HOW DO I USE CLINICAL DECISION SUPPORT FOR PATIENT BLOOD MANAGEMENT?

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Clinical decision support systems (CDSSs) date as far back as the 1960s, when they were introduced to support pharmacists with medication dosing and checking patients' drug interactions, allergies and duplicate therapy.[1] Today, CDSSs have grown to support a variety of clinical indications, including support of patient blood management (PBM) programs. CDSSs can be computerized or non-computerized, active (i.e., interruptive) or passive, and patient-specific or non-patient-specific. A clinical practice guideline (CPG) is an example of a CDSS that is non-computerized, passive (i.e., requires clinician to look up the guideline), and non-patient-specific.

CPG use has increased exponentially throughout the past 30 years, with a shift from opinion- to evidence-based development.[2,3] In fact, the library of the Guidelines International Network has more than 6,000 CPG-related documents from 76 countries.[3] At least 18 CPGs for red blood cell (RBC) transfusions have been developed by various organizations and societies dating back to 1988. Groups that have developed these CPGs include the Association for the Advancement of Blood and Biotherapies (AABB), the National Institutes of Health (NIH), American College of Physicians (ACP), American Society of Anesthesiologists, College of American Pathologists (CAP), and the Society for the Advancement of Patient Blood Management (SABM), among others.[4]

While CPGs are commonly employed across clinical settings, they may not always be successful on their own in accomplishing the desired goal of altering practice habits to comply with best practices. This is because CPG-adherence among clinicians can be low and active interventions, such as educational workshops and reminders, are typically required to enhance uptake.[3] Unfortunately, there is little decisive guidance on the best methods to successfully implement CPGs.[2] Barriers to implementation include CPG-related issues, such as CPG-trustworthiness and patient-related concerns. Trustworthy guidelines contain strong recommendations based upon systematic reviews of the literature by a knowledgeable panel of experts and are revised as new evidence avails. Yet, in a recent study, a large percentage of CPGs were reported to have limited rigor and did not meet all criteria for trustworthiness.[3] Updating CPGs in a timely manner as new evidence becomes published is also problematic.[3] Conflicting or inconsistent recommendations across CPGs published by various organizations may also undermine implementation.[3] Guidelines also tend to be limited

in that they address the common or average patient without taking specific patient factors into account, such as multiple chronic conditions, sociopersonal contexts, and patient preferences in shared decision-making.[2, 3]

POTENTIAL TO IMPROVE CLINICAL PRACTICES

With the widespread adoption of electronic health records (EHRs) throughout the past two decades has come the enhanced potential to improve clinical practices through use of CDSS tools that guide clinicians through best practice alerts (BPAs).[5] Clearly, EHR BPA interventions have the potential to be more useful than simple CPGs, owing to the fact that they are active, computerized and patient-specific, with alerts occurring at the time of computer-physician order entry (CPOE). Yet, even electronic CDSSs have rarely been used in clinical medicine, despite convincing evidence for their effectiveness.[6] Challenges to successful implementation of electronic CDSSs include provider time constraints, economic constraints, lack of knowledge of systems or system complexity, poor system design or too many unwanted alerts, poor computer skills and lack of training, and poor customer support, among other cited reasons in published reports dating from 2000 to 2011.[6]

