research.

In conclusion, in the present population of patients undergoing liver resection, the TRS appeared to be a weak predictor of perioperative transfusion, although each of the contributing items seemed clinically relevant. This study confirms that the external validity of a score for predicting need for transfusion should be subjected to further investigation before it can be implemented in a clinical setting.

\section*{Conflicts of interest}
None declared.

\section*{References}


