



PEARLS OF LABORATORY MEDICINE

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TITLE: Patient Blood Management

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Slide 1:

Hello, my name is Ryan Metcalf. I am an Assistant Professor of Pathology at the University of Utah and Associate Medical Director of Transfusion Services at ARUP Laboratories. Welcome to this Pearl of Laboratory Medicine on “Patient Blood Management.”

Slide 2:

Patient Blood Management, or PBM, can be defined as rationally optimizing anemia and hemostasis in patients with the goal of restricting – or really optimizing – blood component use. Why should we care about PBM? Well, blood transfusion is by far the most commonly performed procedure in the United States, it has been identified as one of the top five most overused procedures. PBM is now considered standard of care because it improves quality while reducing costs. It improves both the numerator and the denominator of the value equation in health care, which you can see is $\text{value} = \text{quality} / \text{cost}$.

Slide 3:

There has been a significant decline in red blood cell, or RBC, transfusions in the United States over the past several years. For example, the number of RBCs transfused from 2008 to 2015 decreased by nearly 25%, which amounts to four million fewer units transfused. This reduction is likely due to the implementation of PBM programs including evidence-based guidelines for transfusion. Several large randomized controlled trials support what we call a restrictive transfusion strategy, which involves a lower hemoglobin threshold for transfusion when compared with a liberal strategy.

Slide 4:

What might a PBM program encompass? Many different types of individuals order and administer blood in a hospital, so it should ideally include a program to educate those making transfusion decisions as well as those administering blood components. The program should develop strategies to optimize blood component use, diagnose and treat perioperative anemia, and reduce blood loss from surgery and from lab draws as an institution. This can all be implemented with effective project management. One of the major challenges to developing an effective PBM program is that blood transfusion is ordered by a variety of specialties and administered by a variety of staff.

Slide 5:

This table provides a summary of the major RBC transfusion trials comparing hemoglobin thresholds in different patient populations, from critical care to upper gastrointestinal bleeding to cardiac surgery. The primary outcome of each study showed either no difference or improved outcomes in the restrictive group compared with the liberal group. If there is no evidence of benefit if patients are transfused liberally instead of restrictively, then a restrictive strategy should be used. This restrictive strategy is

often a hemoglobin threshold of 7g/dL, but also depends on the patient population as you can see here (along with the individual patient's clinical picture). It is worth mentioning that a hemoglobin threshold of 7.5g/dL is supported for cardiac surgery patients intraoperatively and in the postoperative period. There is a notable lack of evidence in the setting of acute coronary ischemia and myocardial infarction.

Slide 6:

That said, we ultimately treat patients rather than laboratory values. The true indications for RBC transfusion are significant acute hemorrhage and significant signs/symptoms of anemia. However, lab values, such as hemoglobin, are very useful pieces of information (in conjunction with the clinical picture) that can help us decide whether to transfuse a patient or not.

Slide 7:

There are tried-and-true strategies to reduce unnecessary transfusions. Clinical decision support in the form of best practice alerts – or “pop-ups” – at computerized provider order entry has been shown to improve RBC usage. RBC transfusion interventions also reduce the proportion of patients transfused. And initiatives that reduce RBC transfusions also reduce health care costs: the cost to buy a unit of RBCs is somewhere around \$200, while the cost of all activities that go into transfusing a unit of RBCs – such as testing and administration of the blood – is about four times greater. So, these projects can improve patient outcomes while reducing some of the unnecessary costs of our relatively expensive health care system.

Slide 8:

In addition to RBCs, there are three other major types of blood components in the transfusion service: platelets, plasma, and cryoprecipitate. The indication for prophylactic platelet transfusion is generally considered to be a platelet count below 5 to 10,000. There is little evidence for the ideal thresholds for platelet transfusion prior to invasive procedures or in the setting of hemorrhage. Plasma transfusion is indicated for massive hemorrhage, disseminated intravascular coagulation, thrombotic thrombocytopenic purpura, or replacement of a factor for which a more targeted therapy is not available. And finally, cryoprecipitate is used to control bleeding associated with fibrinogen deficiency. Note that fibrinogen is critical for achieving hemostasis in hemorrhaging patients since it is both the precursor to fibrin and it facilitates platelet aggregation.

Slide 9:

The education piece of a PBM program might include electronic learning modules and in-person sessions such as grand rounds where indications, risks, and evidence surrounding blood transfusions is discussed. It is recommended that centers develop evidence-based hospital guidelines for transfusions and protocols for specific clinical situations, such as a massive transfusion protocol where relatively large amounts of blood products are rapidly issued to massively hemorrhaging patients in a standardized fashion.

