BLOOD UTILIZATION and blood-related costs are accelerating in the United States at a time when blood components, hospital labor, and healthcare dollars are in short supply. The number of components transfused in the United States was approximately 24 million units in 2008.¹ For the past decade, blood suppliers have struggled to meet the demand, while intermittent blood shortages occur. Difficulties in recruiting donors, increases in the cost of testing and processing...
blood, and increased skilled-labor costs caused more than a tripling of the price of blood components between 1998 and 2008, creating a hardship for hospitals already dealing with thin operating margins and declining reimbursement. In hospitals, the procurement, storage, processing, and transfusion of components involves an array of expensive and increasingly scarce resources, resulting in a three- to fourfold increase in the total cost of blood beyond the base cost of its acquisition.

These operational and economic issues are overshadowed by the patient safety implications of inappropriate transfusion decisions and transfusion errors and the quality management they require. Owing in large part to a lack of formal training in transfusion medicine for most physicians, the administration of components is often guided by emotions, misconceptions, and myths. In spite of mounting evidence that demonstrates significant harm can result from unnecessary blood transfusions, several studies document a generalized lack of compliance with appropriate transfusion guidelines, as well as tremendous variation in transfusion practice both among different institutions and among individual physicians in the same institution.

### Better Patient Blood Management through Transfusion Guidelines

In response to the above issues, forward-looking hospitals are implementing measures that better promote optimal utilization of their blood resources. By reducing variation in transfusion practice and implementing more efficient methods to manage candidates for transfusion, hospitals can reduce the need for allogeneic components while improving patient safety and clinical outcomes and reducing costs. Strategies to more efficiently manage blood resources and transfusion candidates include preoperative anemia management; the judicious use of autologous transfusion devices; topical hemostatic agents and systemic drugs that reduce bleeding and the need for certain surgical and anesthetic techniques; intravenous iron and erythropoietic growth factors; and measures to reduce iatrogenic blood loss.

The most challenging, but potentially the most effective, method of reducing allogeneic transfusions is to develop systems that promote the use of evidence-based transfusion guidelines. Because the decision to transfuse is made thousands of times a day in US hospitals by a multitude of physicians, all with differing backgrounds and
interests in transfusion practice, there is a critical need for active and effective transfusion committees (TCs) to develop, promote, and monitor best practices in blood component therapy. This chapter reviews challenges to the implementation of evidence-based transfusion guidelines and offers guidance based on cases of successful implementation.

Challenges to Changing Physician Practice

In their role as stewards of the blood supply, TCs must function both reactively (ie, providing blood utilization review) and proactively (formulating and implementing effective transfusion guidelines). In this latter role, TCs must serve as agents of change to alter established patterns of physician behavior.

The Hospital Environment

The many challenges to changing physician practice include environmental factors such as poor communication between physicians and other members of the healthcare team, misalignment among individuals and departments resulting from different motivation-and-reward systems, a lack of experience in the use of cross-functional teams, and administrative failure to anticipate and deal with resistance. Since the first publication of this book, there has been an increasing emphasis on reducing inefficiencies and costs in the US health-care system, along with the implementation of the Patient Protection and Affordable Care Act (“Affordable Care Act,” or ACA). By some estimates, 20% or more of health-care costs are due to waste and inefficiencies, and three key drivers are 1) failure of care delivery, including poor execution or lack of widespread adoption of known best-care processes, 2) failure of care coordination, and 3) overtreatment. Because these problems are widespread, many hospitals struggle to implement quality initiatives and departmental reengineering projects. Studies have clearly shown that passive dissemination of information (“stuffing mailboxes”) is an ineffective method of behavioral change, yet it remains a common practice. Administrators and quality managers are frustrated when they invest considerable time and effort in the development of clinical practice guidelines only to see little change in outcomes after the guidelines have been published.

