Should the Transfusion Trigger and Hemoglobin Low Critical Limit be Identical?*

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ABSTRACT

At this medical center, the transfusion trigger and the hemoglobin low critical limit are identical (< 8.0 g/dL), but should they be the same? To answer this question, over one year all hemoglobin results < 8.0 g/dL (n = 421) were reviewed, physician awareness of and response to various hemoglobin levels were evaluated, and the effect of adopting a lower hemoglobin critical limit assessed. Patients were divided into three groups: (1) 7.5–7.9 g/dL (n = 81); (2) 7.0–7.4 g/dL (n = 53); and (3) < 7.0 g/dL (n = 59). Seventy (86 percent), 47 (89 percent), and 52 (88 percent) patients were transfused in Groups 1, 2, and 3; transfused units, mean (sd), were 2.0 (0.8), 2.3 (1.1), and 2.8 (1.7), respectively. Post transfusion hemoglobin increase, mean (sd) was 2.1 (1.0), 2.4 (1.0), and 3.1 (1.5) g/dL for Groups 1, 2, and 3, indicating an inverse correlation between severity of anemia and number of transfused units and post-transfusion hemoglobin increase.

Physicians were aware of anemia for all patients in Groups 1 and 2, but three patients in Group 3, not clinically anemic, had erroneous results (improperly collected specimens). Physicians randomly surveyed (n = 20) indicated that the hemoglobin critical limit could be lowered without adverse clinical consequence. A lower hemoglobin increase, mean (sd) was 2.1 (1.0), 2.4 (1.0), and 3.1 (1.5) g/dL for Groups 1, 2, and 3, indicating an inverse correlation between severity of anemia and number of transfused units and post-transfusion hemoglobin increase.

Physicians were aware of anemia for all patients in Groups 1 and 2, but three patients in Group 3, not clinically anemic, had erroneous results (improperly collected specimens). Physicians randomly surveyed (n = 20) indicated that the hemoglobin critical limit could be lowered without adverse clinical consequence. A lower hemoglobin critical limit of 7.5 and < 7.0 g/dL would lead to a 52 percent and 77 percent decrease in phone calls for physician notification. The medical center has now lowered the critical limit for hemoglobin to < 7.0 g/dL. The transfusion trigger and the low critical limit for hemoglobin are distinct entities, need not be identical, and represent a balance between the need for transfusion response and the need to be aware of a highly abnormal lab result.

Introduction

Anemia is a commonly encountered clinical condition, frequently requiring the transfusion of red blood cells (rbc). Because transfusion is not without risks for the transmission of blood borne diseases such as human immunodeficiency virus (HIV) and because of concerns about the decreasing blood supply,1,2,3 emphasis has been placed on the judicious use of rbc
transfusions. Many clinicians use the transfusion trigger as the minimum hemoglobin threshold level for which rbc transfusion is given; it is also used by many medical center transfusion committees to assess the appropriateness of transfusions and to audit physician usage of blood products.

The low critical limit for hemoglobin is used by the laboratory for urgent clinician notification to alert the physician of an extremely abnormal, often life-threatening, result requiring immediate patient evaluation and possible therapeutic intervention. Extremely low hemoglobin levels may result in heart failure and anoxemia.

At this medical center, the transfusion trigger and the low critical limit for hemoglobin are identical (< 8.0 g/dL), but should they be the same? To answer this question, over a one year period a review was made of all hemoglobin results < 8.0 g/dL, with an evaluation of physician awareness of and response to various hemoglobin levels and assessment made of the impact of adopting a lower hemoglobin critical limit on clinical practice and on laboratory workload.

Materials and Methods

Patient Samples, Study Subjects, and Analytical Methods

Samples were collected into ethylenediamine tetraacetic acid (EDTA) vacutainer tubes from patients over a period of one year and assayed for hemoglobin on the same day of collection, usually within two hours after receipt of the specimen. Hemoglobin determinations were performed on a Sysmex NE 8000* using a standard cyanmethemoglobin method and are linear between 0.1-25.0 g/dL.

All patients studied were adults (> 18 years of age); no pediatric patients were included. In accordance with the federal policy for protection of human subjects (38 CFR Part 16), this study, using data from human subjects, was categorized as exempt research.

