Evidence Review: Periprocedural Use of Blood Products
Lauren C. Hogshire, MD; Manish S. Patel, MD, Edward Rivera, MD, Jeffrey L. Carson, MD

Blood product transfusion has not been subject to rigorous clinical study, and great practice variations exist. Of particular concern to the hospitalist is the use of red blood cells, plasma, and platelets prior to invasive procedures to correct anemia or perceived bleeding risk. We summarize the known risks associated with periprocedural anemia, prolonged international normalized ratio (INR), and thrombocytopenia, as well as the effects of blood product administration on clinical outcomes. Clinical trial evidence argues for a restrictive red blood cell transfusion threshold (a hemoglobin level of 7–8 g/dL or symptomatic anemia) for most perioperative patients. There are no high-quality data to guide plasma and platelet transfusions around the time of procedures. Available data do not support the use of prothrombin time/INR to guide prophylactic administration of plasma, and there are scarce data to guide platelet use around the time of an invasive procedure. Therefore, we rely on current consensus expert opinion, which recommends administration of plasma in moderate- to high-risk procedures when INR is >1.5. We recommend platelet transfusion in low-risk procedures when platelet count is <20,000/μL, for average-risk procedures when platelet count is <50,000/μL, and for procedures involving the central nervous system when the platelet count is <100,000/μL. Journal of Hospital Medicine 2013;8:647–652. © 2013 Society of Hospital Medicine

Although inpatient blood product transfusion is common, many uses have not been subject to rigorous clinical study, and great practice variations exist. Of particular interest to the hospitalist is the use of red blood cells (RBCs), plasma, and platelets prior to an invasive procedure to correct anemia or a perceived bleeding risk. When considering blood product use in this context, the hospitalist faces 2 questions. First, what are the risks of anemia, thrombocytopenia, or abnormal coagulation tests? Second, what is the evidence that administration of the blood product in question improves outcomes such as bleeding and mortality? We address these questions in this review of the data supporting the use of RBCs, platelets, and plasma prior to invasive procedures.

RED BLOOD CELLS
Anemia is the most common hematologic concern in the perioperative setting. In 2009, approximately 15 million units of RBCs were transfused in the United States, 40% to 70% of which were given in the perioperative setting.1,2

Risks of Periprocedural Anemia
The best evidence regarding the risks of perioperative anemia comes from studies in patients who declined blood transfusions. A retrospective cohort study of 1958 consecutive surgical patients who refused transfusions due to religious reasons showed an increase in 30-day mortality as preoperative hemoglobin values fell, especially for those with preoperative hemoglobin concentrations <6 g/dL.3 For patients with underlying cardiovascular disease, the risk of death was greatest when the preoperative hemoglobin value was <10 g/dL. Subsequent analysis showed that mortality rose with postoperative hemoglobin levels <7 g/dL, with a sharp rise in morbidity (myocardial infarction [MI], congestive heart failure [CHF], arrhythmia, and infection) and mortality in those with postoperative hemoglobin of <5 to 6 g/dL.4 These results are consistent with studies of healthy volunteers who underwent acute isovolumic hemoglobin reduction, demonstrating clinical changes when hemoglobin values fell to 5 to 7 g/dL.5–8

Several large, retrospective cohort studies have evaluated anemia and perioperative morbidity and mortality. A 2007 study analyzed data from over 310,000 predominantly male patients over age 65 years undergoing major noncardiac surgery.9 Even mild degrees of preoperative anemia were associated with increased 30-day mortality and cardiovascular morbidity (cardiac arrest or Q-wave MI), with a monotonic rise in mortality (3.5%–35.4%) and cardiac events (1.8%–14.6%) when the hematocrit was <39%. Utilizing data from the American College of Surgeons’ National Surgical Quality Improvement Program database, a 2011 study evaluated over 227,000 patients who underwent major noncardiac surgery.10 Again, even mild anemia (hematocrit 29%–39%) was independently associated with an increase in 30-day composite morbidity, including MI, stroke, pneumonia, acute renal failure, wound infection, sepsis (13.27%), and mortality (3.52%).
TABLE 1. Reviewed Randomized Controlled Trials of Restrictive Versus Liberal Red Blood Cell Transfusion