Staff Resistance

Resistance within organizations is a leading cause of failed change initiatives. Common sources of resis-
Resistance include the inertia resulting from previously established practice, negative experience with previous change initiatives, insufficient time for team members to implement the change process, and a lack of resources to effect the change. Resistance to change is both predictable and understandable; because change represents uncertainty for the organization and for individuals, resistance is a natural response. Acknowledging sources of resistance and actively working toward removing barriers to progress are vital steps in building trust among those involved in changing practice.

In some cases, inappropriate responses to resistance can lead to further problems. It is well known that individuals adapt to new ideas at different rates. Rogers is credited with first defining the rate of time required for adoption of novel processes within a group, by means of a graphed curve that plots the number of adopters over time in a sigmoidal shape similar to that of the spread of an epidemic (Fig 9-1). For comparative purposes, individuals can be classified based on their deviation from the mean adoption time and grouped as innovators, early adopters, early majority, late majority, and laggards (Fig 9-2). When approaching the more conservative physicians in a group with a new concept or practice pattern, it is important to recognize that resistance from these individuals is predictable and is likely the result of the inertia of established practice, rather than true opposition to the concept itself. Therefore, the best approach to these physicians is patience and gentle persistence, with the understanding that they will probably not adopt the change until they see other colleagues leading the way. As such,
visibility of change efforts by key physician groups and communication of implementation progress are mechanisms to shorten adaption time. Failure to recognize the tendency of these individuals to resist change in general can worsen the situation; an antagonistic and overly aggressive approach often leads to genuine opposition. It is also important that clinical and administrative leaders set the expectation that the change effort will be supported and will not go away; otherwise, resistant individuals may be tempted to simply try and “wait it out.”

Implementing Clinical Practice Guidelines

The Root of Resistance

The Institute of Medicine of the National Academies and other agencies have called for the increased use of clinical practice guidelines to reduce practice variation, improve quality of care, and decrease inefficiencies. Providing such guidance is a major function of hospital TCs. Although the use of transfusion guidelines can improve blood utilization and transfusion outcomes by providing education and guidance for best practice in specific clinical situations, the mere publishing of guidelines does nothing to change actual physician practice. Even when the rationale behind practice guidelines has been given thoughtful consideration and is quite logical, the successful implementation of the guidelines relies heavily upon the emotional reactions and other responses of the physicians affected. Because of this, implementation of practice guidelines first requires changes in perceptions and attitudes in order to achieve changes in behavior.

To facilitate attitudinal change, it is important that practice guidelines be internally generated with an expanding process of ownership and “buy-in.” The development of ownership is a process by which stakeholders in the organization are actively involved in shaping the change effort. The process of buy-in builds with a movement toward acceptance and endorsement of the change process by affected individuals. In the early stages of guideline implementation, “buy-in” may mean merely that certain key individuals in the group do not actively resist the guidelines.

Key Elements in Implementation

Several published studies have investigated methods to successfully implement practice guidelines. This literature supports the selection of several conditions that should be met in
the process of guideline implementation:

1. The guidelines should be based on scientific evidence, and their application must be meaningful in clinical practice (i.e., they must be worth the effort).
2. Key local physicians who are responsible for adapting them to local circumstances should formulate the guidelines, and affected users should have the opportunity to critique them.
3. The guidelines should have readily discernible benchmarks or targets for good practice.
4. Active educational efforts should accompany dissemination of the guidelines to all affected health-care providers, and manual or computerized reminder systems should prompt use of the guidelines at points of intervention.
5. Implementation of the guidelines must include either direct feedback on performance to individual physicians or general feedback on system performance.
6. Accountability for adherence to the guidelines must come from peer pressure, administrative sanction, and/or financial incentives or disincentives.