Goodnough et al. described their institutional implementation of a CDSS for RBC transfusions in 2010, in which a smart BPA was triggered for provider RBC orders when hemoglobin (Hgb) concentration was above the threshold of 7 g/dL for otherwise stable, nonbleeding patients, or 8 g/dL for patients with acute coronary syndrome or postcardiothoracic procedure.[4] Prior to CDSS implementation, a multidisciplinary blood utilization clinical effectiveness (CE) team was formed to develop institutional guidelines for blood transfusions based on published studies. These guidelines were incorporated into the CDSS, which consisted of an interruptive BPA at the time of CPOE and required providers to answer an alert for RBC transfusion orders that did not meet institutional guidelines based on the patient's most recent Hgb concentration and clinical status (e.g., bleeding, hemodynamic instability, acute coronary syndrome, or postcardiothoracic procedure, etc.). The BPA also reminded providers about the use of single-unit transfusions and provided links to relevant literature citations. The authors reported in a follow up study that implementation of the CDSS often had a positive impact, with a reduction of RBC transfusions by 42% when analyzed by units transfused per number of patient-days at risk, and from 18.3 RBC units per 100 days at risk prior to implementation down to 10.9 RBC units per 100 days at risk at 8 years post-implementation.[5] Goodnough et al. further reported improvements in patient outcomes in terms of mortality, length of stay and 30-day readmission rate during the post-implementation interval. The researchers noted that although they could not assume these improvements were causal, they were reassuring in that adverse patient outcomes did not demonstrably increase despite restrictive transfusion practices.[5] However, the researchers did note several challenges to overcome, including the fact that up to 25% of RBC transfusions still occurred in patients with Hgb levels above 8 g/dL despite CDSS and that some clinical services, such as stem cell transplant, transfused patients with Hgb levels above 7 g/dL without any evidence to support this practice. They also expressed concern that a high number of BPA's were overridden by the ordering providers (98% in 2011-2012), possibly owing to alert fatigue.

Jenkins et al. also reported improvements in transfusion practices at their academic medical center related to CPOE-CDS enhancements, including BPA and education. In their prospective pre- and post-implementation study, they found a 67% reduction in multiunit RBC transfusions, a 47% reduction in transfusions for Hgb above 7 g/dL, and an estimated annual cost savings of over $1 million.[7]

SYSTEMS IN PRACTICE

In my health system the NYU Langone Health System, similar to Goodnough et al., the EHR includes a drop-down menu for ordering providers to select the appropriate indication for transfusion. The system is programmed to alert the clinician to the most recent relevant patient laboratory value (i.e., Hgb for RBC orders, platelet count for apheresis platelet orders, prothrombin time [PT]/international normalized ratio [INR] for plasma orders, and fibrinogen level for cryoprecipitate orders) at the time of CPOE. Figure 1 shows an example of a RBC order, alerting the clinician that the Hgb level (9.4 g/dL, highlighted in yellow) is above the range for transfusion in an adult patient; note the drop-down list of RBC transfusion indications (Figure 2) that would populate the "Indication for RBC Transfusion" box in the RBC order EHR screen (Figure 1, box highlighted in green). For blood product orders that do not meet guideline criteria and for which an appropriate non-standard explanation is not provided, a system-generated email (Figure 3) is sent to the ordering clinician as a reminder to adhere to restrictive transfusion practices and to provide comments when non-standard criteria must be applied based on the patient's clinical condition. Furthermore, inclusion of the patient's relevant laboratory value on the EHR blood bank order slip printout allows for prospective screening of blood product orders when the situation calls for such measures, such as during severe blood shortages or for unusual blood product requests.

Although our hospital (NYU Langone Hospital-Long Island) experienced a 25% drop in RBC transfusions from the year prior to the year after enhanced CDSS implementation, the direct effect of CDSS on RBC utilization is unknown. This is because a number of changes occurred surrounding CDSS implementation, including the fact that the hospital merged with a larger health system, new EHR and blood bank information systems were launched as a result of the merger, the Hgb critical (alert) value was dropped from 7 to 6 g/dL, and the RBC transfusion guideline threshold was changed from 8 to 7 g/dL in stable, nonbleeding patients. Furthermore, because the health system had a budding PBM program in place, more emphasis was placed on transfusion oversight and blood utilization. Additionally, the impact of the COVID-19 pandemic, which began within six months of the hospital affiliation/merger with the health system and enhanced CDSS implementation, also must be factored into the equation. Nevertheless, RBC utilization has remained well below the level that it was prior to the hospital merger despite patient care activities returning to pre-pandemic levels, indicating that a combination of PBM oversight, restrictive transfusion guidelines, and the enhanced CPOE/CDSS have been effective in reducing RBC transfusions.