<table>
<thead>
<tr>
<th>Study/Year</th>
<th>No. of Patients</th>
<th>Brief Description</th>
<th>Transfusion Strategy</th>
<th>Outcomes (Restrictive Versus Liberal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Herbert et al. (TRICC)/1999&lt;sup&gt;12&lt;/sup&gt;</td>
<td>838</td>
<td>Normovolemic patients admitted to ICU with Hg &lt; 9 g/dL within 72 hours of admission.</td>
<td>Restrictive: Hg maintained 7–9 g/dL. Liberal: Hg maintained 10–12 g/dL.</td>
<td>30-day mortality (18.7% vs 23.3%, P = 0.11). Pulmonary edema (5.3% vs 10.7%, P &lt; 0.01) and MI (0.7% vs 2.9%, P = 0.02) rates while in the ICU.</td>
</tr>
<tr>
<td>Carson et al. (FOCUS)/2011&lt;sup&gt;14&lt;/sup&gt;</td>
<td>2016</td>
<td>Patients undergoing surgery for hip fracture with a history of cardiovascular disease or cardiovascular risk factors.</td>
<td>Restrictive: transfused for Hg &lt; 8 g/dL or symptomatic anemia. Liberal: transfused to maintain Hg &gt; 10 g/dL.</td>
<td>Primary outcome of death or the inability to walk 10 feet across the room without human assistance at 60 days (34.7% vs 35.2%, P = 0.9). Composite of in-hospital ACS or death (5.2% vs. 4.3%). The frequencies of in-hospital clinical events and adverse events did not differ significantly between groups.</td>
</tr>
<tr>
<td>Hajjar et al. (TRACS)/2010&lt;sup&gt;15&lt;/sup&gt;</td>
<td>502</td>
<td>Patients admitted to ICU for elective cardiac surgery with cardiopulmonary bypass.</td>
<td>Restrictive: transfused to maintain Hct ≥ 24%. Liberal: transfused to maintain Hct ≥ 30%.</td>
<td>Composite primary outcome of 30-day all-cause mortality = severe in-hospital morbidity (cardiogenic shock, ARDS, or AKI requiring renal replacement therapy) (11% vs 10%, P = 0.65).</td>
</tr>
<tr>
<td>Bracey et al./1999&lt;sup&gt;16&lt;/sup&gt;</td>
<td>428</td>
<td>Patients undergoing first-time elective coronary surgical revascularization.</td>
<td>Restrictive: postoperative transfusion for Hg &lt; 8 g/dL or predetermined clinical conditions requiring RBC transfusion (ie, hemodynamic instability). Liberal: transfusion at discretion of physician with institutional guidelines recommending postoperative transfusion for Hg &lt; 9 g/dL.</td>
<td>No differences in morbidity (including pulmonary complications, renal failure, and MI), duration of mechanical ventilation, and length of hospital stay (7.5 ± 2.9 days vs 7.9 ± 4.9 days).</td>
</tr>
<tr>
<td>Villaruevas et al./2013&lt;sup&gt;17&lt;/sup&gt;</td>
<td>921</td>
<td>Severe upper GI bleeding, gastroscopy within 6 hours.</td>
<td>Restrictive: transfused if Hg &lt; 7 g/dL. Liberal: transfused if Hg &lt; 9 g/dL.</td>
<td>Hospital mortality (1.4% vs 2.7%, P = 0.3).</td>
</tr>
<tr>
<td>Carson et al. (MINT)/2013&lt;sup&gt;18&lt;/sup&gt;</td>
<td>110</td>
<td>Pilot study in patients with Hg &lt; 10 g/dL and either ACS or stable angina undergoing cardiac catheterization.</td>
<td>Restrictive: transfused if Hg &lt; 8 g/dL or symptomatic anemia. Liberal: transfused to raise Hg ≥ 10 g/dL.</td>
<td>Composite primary outcome of all cause mortality + MI = unscheduled coronary revascularization within 30 days (25.5% vs 10.9%, P = 0.054). Death at 30 days (13% vs 1.8%, P = 0.032).</td>
</tr>
<tr>
<td>Cooper et al. (CRIT)/2011&lt;sup&gt;19&lt;/sup&gt;</td>
<td>45</td>
<td>Pilot study in patients with acute MI (chest pain and positive cardiac biomarker) and Hct &lt; 30% within 72 hours of symptom onset.</td>
<td>Restrictive: transfused to maintain Hct 24%–27%. Liberal: transfused to maintain Hct 30% to 33%.</td>
<td>The primary composite outcome (in-hospital death, recurrent MI, or new or worsening CHF) (13% vs 38%, P = 0.046).</td>
</tr>
</tbody>
</table>