Conversely, guideline implementation techniques shown to be ineffective are those that rely on passive dissemination or voluntary change in practice patterns or that lack an accountability component.32

**Key Leaders in Implementation**

Once practice guidelines have been formulated, the TC needs to devote a great deal of time and effort to promoting their use. It has been proposed that as much as 90% of total efforts should be spent on guideline implementation and only 10% on development.40 More specifically, educational efforts should target key physicians known to be influential with their peers. Clinicians usually analyze new clinical information by seeking additional information and opinions from peers in their local network rather than individually reviewing the scientific merits.41

Physician opinion leaders are those physicians informally judged by their peers as educationally influential and trustworthy to evaluate new information in the context of the local group norms.41 To lead opinion, a physician must be considered by associates to be technically competent and well integrated with his or her peers in the local medical community.34 It is important to note that opinion leaders are informal leaders who are practicing physicians and generally not administrators or authority figures.42 Opinion leaders are also not innovators or early adopters; rather, they are conservative evaluators.34 Because their clinical judgment is highly valued, physician opinion leaders have the ability to directly or indirectly affect the prac-
practice patterns of their peers. The adoption of new information or technology into one opinion leader’s practice is tremendously influential, because similar adoption by peers can occur by leader emulation alone. Concentrating educational and buy-in efforts on physician opinion leaders is an efficient and effective method of facilitating changes in practice.\textsuperscript{34,41}

Case Study: Transfusion Guideline Implementation at St. Vincent Indianapolis Hospital

St. Vincent Hospital is an 800-bed, tertiary care, community hospital in Indianapolis, IN. A comprehensive patient blood management (PBM) program was created in 2001 in response to rising blood utilization and blood costs, disparate patterns in blood use among physicians, and concerns about patient safety. A core element of this program was the formulation and implementation of evidence-based transfusion guidelines by the TC in order to reduce variation and promote best practices in transfusion medicine. A description of the process and the results of the program follow.

The Guideline Revision Process

Following publication of evidence that conservative transfusion strategies might be at least as effective as (and possibly even superior to) more liberal transfusion strategies,\textsuperscript{9} the St. Vincent TC decided to significantly revise its recommendations for RBC transfusions. Understanding that a transition to this more conservative approach would require major changes in physician attitudes and practice, the TC devised an extensive process for the formulation, review, and approval of revised transfusion guidelines. The process was specifically designed to build awareness, interest, and buy-in with hospital clinical and administrative leadership groups. In addition, the TC began educational efforts about transfusion risks and benefits in tandem with the guideline formulation and implementation.

The first step for the TC in the formulation of the transfusion guidelines was to convene a local expert panel to review the transfusion literature. The membership of this panel included respected clinical leaders in anesthesiology, cardiology, pathology, hematology/oncology, pediatrics, critical care, cardiac surgery, vascular surgery, and orthopedics, some from outside the existing TC. Articles reviewed included consensus conference recommendations, as well as current clinical trials of transfu-
sion strategies, both observational and controlled. The panel then constructed the core recommendations for the hospital’s evidence-based transfusion guidelines covering red cells, platelets, plasma, and cryoprecipitate.

The recommendations of this panel were presented to the TC as a whole for comment, revision, and approval. An interesting phenomenon that occurred during the review process was that TC members who had been inactive in the past became actively involved and highly participative because they wanted to be certain that their opinions were heard in the guidelines process.

Following approval by the TC, the transfusion guidelines were presented for review to the Quality Management Committee, which was the largest committee in the hospital and represented a diverse group of clinical and nonclinical departments. Again, the transfusion guidelines were openly reviewed before approval.

The final step in the approval process involved the medical executive committee (MEC). A formal presentation was prepared for the MEC; once again, the guidelines were carefully scrutinized before being approved. This final approval step added considerable weight to the enforcement of the guidelines, because compliance was deemed a component criterion for physician recredentialing by the MEC.

The entire process of guideline formulation, review, and approval through an expert panel and three committees took 5 months—a remarkably short time to accomplish such a major undertaking. Although the process was laborious, challenging, and at times contentious, the benefit of this meticulous and transparent review of the transfusion guidelines was a sense of ownership and buy-in by key hospital staff. Further, the extensive internal review of the new guidelines proved extremely useful later when they were challenged by individual physicians. In these instances, the process of guideline approval and a list of the relevant clinicians involved in the review process were recounted to support the guidelines.