Reference Range and Definition of Low Critical Limit for Hemoglobin

The reference range for hemoglobin was 12 to 14 g/dL for males and 11 to 13 g/dL for females. The low critical limit for hemoglobin was defined as any hemoglobin level < 8.0 g/dL.

Assessment of the Low Critical Limit and Transfusion Trigger for Hemoglobin

Patients were divided into three groups according to their hemoglobin level: Group 1, 7.5 to 7.9 g/dL; Group 2, 7.0 to 7.4 g/dL, and Group 3 < 7.0 g/dL. Patients with multiple hemoglobin levels were assigned to a group based on their lowest hemoglobin level.

A list of all patients with hemoglobin levels < 8.0 g/dL was generated by the medical center computer over a one year period. The computer also provided data regarding the number of transfused red blood cell units, time of transfusion, hemoglobin levels pre- and post-transfusion and computerized medical data, including electronic discharge summaries and progress notes. Patient charts were reviewed to assess whether or not physicians were aware of anemia or whether or not there was clinical response, including blood transfusions.

Physicians were also randomly surveyed to ascertain whether or not changing the low critical limit for hemoglobin for urgent clinician notification by the laboratory would have any adverse clinical consequences. The laboratory also assessed the impact of adopting a lower (7.5 and < 7.0 g/dL) critical limit for hemoglobin.

Results

There was a total of 51,010 hemoglobin determinations over the one year period of study. In figure 1 are summarized the frequency distribution for hemoglobin levels < 8.0 g/dL (n = 421) in 193 patients. Approximately half of the results are between 7.5 to 7.9 g/dL (Group 1), and the remaining half

* TOA Medical Electronics, Co., Ltd, Kobe, Japan.
Figure 1. Frequency distribution (percentage) of Hemoglobin Levels < 8.0 g/dL.

about equally distributed between hemoglobin levels of 7.0 to 7.4 g/dL (Group 2) and < 7.0 g/dL (Group 3).

In Table 1 are summarized the data for all patients with low hemoglobin levels. Clinical response to anemia was comparable in the three groups. The mean number of transfused rbc units showed an inverse correlation between the

**TABLE 1**

*Summary of Patients with Hemoglobin Levels < 8.0 g/dL*

<table>
<thead>
<tr>
<th></th>
<th>Group 1 7.5–7.9 g/dL</th>
<th>Group 2 7.0–7.4 g/dL</th>
<th>Group 3 &lt; 7.0 g/dL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of patients</td>
<td>81</td>
<td>53</td>
<td>59</td>
</tr>
<tr>
<td>Patients transfused (%)</td>
<td>70 (86)</td>
<td>47 (89)</td>
<td>52 (86)</td>
</tr>
<tr>
<td>Mean # units transfused (SD)</td>
<td>2.0 (0.8)</td>
<td>2.3 (1.1)</td>
<td>2.8 (1.7)</td>
</tr>
<tr>
<td>Mean hemoglobin increase post-transfusion (SD)</td>
<td>2.1 (1.0)</td>
<td>2.4 (1.0)</td>
<td>3.1 (1.5)</td>
</tr>
<tr>
<td>Physician awareness of anemia (%)</td>
<td>81 (100)</td>
<td>53 (100)</td>
<td>56 (95)</td>
</tr>
<tr>
<td>Patients not transfused (%)</td>
<td>11 (14)</td>
<td>6 (11)</td>
<td>7 (12)</td>
</tr>
<tr>
<td>Reasons for no transfusion</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Terminal case</td>
<td>2 (2.5%)</td>
<td>5 (9%)</td>
<td>1 (2%)</td>
</tr>
<tr>
<td>Incorrectly collected specimen</td>
<td></td>
<td></td>
<td>3 (5%)</td>
</tr>
<tr>
<td>No clinical need for blood transfusion</td>
<td>1 (1.3%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hemochromatosis</td>
<td>1 (1.3%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fe therapy</td>
<td>2 (2.5%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clinical reason not cited</td>
<td>5 (6.2%)</td>
<td>1 (2%)</td>
<td>3 (5%)</td>
</tr>
</tbody>
</table>
hemoglobin level and the mean number of units transfused; as the hemoglobin level decreased, the mean number of units transfused increased. There was also an inverse correlation between the hemoglobin level and the post transfusion mean increase in hemoglobin.