NOTE: Abbreviations: ACS, acute coronary syndrome; AKI, acute kidney injury; ARDS, acute respiratory distress syndrome; CHE, congestive heart failure; CRIT, Conservative versus liberal red cell transfusion in acute myocardial infarction; FOCUS, Transfusion Trigger Trial for Functional Outcomes in Cardiovascular Patients Undergoing Surgical Hip Fracture Repair trial; GI, gastrointestinal; Hct, hematocrit; Hg, hemoglobin; ICU, intensive care unit; MI, myocardial infarction; MINT, Myocardial Ischemia and Transfusion trial; RBC, red blood cell; TIA, transient ischemic attack; TRACS, Transfusion Requirements After Cardiac Surgery study; TRICC, Transfusion Requirements in Critical Care trial.

Does RBC Transfusion Improve Outcomes?

Although the evidence argues that perioperative anemia is associated with poor surgical outcomes, it is not clear whether RBC transfusion in the perioperative setting improves these outcomes. Furthermore, the optimal perioperative hemoglobin level remains controversial. Importantly, most periprocedural trials were not sufficiently powered to assess differences in clinical outcomes.<sup>11</sup>

Several noteworthy randomized controlled trials (RCTs) comprise the bulk of the evidence regarding transfusion thresholds and are summarized in Table 1. The Transfusion Requirements in Critical Care (TRICC) was a landmark trial that randomized patients to a “restrictive” or a “liberal” transfusion strategy and demonstrated a trend toward lower 30-day mortality in the restrictive group.<sup>12</sup> In addition, the restrictive transfusion group had lower rates of myocardial infarction and pulmonary edema. A subsequent subanalysis found no difference in mortality in patients with underlying cardiovascular disease.<sup>13</sup>

The largest RCT of transfusion thresholds, the Transfusion Trigger Trial for Functional Outcomes in Cardiovascular Patients Undergoing Surgical Hip Fracture Repair (FOCUS), randomized patients undergoing surgery for hip fracture with a history of cardiovascular disease or cardiovascular risk factors to a restrictive or liberal transfusion strategy.<sup>14</sup> The primary outcome of death or the inability to walk 10 feet across the room without human assistance at 60 days was similar in both the liberal and restrictive group, and the composite rate of acute coronary syndrome and in-hospital death, stroke, CHF, venous thromboembolism, and the frequencies of other in-hospital events or lengths of stay did not differ between the groups.

Several RCTs have examined the effect of transfusion practice on patients undergoing elective cardiac procedures.
surgery. The Transfusion Requirements After Cardiac Surgery (TRACS) study did not show a difference in the primary composite outcome of 30-day all-cause mortality and in-hospital morbidity between the restrictive and liberal transfusion groups. A second cardiac surgery trial also found no difference in mortality or morbidity outcomes when comparing a restrictive versus liberal transfusion threshold.

A recent RBC transfusion trial evaluated transfusion thresholds in patients with severe upper gastrointestinal bleeding. All patients underwent gastroscopy within 6 hours of hospital admission and were randomly allocated to a restrictive or liberal transfusion threshold. The restrictive group had a significantly higher survival at 6 weeks when compared to the liberal group, as well as lower rates of adverse events such as further bleeding, acute coronary syndrome, transfusion reactions, and pulmonary edema.

Finally, the Myocardial Ischemia and Transfusion (MINT) pilot trial evaluated 110 patients with hemoglobin concentration \( \leq 10 \) g/dL admitted for ST-segment elevation MI, non-ST-segment elevation MI, unstable angina, or stable coronary disease undergoing a cardiac catheterization. The composite end point of death, MI, and unscheduled revascularizations within 30 days was higher in the restrictive group when compared to the liberal group, and 30-day mortality was less frequent in liberal strategy compared to restrictive strategy. Given the small study size and the fact that patients in the restrictive group were significantly older than those in the liberal group, the results of this study must be interpreted carefully. The results of this trial contrast an earlier RCT of 45 patients admitted with acute MI, which showed higher rates of in-hospital death, recurrent MI, or CHF in the liberal transfusion group versus the restrictive group.

Clearly, there is insufficient evidence to define transfusion threshold in acute coronary syndrome, and further study is needed in this area.