Education

As previously mentioned, general educational efforts were begun during the development of the guidelines, and these efforts were continued through the period of guideline implementation. Medical and surgical departments held meetings, and hospital newsletters disseminated information. The TC actively sought out key physician opinion leaders who had not been involved in the formulation of the guidelines and briefed them through an informal academic detailing process. In addition, the TC made significant efforts to edu-
cate nursing leadership and nursing staff. The TC deemed the inclusion of nursing education efforts particularly important, because nurses are generally the interface between physician blood-ordering practices and patients. Nursing staff received education about transfusion risks and benefits, the importance of patient safety measures such as positive patient identification, and the need to “encourage” the use of the new transfusion guidelines in their role as patient advocates.

Implementation of a Transfusion Order Form

A critical component of the implementation process required the timely provision of information to support transfusion decisions. Considering the challenges of disseminating information to a large medical staff in a community hospital and the need to provide manual or computerized reminder systems at points of intervention, the TC decided to create a transfusion order form to promote the use of the transfusion guidelines (see Appendix 9-1).

The TC used the following rationale to support this form, based on its benefits:

1. Awareness/Visibility. To counterbalance sparse attendance at department meetings and grand rounds presentations, the use of a transfusion order form provided a tangible reminder of the changes the hospital was making in blood utilization. Although the physician response to additional paperwork may have been less than enthusiastic, the implementation of a novel process served to create high visibility for the effort.

2. Education. As previously mentioned, most physicians do not have formal training in blood component therapy, and remaining current with new research can be challenging when transfusion medicine is not a physician’s area of clinical focus. Therefore, the major driver for the creation of the order form was to provide an educational opportunity for physicians. The order form provided approved clinical indications and dosing recommendations for RBCs and coagulation-factor therapy (platelets, plasma, and cryoprecipitate).

3. Compliance/Peer Review. The last major rationale for the inception of the transfusion order form was to improve documentation for blood component use and to provide a mechanism for peer review through audit and feedback. Although documenting clinical indications for blood component therapy in the medical record is required by accrediting organizations such as The
Joint Commission and is considered sound practice, a review of the medical records at St. Vincent revealed a lack of adequate documentation in a significant percentage of cases. The transfusion order form allowed physicians to quickly document the patient’s consent, pretransfusion physiologic status, and clinical indication for the transfusion. If the physician chose not to select an approved indication for a component, additional documentation was required. The printed format of the transfusion order form allowed for the creation of a carbonless copy, so that one sheet could remain in the chart to serve as documentation, and one sheet could be sent to the blood bank and then the TC. A small sampling of these forms was reviewed each quarter (approximately 5% to 10% of cases) for the purposes of peer review and enforcing compliance.

**Blood Utilization Benchmarking**

In addition to audit of and feedback from the transfusion order form, blood utilization benchmarking was employed by the St. Vincent TC to promote better blood utilization. Utilization benchmarking is a valuable tool for process improvement in health care and should be used as part of a larger quality improvement tool set that includes metrics, education, and change management strategies. The three purposes of benchmarking are learning from others, identification of performance gaps, and implementation of best practices. A system of peer profiling to compare average blood component transfusion rates within major Medicare severity diagnosis-related groups (MS-DRGs) was used. MS-DRGs are defined by the Centers for Medicare and Medicaid Services and are intended to group patients with like procedures or diagnoses for purposes of cost reporting and reimbursement. The MS-DRG system also contains three levels of patient comorbidity for each procedure grouping, so it constitutes a reasonable and standardized method of comparing similar patients across institutions.