CONCLUSION

Although up-to-date CPGs may provide a framework for evidence-based transfusion practices within a PBM program, they are unlikely to sustain best practices on their own account. Modern day EHRs can provide enhanced CDSSs via interruptive BPAs at the time of CPOE to improve compliance with restrictive transfusion practices, which may favorably impact patient outcomes. Nevertheless, despite evidence of effectiveness, barriers to electronic CDSS implementation still exist.

FIGURE 1: EHR RBC ORDER SCREEN

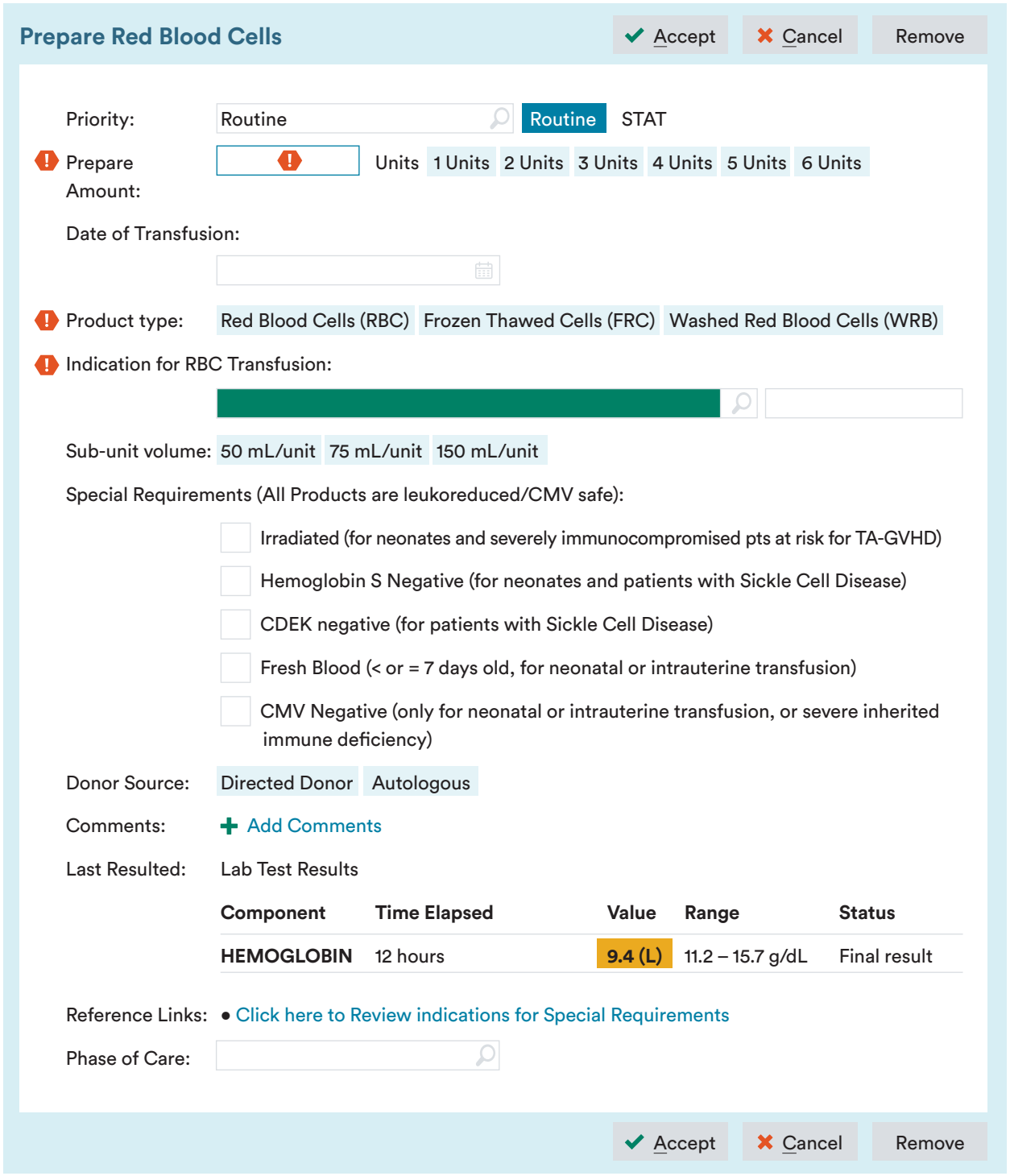

FIGURE 2: EHR RBC INDICATION DROP-DOWN MENU

Title
Hemoglobin <7 gm/dL
Hemoglobin <8 gm/dL with Acute Cardiac Ischemia or Non-GI active bleeding
Hemoglobin <8 gm/dL with Bone Marrow suppression and anticipated discharge within 24 hours
Hgb <10 gm/dL and 4 months of age or less on supplemental oxygen (FiO2<35), clinical signs of apnea, tachypnea, arrhythmia and low...
Hgb <12 gm/dL and 4 months of age or less on supplemental oxygen (FiO2>35)
Hgb <10 gm/dL and 4 months of age or less ECMO or congenital cyanotic heart disease
Major or Emergency Surgery
Non Standard – Comment:

FIGURE 3: SAMPLE SYSTEM-GENERATED EMAIL SENT TO ORDERING PROVIDER

We have been auditing transfusion orders to assure the fidelity of the ordering process.

On DATE/TIME you ordered a Red Blood Cell Transfusion for PATIENT NAME (MEDICAL RECORD NUMBER), specifying the following indication: ''HGB <7.0 g/dL".

In this instance, the medical record indicates that the patient's hemoglobin was 9.4 g/dL prior to transfusion.