Slide 10:

Blood transfusion is a useful therapy in certain clinical circumstances, but I want to emphasize the importance of treating the underlying cause of anemia. For example,

preoperative anemia is common and is associated with adverse outcomes. For elective surgeries with expected major blood loss, screening for anemia and, if present, identifying its underlying cause should be performed 3-4 weeks prior if possible. This allows time for treatment (for example, with iron for iron deficiency anemia) and hemoglobin improvement before surgery. Acute normovolemic hemodilution (ANH) involves the isovolemic removal of whole blood from a patient at the beginning of a major surgery and volume replacement with saline. As surgery progresses and the patient reaches a threshold requiring a transfusion, the autologous whole blood is reinfused first. If used in the appropriate setting, it may reduce allogeneic transfusion requirements by about one unit or so on average. And, of course, avoiding unnecessary transfusion after surgery is important just like any other situation.

Slide 11:

Optimizing coagulopathy is important in the bleeding patient or in patients at risk of significant bleeding. Preoperative protocols for patients on anticoagulants or antiplatelet drugs can be used. In bleeding patients, normothermia and avoidance of acidosis can help achieve hemostasis. The patient can be monitored clinically as well as using laboratory values such as viscoelastic testing, hemoglobin, platelet count, and coagulation studies including fibrinogen. Protocols for administration of blood components, use of factor concentrates (such as prothrombin complex concentrates), and antifibrinolytic agents can be useful as well. Antifibrinolytics can reduce transfusion requirements in many clinical settings. Finally, bleeding patients with uremic platelet

dysfunction can be given dideoxy arginine vasopressin, or DDAVP, to release endogenous von Willebrand factor and improve platelet adhesion.

Slide 12:

To appropriately conserve the patient's own blood, reduce phlebotomy tube size and avoid unnecessary draws and testing that will not impact management. I am not a surgeon, but it makes intuitive sense to me that close attention to blood loss by using meticulous surgical technique would facilitate blood conservation. Minimally invasive surgical techniques can also help. Finally, cell salvage is used in many major blood loss surgical settings to recycle and reinfuse the patient's own shed red blood cells.

Slide 13:

We aim to optimize blood utilization and try to use patient-centered decision making as much as possible. Informed consent involves explaining risks, benefits, and alternatives to blood transfusion. Transfusion thresholds for a given patient can be defined based on their risk profile. Other important approaches include a single unit transfusion policy for most hemodynamically stable patients in the hospital, an intelligent electronic ordering system using clinical decision support, the ability to identify the ordering physician, indication lists or guidelines, and documentation of the reason for transfusion of each component.

Slide 14:

There are several examples of how one can use data to evaluate the performance of the PBM program. One can track anemia in different settings and appropriate use of antifibrinolytics and cell salvage. Blood usage by department, by procedure, and by

physician can be used for benchmarking. For example, in the table to the right, Dr. Jones uses more blood and appears to be an outlier compared to the peer group. Other important metrics involve the blood supply operation, such as the crossmatch-to-transfusion ratio (which is ideally ≤ 1.7), the issue-to-transfusion ratio, and the amount of wasted blood products along with the reason. These strategies and metrics have been used successfully by PBM programs. Blood is a precious resource and should be used thoughtfully and efficiently. Our ultimate goal is to give the right product to the right patient at the right time for the right reason.

Slide 15:

It is also paramount to include patient outcomes when evaluating your PBM program. As you can see here, these can be broad or more specific to blood transfusion. All these data can be reported to clinicians as well as hospital administration. Additional data regarding cost savings and return on investment can also be included. Taken together, a data-driven approach to PBM can help you evaluate your program and identify areas for improvement on a continuous basis.

Slide 16: References

Slide 17: Disclosures

Slide 18: Thank You from www.TraineeCouncil.org

Thank you for joining me on this Pearl of Laboratory Medicine on “Patient Blood Management.”



*Better health through
laboratory medicine.*

PEARLS OF LABORATORY MEDICINE

Patient Blood Management

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DOI:



Patient Blood Management (PBM)

- What is it?
 - Rationally optimizing anemia and hemostasis
 - Goal of restricting (optimizing) blood component use
- Why do we care?
 - Blood transfusion = most common procedure¹
 - Top five most overused²
 - Standard of care³

Value = Quality / Cost



Decline in transfusions in US⁴

- 2008: ~15 million RBC units transfused
- 2015: 11.3 million RBC units transfused
- Likely due to implementation of PBM programs including evidence-based transfusion guidelines
 - Several large trials support a “restrictive” transfusion strategy



What might a PBM program encompass?