The first step in the process was to compare the average number of blood components used per patient, by MS-DRG grouping, to benchmark figures derived from multiple hospitals. In order to reduce the impact of outliers and to provide more meaningful data, a 12-month rolling average was used. This analysis provided hospital leadership with a general overview of blood component utilization in each service line or department and helped to target opportunities for improvement. The second step was to then compare individual physicians’ blood component use to that
of their hospital peers. This second evaluation provided a clear view of variability in practice patterns among physicians managing similar patients within the hospital, and generally had greater impact on shaping physician behavior. Although review of individual transfusion decisions through audit and feedback is important, this benchmarking data can provide a more holistic view of PBM practices. Because transfusions, or the lack of them, are often the end result of a series of events (ie, pre-operative preparation, surgical techniques, pharmaceutical use, and adherence to transfusion guidelines), significant deviations from peer norms may represent multiple opportunities for improvement. Upon review, if the TC deemed that a physician was overusing components in relationship to his or her peers, the TC sent the benchmark utilization data, along with a supporting letter, to the appropriate clinical department head for discussion with the physician. The role of the TC in these cases was to provide educational support to the department head and physician, rather than to function as a disciplinary body. The use of this blood utilization benchmarking method as a component of a comprehensive PBM program in a large academic center was recently published, and it is important to note that blood utilization profiling such as this can be used for ongoing professional practice evaluation (OPPE).

Program Advancements—Addition of a Transfusion Safety Coordinator

In order to provide support for ongoing education, training, and quality improvement related to blood utilization and transfusion administration safety, St. Vincent created a transfusion safety coordinator (TSC) position based on successful models in Canada and the United Kingdom. TSCs, also called transfusion safety officers, are specialists that educate clinical staff on transfusion guidelines, safe transfusion administration practices, and protocols that improve PBM. Goals and activities for TSCs include the following:

- Tracking hospital performance of key processes by active surveillance (observation audits) and chart reviews.
- Tracking data on key performance indicators developed by the TC.
- Participating in an overall program of transfusion safety error and/or accident reporting (bio/hemovigilance).
- Educating clinical staff (nursing, physician) regarding hospital transfusion guidelines, risks of blood transfusion, and recognition and reporting of transfusion reactions.
Providing orientation training for new physician and nursing staff responsible for administering blood in high-usage areas.

- Contributing to continual improvement processes for blood utilization review through transfusion order audit and feedback.

There is a growing body of evidence that trained and empowered TSCs provide tangible improvements in patient safety, blood utilization, and quality of care. After training and deploying TSCs to a hospital network in Ontario, Canada, a significant decrease in blood use was experienced, including a 24% reduction of use in knee surgeries and a 23% reduction of use in coronary artery bypass graft surgery. Further, patients that were visited preoperatively by a TSC for preoperative evaluation and anemia management were 38% less likely to receive a transfusion during cardiac surgery. Experience to date at St. Vincent has shown the TSC to be a tremendous addition to the TC, as well as the quality management department, by providing a day-to-day resource for promoting the overall objectives of safe and effective blood component therapy.

**Results of Successful Transfusion Guideline Implementation**

The results of the interventions at St. Vincent Hospital were remarkable for both the short time required for measurable change and the degree to which transfusions were reduced. RBC use declined 15% in the first year of the program, and a further 12% in the second year (see Fig 9-3). A dramatic reduction also occurred in autologous RBC transfusions (see Fig 9-4) through the implementation of an orthopedic PBM algorithm that discouraged the use of preoperative autologous donation.

In year 2 of the program, platelet transfusions began to show reductions similar to those seen in RBCs, following additional education about platelet transfusion therapy directed at cardiac surgery and oncology departments (see Fig 9-5). The dramatic reduction in transfusion rates at St. Vincent can be attributed to a combination of PBM strategies that included the successful implementation of evidence-based transfusion guidelines, innovative peer review of transfusion, the use of PBM algorithms, and the formation of multidisciplinary teams to study, implement, and monitor PBM interventions in high-blood-use departments. A variety of authors have advocated a similar multimodal, multidisciplinary, evidence-based and data-driven approach to implementing transfusion guidelines and PBM strategies.