A recent meta-analysis of 19 RCTs through February 2011 compared restrictive versus liberal transfusion strategies. Although not all of these studies looked at periprocedural RBC transfusion, employment of a restrictive strategy saved an average of 1.19 units of blood per patient transfused without a difference in 30-day mortality. This meta-analysis also showed that in-hospital mortality was 23% lower in patients assigned to a restrictive strategy, and there were no differences in cardiac events or strokes between restrictive and liberal strategies.

Encompassing the latest evidence, the AABB (formerly, the American Association of Blood Banks) guidelines recommend a restrictive transfusion strategy utilizing a transfusion threshold of 7 to 8 g/dL in stable hospitalized patients. The AABB also recommends a restrictive strategy for patients with underlying cardiovascular disease, advocating for a transfusion threshold of 8 g/dL or less, or for symptoms of anemia. No transfusion recommendations were provided for acute coronary syndrome.

**PLASMA**

In the United States, approximately 4 million units of frozen plasma (FP) were transfused in 2006, and recent data demonstrate that relative to RBCs, the number of FP units transfused in the United States is higher than in other countries with advanced medical care. Many transfusions are given prior to a procedure to correct perceived bleeding risk.

**Risks of Periprocedural Coagulopathy**

Laboratory measures of coagulation such as prothrombin time (PT)/international normalized ratio (INR) are frequently used to guide transfusion of FP. A 3-month audit at Massachusetts General Hospital found approximately one-third of all FP units used outside of the operating room were requested before a procedure because of an elevated INR. However, PT and activated partial thromboplastin time were never validated in nonbleeding patients, and INR was never validated for use in non-vitamin K antagonist settings.

A recent systematic review assessed whether abnormalities in preprocedure coagulation tests correlate with increased risk of bleeding. Analysis of 24 observational studies and 1 RCT included nearly 2000 procedures performed on patients with abnormal coagulation studies and concluded that there is not sufficient data to support PT and INR as predictors of bleeding risk. One study examining how well INR can be used to predict the degree of deficiency of a given factor found that blood samples with an INR as high as 1.9 contained factor levels adequate to support hemostasis.

Furthermore, there is surprisingly little evidence to support the ability of FP to correct an abnormal INR. Given that the INR of FP can be as high as 1.3, transfusion will have little effect on minimally elevated INRs. This point is highlighted by a prospective study evaluating the effectiveness of transfusing FP to correct an increased INR in patients with a mildly prolonged PT (13.1 to 17 seconds). Of 121 patients studied, <1% normalized their INR, and only 15% demonstrated improvement at least halfway to normal. There was no correlation between plasma dose and change in INR. Additionally, a study attempting to quantify the relationship between change in INR and the pretransfusion INR observed that a reliable significant change in INR is only likely when the INR is >1.7.

**Does FP Transfusion Improve Outcomes?**

Most clinical uses of FP are not supported by evidence from RCTs. A 2012 systematic review examining the clinical effectiveness of FP included RCT data from 1964 to 2011. In terms of periprocedural FP
administration, this review included studies of FP in cardiac surgery and revealed a lack of evidence to support the effectiveness of FP to prevent bleeding. Notably, this review did not examine the use of FP prior to percutaneous procedures.

Despite the paucity of evidence to guide FP transfusions, in 2010 the AABB published practice guidelines to assist practitioners in the use of FP. In terms of periprocedural FP administration, these practice guidelines questioned the use of FP in surgical or trauma patients without massive bleeding, as only 6 studies were available for analysis. The panel could not recommend for or against the use of FP in surgical patients, although meta-analysis showed that FP transfusion was associated with a trend toward increased risk of death. No studies of nonsurgical invasive procedures met review inclusion criteria. Given the potential for harm and the lack of data with regard to use of FP prior to nonsurgical invasive procedures, hospitalists should view the use of FP prior to a procedure with caution.

The Society of Interventional Radiology (SIR) recently published consensus guidelines for periprocedural management of coagulation status and hemostasis risk in percutaneous-guided interventions. Acknowledging the lack of data regarding periprocedural management of patients with abnormal coagulation parameters, this society’s Standards of Practice Committee recommends that in the absence of warfarin treatment or liver disease, preprocedure INR testing should be conducted only prior to procedures with moderate to high bleeding risk. Notably, low bleeding risk procedures include thoracentesis, paracentesis, drainage catheter exchange, and dialysis access interventions. This recommendation is consistent with observational studies of paracentesis and thoracentesis, which have failed to show increased bleeding risk in patients with an elevated INR. The largest of these studies retrospectively examined 608 patient procedures and found no significant difference in hemoglobin drop or average hemoglobin among patients with normal PT compared to patients with prolonged PT who underwent either a paracentesis or thoracentesis.