- Education program
- Optimize blood component use
- Diagnose and treat perioperative anemia
- Reduce/optimize blood loss in surgery and from lab draws
- Challenge: blood transfusion ordered by a variety of specialties and administered by a variety of health care staff



Project
Management



Red Blood Cell (RBC) Transfusion Trials Comparing Hemoglobin Thresholds⁵

Trial	Population	Participants (n)	Thresholds (hemoglobin)	Primary outcome
TRICC	Critical care	838	7 g/dL vs 10 g/dL	30d mortality 18.7% vs 23.3%, P=0.11
FOCUS	Hip fracture	2016	8 g/dL vs 10 g/dL	Death or inability to walk across room at 60d, 35.2% vs 34.7%, P=0.9
Villanueva et al.	Upper GI Hemorrhage	921	7 g/dL vs 9 g/dL	Mortality at 45d, 5% vs 9% P=0.02
TRISS	Septic Shock	998	7 g/dL vs 9 g/dL	90d mortality, 43% vs 45% P=0.44
TITRE2	Post-cardiac surgery	2003	7.5 g/dL vs 9 g/dL	Infection or ischemic event in 3mo, 35.1% vs 33.0% P=0.3
TRICS-III	Cardiac surgery	4860	7.5 g/dL vs 8.5 or 9.5 g/dL	Composite, 11.4% vs 12.5% P<0.001 for noninferiority

Treat the patient, not the laboratory value

- Indications for RBC transfusion
 - Significant acute hemorrhage
 - Significant signs/symptoms of anemia
- However, lab values (e.g. hemoglobin) do provide very useful information to help decide whether to transfuse or not



PBM strategies to reduce unnecessary transfusions

- Clinical decision support improves RBC usage⁶
 - Best practice alert (“pop-ups”) at computerized provider order entry
- RBC transfusion interventions reduce the proportion of patients transfused⁷
- Initiatives that successfully reduce RBC transfusion also reduce health care costs
 - RBC acquisition cost ~\$200
 - RBC total activity based cost ~\$800+

Indications for transfusion of other blood components

- **Platelets**
 - Bleeding prophylaxis (general): platelet count $<5-10\text{k/ul}$
 - Procedures/hemorrhage: paucity of evidence
- **Plasma**
 - Massive hemorrhage
 - Disseminated intravascular coagulation
 - Thrombotic thrombocytopenic purpura
 - Replacement of plasma constituent for which a more targeted therapy is not available
- **Cryoprecipitate** (contains fibrinogen, FVIII, vWF, FXIII)
 - Control bleeding associated with fibrinogen deficiency



Education program

- Materials: e.g. learning modules
- In-person: e.g. grand rounds
- Indications for transfusion, risks, evidence
- Develop hospital guidelines, protocols for specific clinical situations





Anemia Management⁸

- Preoperative
 - Screening: 3-4 weeks prior to elective surgery with expected major blood loss
 - Diagnose and treat iron/B12/folate deficiency anemia
- Optimize cardiac and pulmonary function
 - Acute normovolemic hemodilution
- Postoperative
 - Avoid unnecessary RBC transfusion





Optimizing Coagulopathy⁸

- Preoperative
 - Algorithm for patients on anticoagulation or anti-platelet medication
- Management of bleeding patients
 - Body temp > 36C
 - pH > 7.2
 - Hemorrhage monitoring (e.g. viscoelastic tests and/or hemoglobin, platelet count, coags including fibrinogen levels)
- Protocols for administration of blood components, factor concentrates, and antifibrinolytic agents
- Antifibrinolytics for cardiac, ortho, obstetric hemorrhage, massive hemorrhage surgeries
- Uremic platelet dysfunction (e.g. di-deoxy arginine vasopressin, DDAVP)



Blood Conservation Strategies⁸

- Minimize diagnostic blood loss
 - Reduced tube size
 - Fewer draws
- Surgical blood loss
 - “Close attention”
 - Minimally invasive techniques
 - Cell salvage



Optimal Blood Use with Patient-Centered Decision Making

- Informed consent
- Transfusion plan with thresholds based on risk
- Single unit transfusion policy
- Intelligent electronic ordering
- Ability to identify ordering provider
- Indication list (e.g. pocket card, posters)
- Documentation of the indication for each component



PBM-Related Metrics & Benchmarks^{9,10}

- Track anemia: preop, hospital-acquired, treated patients
- Use of antifibrinolytics, cell salvage
- Blood usage by dept or procedure or physician: # units/patient
 - Benchmarking
- Blood supply chain efficiency
 - Crossmatch : transfusion ratio (<1.7:1)
 - Issue : transfusion ratio
 - Wasted products

Physician	RBCs Transfused / Procedure
Smith	0.5
Jones	8
Doe	1
Adams	1.2



PBM-Related Metrics & Reporting

- Patient outcomes!
 - In-hospital mortality
 - Morbidity (infections, myocardial infarction, stroke, etc.)
 - Length-of-stay (LOS)
 - Hemoglobin (presurgical and postoperative)
 - Hemovigilance (e.g. transfusion reactions)
- Report to clinicians and hospital administration
 - Include cost savings, return on investment



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Upon Pearl submission, the presenter completed the Clinical Chemistry disclosure form. Disclosures and/or potential conflicts of interest:

- **Employment or Leadership:**
- **Consultant or Advisory Role:**
- **Stock Ownership:**
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