Although it is difficult to isolate and estimate the effect of transfusion guidelines on total hospital
Figure 9-3. Red Blood Cell use at St. Vincent Indianapolis Hospital.

Figure 9-4. The use of Red Blood Cells from preoperative autologous donation at St. Vincent Indianapolis Hospital.
blood use, an analysis of transfusion patterns in cardiac surgery patients at St. Vincent indicated the effect was substantial. Shortly after implementing the new transfusion guidelines, a retrospective review was conducted to investigate factors leading to transfusion in the cardiac surgery population. A multivariate analysis was performed to minimize confounding factors and to determine what independent factors increased the likelihood of transfusion for a patient. One component of the analysis was an evaluation of the impact of the transfusion guidelines, because they were implemented at a fixed time and universally adopted through the strong leadership of the chief of cardiac surgery. Remarkably, the analysis demonstrated that the transfusion guidelines as an independent factor reduced the likelihood of transfusion in cardiac surgical patients at St. Vincent by 32% (odds ratio of 0.68).

The next advancement at St. Vincent for improving compliance with transfusion guidelines will involve the use of computerized physician-order entry (CPOE), described below.

**Electronic Tools in the Implementation of Transfusion Guidelines**

CPOE can be a useful tool in “hard-wiring” transfusion guidelines, and
has been proven to be effective in terms of overall reduction in blood component use.\textsuperscript{51,52} One pediatric intensive care unit (ICU) had a 52% decrease in RBC transfusions per patient per day after employing CPOE,\textsuperscript{53} and CPOE was shown to improve compliance with existing transfusion guidelines in a neonatal ICU by 25%.\textsuperscript{27}

The use of paper orders for transfusion guidelines can serve as a precursor for successful implementation of CPOE, and subsequently the guidelines become an integral part of electronic decision support. Ideally, the CPOE design should do more than simply recreate an existing paper process for ordering transfusions. CPOE is of greatest value in improving and then hardwiring physician transfusion practices when clinical decision support (CDS) is incorporated into the design. CDS systems provide physicians (and others) with relevant knowledge and patient-specific information to support clinical decision making. This may take the form of references, reminders, alerts, recommendations, and guidelines. These decision support tools work best when they fit into the physician’s workflow and provide clinically relevant information to redirect physicians to an alternative action rather than stopping them without offering an alternative.\textsuperscript{54} Well-designed CDS systems as part of a CPOE system can help educate physicians about a hospital’s transfusion guidelines at the point of decision.

The design of the CPOE process can have a profound impact on user acceptance, as well as the degree to which CPOE has a meaningful influence on physician decision making. In a retrospective study of the impact of CPOE on compliance with transfusion guidelines 2 years after implementation, providers indicated the presence of “active bleeding” in 66% of transfusion orders that effectively bypassed the CDS. However, medical record review showed that in only 46% of these cases was the presence of bleeding substantiated.\textsuperscript{55} The number and complexity of the input screens may have contributed to a lack of user acceptance and encouraged efforts to avoid the CDS.

In a study of a computerized transfusion decision support system (CTDSS) for frozen plasma, more than one-third of transfused plasma was given to patients with normal coagulation studies. The CTDSS was not enabled to reject inappropriate transfusion requests, and did not require that an indication be chosen before completing the order. This CPOE process failed to make clinically relevant pre-transfusion coagulation results available on the request screen at the time transfusion was being ordered, limiting its utility.\textsuperscript{56}
Elements of Successful Implementation for Electronic Tools