In patients scheduled to undergo moderate or high bleeding risk procedures, these guidelines recommend that the INR be corrected to <1.5, although this recommendation was derived by Delphi consensus of expert practitioners due to lack of available data. Central venous catheter insertion highlights the discrepancy between SIR recommendations and review of the available, albeit limited, data. A study of 580 patients with an INR >1.5 found that only 1 patient had a major bleeding event due to accidental puncture of the carotid artery. Along with several others, this study is cited as evidence that central venous catheterization can be performed safely in patients with coagulation abnormalities. However, because of the observational nature of these data, SIR guidelines categorize central venous catheterization as a moderate risk procedure, and as such recommend a preprocedure INR check and correction of INR to 1.5. There are no prospective studies looking at what INR it is safe to perform endoscopic interventions. Additionally, there are no studies looking at the effect of preprocedure FP administration on endoscopic outcomes.

**PLATELETS**

Over 10 million units of platelets are transfused in the United States annually. Severe thrombocytopenia is thought to confer increased bleeding risk, and allo- genic platelet transfusions are commonly given to thrombocytopenic patients as supportive care. Given that recommendations on platelet transfusion thresholds are largely derived from studies looking at patients with hematological malignancies, there is concern about using these data to inform transfusion thresholds in other patient populations. Despite this limitation, we examine the evidence for an optimum platelet transfusion threshold and review available practice guidelines for the perioperative setting.

**Risks of Thrombocytopenia and When to Transfuse**

Hemostasis depends on an adequate number of functional platelets along with an intact coagulation system. Circulating platelets likely contribute to hemostasis via an endothelial supportive function by plugging gaps in the endothelium of blood vessels. Early observational studies of clinically stable patients with chronic thrombocytopenia showed that significant spontaneous bleeding through an intact vascular system typically occurred with a platelet count below 5,000 platelets/µL. Despite this, a platelet count of 20,000/µL was adopted as a transfusion threshold and used for over 25 years.

Beginning in the late 1990s, RCTs comparing a prophylactic transfusion trigger of 10,000 platelets/µL to 20,000 platelets/µL showed no difference in hemorrhagic risks or RBC transfusion requirements. The American Society of Clinical Oncology and the British Committee for Standards in Haematology (BCHS) now recommend a prophylactic platelet transfusion trigger of 10,000/µL for all patients with chronic thrombocytopenia due to hypoproliferative causes. A 2012 Cochrane review of 13 RCTs examining prophylactic platelet transfusion for prevention of bleeding in patients with hematological disorders did not find evidence to change this recommendation, but did question the strength of the data showing bleeding risk equivalency between 10,000/µL and 20,000/µL.

In addition to studies examining platelet transfusion thresholds, various studies have questioned whether platelet transfusions should be given prophylactically before bleeding onset or as treatment afterward. Two early small RCTs and several observational studies examining prophylactic versus therapeutic platelet
transfusion failed to show increased risk of bleeding or mortality in patients with leukemia who were transfused only after bleeding had begun.\textsuperscript{45,46} However, a recent RCT of 600 patients undergoing chemotherapy or stem cell transplantation showed that patients who were not given prophylactic platelet transfusions had more days with bleeding and shorter time to first bleeding episode compared to patients given prophylactic platelet transfusion for a platelet count below 10,000/μL.\textsuperscript{47} This study supports continued use of prophylactic platelet transfusions to prevent bleeding. Based on this recent trial and the 2012 Cochrane review, prophylactic platelet transfusion for a platelet count lower than 10,000/μL is currently the standard of care for patients with chronic thrombocytopenia due to a hypoproliferative cause.

**Perioperative Platelet Transfusion Practice Guidelines**

It is unknown at what platelet count the risk of surgical bleeding increases, and there are no definitive studies to guide the use of prophylactic platelet transfusions for patients prior to procedures. Given this paucity of data, we are left to review consensus expert opinion and the nonrandomized studies that inform them.