In table I it is shown that physicians were universally aware of anemia for patients in Groups 1 and 2. However, there were three patients in Group 3 who were not clinically anemic, who were not transfused, and whose specimens were incorrectly collected.

In table I it is indicated that between 11 to 14 percent of all patients were not transfused. A small percentage (approximately 2 percent) in Groups 1 and 3 were terminal cases, but a significant percentage of patients (9 percent) in Group 2 were terminal.

Physicians were randomly surveyed (n = 20) with the proposal of lowering the critical limit for hemoglobin for urgent physician notification to < 7.0 g/dL; all physicians responded favorably, and many commented that in reaching a decision for patient transfusion, the entire clinical picture is considered, not just the hemoglobin level.

In table II is shown the effect of adopting lower critical limits for hemoglobin on the volume of laboratory telephone calls for urgent clinician notification. Adopting a critical limit of 7.5 g/dL would result in a decrease of 52 percent (217/421) in the volume of telephone calls, while adopting a critical limit of < 7.0 g/dL would result in an even greater decrease in laboratory telephone calls of 77 percent (326/421).

### TABLE II

<table>
<thead>
<tr>
<th>Critical Limit</th>
<th>No. of Telephone Calls</th>
<th>Decrease in Telephone Calls</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.0 g/dl</td>
<td>421</td>
<td></td>
<td>Present protocol</td>
</tr>
<tr>
<td>7.5 g/dl</td>
<td>204</td>
<td>217</td>
<td>-52%</td>
</tr>
<tr>
<td>&lt;7.0 g/dl</td>
<td>95</td>
<td>326</td>
<td>-77%</td>
</tr>
</tbody>
</table>

**Discussion**

The 8.0 g/dL transfusion trigger is consistent with recommendations regarding the need for blood transfusion and the correlation between significant signs and symptoms of anemia and hemoglobin concentration. Using this transfusion trigger as appropriate for rbc transfusions without need for review, the Transfusion Committee was then able to limit its audit of physician blood usage to cases not meeting this criteria. This practice has streamlined the process of physician blood usage review and has focused blood usage audit to an assessment of the need for blood transfusions based on clinical grounds, including appropriate red cell transfusions for acute blood loss, intra and peri-operative need for blood, underlying cardiopulmonary disease, and the patient's functional capacity.

Recent studies have shown that humans have a remarkable tolerance for anemia and that adequate oxygen carrying capacity can be achieved with a hemoglobin of 7.0 g/dL or even lower if the intravascular volume is adequate. Recently, one study recommended that a minimum transfusion hemoglobin of 6.0 g/dL was acceptable for well compensated, chronically anemic patients having a hemoglobin level of approximately 8.0 g/dL before sustaining acute blood loss and for patients undergoing intentional intraoperative hemodilution with an uncomplicated operative course. Recently national guidelines recommend that transfusion is almost always indicated when the hemoglobin is <6.0 g/dL.

There is no consensus regarding the hemoglobin low critical limit for urgent physician notification. A recent national survey of 92 institutions, including 20 trauma centers, found a mean low critical limit for hemoglobin of 6.6 g/dL (SD 1.7 g/dL) with a range of 4.0 to 12.0 g/dL. The selection of 7.0 g/dL as this medical center's low hemoglobin critical limit was made because it was an intermediate hemoglobin value between the previous low hemoglobin critical limit of 8.0 g/dL and 6.0 g/dL, the hemoglobin level for which transfusion is almost universally recommended.
Physicians at this medical center felt strongly that, in our patient population, consisting of an elderly male veteran population with many underlying medical problems, 7.0 g/dL was a reasonable low critical limit for hemoglobin since many patients may need to be transfused because they would be unable to tolerate hemoglobin levels <7.0 g/dL.

This medical center has lowered the hemoglobin critical limit to <7.0 g/dL, which has resulted in a significant decrease in telephone calls for urgent clinician notification for a highly abnormal hemoglobin level. Since the institution of this policy, the laboratory has received no complaints for any patient who might have been overlooked by this low hemoglobin critical limit protocol.

References