A number of design features may improve the probability of successful implementation of transfusion guidelines as part of CDS for CPOE. Speed and a user-friendly interface are important. Minor changes in the appearance of an input screen can have a major impact on provider actions. The process should fit the user’s workflow and provide clinically relevant information at the right time within that workflow. A recommended practice is to avoid “hard stops” in computerized orders, because these are strongly resisted by physicians and often lead physicians to develop work-arounds that circumvent CDS. Alerts with a hard stop should be reserved for situations that place patient safety at risk. Instead, the preferred actions should be made as easy as possible to execute, while decisions or actions that are discouraged should be made more difficult. The clinician should not be able to override critical alerts or barriers but should be allowed to easily exercise clinical judgment where appropriate. Changing a physician’s direction is easier than stopping it. For example, redirecting a physician to order vitamin K rather than plasma for warfarin reversal without having to leave the transfusion order input screen will be more likely to achieve compliance with guidelines than a hard stop with no alternative or the need to initiate a new ordering process. Setting defaults to be consistent with guideline recommendations offers a path of least resistance and will improve compliance with guidelines. Finally, CPOE is most successful when its use is mandatory. With regards to blood component therapy, exceptions to mandatory use might include urgent or emergency requests for blood in an unstable patient with active bleeding.

Successful implementation of transfusion guidelines does not guarantee that initial changes in clinical practice will be durable. Tethering transfusion guidelines to CPOE facilitates transfusion utilization review and helps ensure compliance. CPOE allows the transfusion service to assign the ordering physician with great accuracy and avoids attribution of a transfused unit to an admitting or consulting physician who may have had no role in the transfusion decision. The indication for transfusion and relevant clinical data should also be captured electronically, facilitating statistical analysis of transfusion practice as well as utilization review.
CPOE Case Study: The Use of CPOE to Encourage Ordering RBCs as Single Units

Eastern Maine Medical Center (EMMC) is a 375-bed tertiary hospital in Bangor, ME. EMMC implemented a comprehensive PBM program in 2007 and used CPOE with CDS as part of a transfusion guideline implementation strategy. One component of that strategy was to encourage single-unit RBC transfusions in stable, nonbleeding patients. Many physicians were taught informally that single-unit transfusions were likely to be ineffective, and some TCs have used single-unit RBC transfusions as a quality indicator prompting utilization review. Based on the current risk/benefit profile of blood component therapy, there should be an emphasis on using the minimum effective dose, which is often a single unit in an otherwise stable patient who has dropped below a transfusion threshold.

EMMC decided that for most patients without significant active bleeding, the appropriate RBC order should be for a single unit, with clinical reassessment before a second unit is ordered. This was promoted through education and hospital policy as established by hospital transfusion guidelines. A significant level of success was achieved by this educational effort, with approximately 60% to 65% of all RBC orders being entered as single-unit orders from August 2006 through November 2007 (Fig 9-6).

In an effort to improve compliance, a CPOE process was designed that introduced a barrier to multiunit orders. Specifically, the process required the ordering physician to indicate whether or not the patient had active bleeding. If the patient was not actively bleeding, the transfusion ordering “conversation” within the CDS allowed only 1 unit to be ordered. To order a second unit, the physician needed to begin a new order “conversation.” This then required additional effort to go through the order process a second time, making it harder to do “the wrong thing.” As seen in Fig 9-6, after implementation of the CPOE process in November 2007, there was a rapid and sustainable increase in the percentage of RBC orders entered as single-unit orders, to approximately 85%. Further, quality monitoring showed that in patients transfused with only 1 unit, a second unit was ordered within the next 24 hours only 9% of the time (data not shown).

In conclusion, CPOE with CDS is a useful tool when combined with other behavioral interventions to reduce transfusions and assist in the implementation of transfusion guidelines. It may be difficult to discern the independent effect of any one intervention, but in combination these behavioral interventions may have a significant effect on
reducing transfusion rates.\textsuperscript{60} CPOE has been shown to improve compliance even when transfusion guidelines are well-established, being accompanied by a significant reduction in transfusions given.\textsuperscript{27} In addition, CPOE also improves the ease, accuracy, and timeliness of the utilization review process. Data from the computer orders can be collected and reviewed regularly by the TC with the goal of identifying physicians that regularly order against the guidelines, providing the opportunity for feedback and education.