Prior to surgical procedures, prophylactic platelet transfusion is rarely required for platelet counts >100,000/μL and is usually required for a platelet count <50,000/μL.\textsuperscript{48} For platelet counts in the range of 50,000/μL to 100,000/μL, guidelines from the American Society of Anesthesiologists and the Royal College of Physicians state that platelet transfusion should be based on the extent of surgery, the risk and ability to control bleeding, the rate of bleeding with regard to trauma, the presence of platelet dysfunction, and other coagulation abnormalities.\textsuperscript{48} Recognizing the inability to easily control bleeding during nonsurgical procedures and the potential for significant adverse outcomes with intracranial bleeding, experts recommend that neurosurgical patients have platelet counts maintained >100,000/μL.\textsuperscript{43}

For bedside and minimally invasive procedures, various thresholds are considered standard of care without rigorous supporting data. For example, based solely on interpretation of case reports, a platelet count of 80,000/μL has been proposed by the American Red Cross, the French Society of Anesthesiology, and the BCSH for epidural anesthesia in patients with thrombocytopenia due to idiopathic thrombocytopenia.\textsuperscript{49} For endoscopic procedures, the American Society for Gastrointestinal Endoscopy recommends a platelet count of 50,000/μL for therapeutic endoscopy and 20,000/μL for low-risk diagnostic endoscopy.\textsuperscript{50}

Puncture is thought to require a platelet count of 10,000 to 20,000/μL in patients with marrow failure but 50,000/μL in patients without hematologic malignancies.\textsuperscript{49–51} In terms of central venous catheter placement, a recent retrospective analysis included 193 adult leukemic patients who received 604 central venous catheter placements at 1 institution.\textsuperscript{52} This study showed that only platelet counts below 20,000/μL were associated with a higher risk of nonsevere bleeding. These results are consistent with several earlier observational studies reporting a very low risk of bleeding in patients with thrombocytopenia requiring central venous catheterization.\textsuperscript{53,54} With regard to paracentesis and thoracentesis, a study of 391 patients who underwent paracentesis and 207 patients who underwent thoracentesis did not demonstrate bleeding with platelet counts of 50,000/μL to 100,000/μL.\textsuperscript{33} However, no specific platelet transfusion threshold was identified by this retrospective single-institution study.

**SUMMARY**

We summarize our recommendations in Table 2, recognizing that evidence is limited and many of these recommendations are based on expert opinion. The limited evidence highlights opportunity for hospitalist-driven research in peri procedural blood product transfusion.

**TABLE 2. Summary of Recommendations for Peri-procedural Blood Product Transfusion**

<table>
<thead>
<tr>
<th>Transfusion</th>
<th>Threshold</th>
</tr>
</thead>
<tbody>
<tr>
<td>RBC</td>
<td>Hg &lt;7–8 g/dL or symptomatic anemia in most hemodynamically stable hospitalized patients.</td>
</tr>
<tr>
<td>RBC</td>
<td>Hg &lt;8 g/dL or for symptomatic anemia in patients with underlying CV disease.</td>
</tr>
<tr>
<td>Optimal</td>
<td>Transfusion threshold is unknown in patients with acute coronary syndrome.</td>
</tr>
<tr>
<td>Insufficient evidence to support routine INR testing for low-risk procedures in the absence of warfarin treatment or liver disease.</td>
<td></td>
</tr>
<tr>
<td>Insufficient evidence to guide transfusion practice prior to endoscopic procedures.</td>
<td></td>
</tr>
<tr>
<td>Platelet transfusion</td>
<td>Transfusion threshold of &lt;20,000/μL for low bleeding risk procedures, including central venous catheters.</td>
</tr>
<tr>
<td>Platelet transfusion</td>
<td>Transfusion threshold of &lt;50,000–100,000/μL for moderate bleeding risk procedures.</td>
</tr>
<tr>
<td>Platelet transfusion</td>
<td>Transfusion threshold of &lt;100,000/μL for neurosurgical procedures.</td>
</tr>
<tr>
<td>Platelet transfusion</td>
<td>Transfusion threshold of &lt;50,000/μL for therapeutic endoscopy and &lt;20,000/μL for low-risk diagnostic endoscopy.</td>
</tr>
</tbody>
</table>

**NOTE:** Abbreviations: CV, cardiovascular; Hg, hemoglobin; INR, international normalized ratio; RBC, red blood cell.

Disclosures: Dr. Carson reports grants from the National Institutes of Health (NIH) during the conduct of the study, personal fees from Cerus Corporation, grants from Amgen, and grants from the NIH outside the submitted work.

**References**