\textbf{Summary}

Faced with a tenuous blood supply and increasing blood costs, hospitals should work toward altering blood demand by promoting best practices for blood utilization and by the more efficient management of patients at high risk of transfusion. TCs are vital to PBM efforts in
the development of evidence-based transfusion guidelines. Successful implementation of such guidelines requires an organizational commitment at all levels and a firm understanding of the principles involved in formulating and internally marketing practice change among physicians. The experiences at St. Vincent Hospital and EMMC demonstrate that the impact of these guidelines can be substantial when combined with other methods to manage blood utilization in the most appropriate and systematic manner.

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Appendix 9-1. Transfusion Order Form in Use at St. Vincent Indianapolis Hospital Since 2001

ST. VINCENT HOSPITALS AND HEALTH SERVICES

- USE THIS FORM FOR ALL BLOOD COMPONENT TRANSFUSION ORDERS.
- Check off at least one indication for each type of blood component order.
- The minimal effective dose of all blood components should be used; SINGLE UNIT transfusions of red cells are often effective.
- Compliance with transfusion guidelines will be monitored by the transfusion committee.
- The blood bank phone # is 803-0421 (86th Street).

☐ Blood Transfusion Consent signed

TRANSFUSION ORDER (indicate type and amount):

Request for special red cell products: ___________Irradiated _______Washed _______CMV negative
Patient location (3E, ICU, OR, PACU, etc) __________________________ Utilization review☐

INDICATION (check all that apply):

- Packed Red Cells Most recent hemoglobin ______ g/dL or hematocrit %
  One unit of packed red cells in an adult, 8 mL/kg pediatric dose, will increase hematoctrit by approximately 3% and hemoglobin by 1 g/dL.
  - Hematocrit ≤ 21% or hemoglobin ≤ 7 g/dL
  - Hematocrit ≤ 24% or hemoglobin ≤ 8g/dL in a patient with coronary artery disease and unstable angina/myocardial infarction/cardiogenic shock
  - Rapid blood loss with >30-40% of estimated blood volume (>1500-2000 mL) not responding to appropriate volume resuscitation, or with ongoing blood loss
  - The patient has been determined to be normovolemic and there is evidence to support the need for increased oxygen carrying capacity as witnessed by (indicate):
    NOTE: these indications will be tracked and may be peer reviewed
    - Tachycardia, hypotension not corrected by adequate volume replacement alone
    - PVO2 < 25 torr, extraction ratio > 50%, VO2 < 50% of baseline - specify
    - Other - specify

- Autologous predonated red cells: same criteria as above

- Platelets Most recent platelet count _________/cc²
  A single dose of platelets (adult: one apheresis or 6 concentrates; pediatric dose: 1 unit/10 kg) will increase the platelet count by 25,000-35,000/cc²
  - Platelet count ≤ 10,000/cc² prophylactically in a patient with failure of platelet production
  - Platelet count ≤ 20,000/cc² and signs of hemorrhagic diathesis (petechiae, mucosal bleeding)
  - Platelet count ≤ 50,000/cc² in a patient with (indicate):
    - Active hemorrhage
    - Invasive procedure (recent, in-progress, planned)
  - Platelet dysfunction as documented by - specify

- Fresh Frozen Plasma Most recent coag. studies: PT __________ INR _______PTT _______Fibrinogen ______
  A dose of 10-15 mL/kg is usually adequate to correct a coagulopathy.
  Patient weight _______kg
  - Abnormal coagulation studies and significant hemorrhage
  - Prophylactic use for PT/ APTT > 1.5 times the mean of the reference range
  - Emergent reversal of coumadin

- Cryoprecipitate Most recent coag. studies: PT __________ INR _______PTT _______Fibrinogen ______
  One unit per 10 kg is usually adequate when cryoprecipitate is required.
  Patient weight _______kg
  - Fibrinogen ≤ 100 mg/dL
  - Fibrinogen ≤ 150 mg/dL with active hemorrhage

/printed name

Physician’s signature

Pager #

Date

Time