We ask that you do your best to find the appropriate clinical criteria from the indications listed and fully embrace the fact that clinical situations arise which require transfusions outside of the indications provided. When this situation arises we ask that you select the "Non-Standard Criteria" as an indication for transfusion, and describe the patient's specific indication in the comment section.

By amassing more accurate answers, we are able to have a better sense of our transfusion practices in aggregate and assess important trends and changes.

1. Wasylewicz ATM, Scheepers-Hoeks AMJW. Clinical Decision Support Systems. 2018 Dec 22. In: Kubben P, Dumontier M, Dekker A, editors. *Fundamentals of Clinical Data Science* [Internet]. Cham (CH): Springer; 2019. Chapter 11. Available from: *https://www.ncbi.nlm.nih.gov/books/NBK543516/ doi: 10.1007/978-3-319-99713-1_11*
2. Kredo T, Bernhardsson S, Machingaidze S, et al. Guide to clinical practice guidelines: the current state of play. *Int J Qual Health Care*. 2016;28(1):122-128. doi:10.1093/intqhc/mzv115
3. Hassan Murad M. Clinical practice guidelines: a primer on development and dissemination. *Mayo Clin Proc*. 2017;92(3):423-433. *https://doi.org/10.1016/j.mayocp.2017.01.001*
4. Goodnough LT, Baker AS, Shah N. How I use clinical decision support to improve red blood cell utilization. *Transfusion*. 2016 Oct;56(10):2406-2411. doi: 10.1111/trf.13767. Epub 2016 Aug 21. PMID: 27546388.
5. Goodnough LT, Hollenhorst MA. Clinical decision support and improved blood use in patient blood management. *Hematology Am Soc Hematol Educ Program* 2019; 2019 (1): 577–582. doi: *https://doi.org/10.1182/hematology.2019000062*
6. Deveraji S, Sharma SK, Fausto DJ, et al. Barriers and facilitators to clinical decision support systems adoption: a systematic review. *J Bus Adm Res*. 2014;3(2):36-53. *http://dx.doi.org/10.5430/jbar.v3n2p36*
7. Jenkins I, Doucet JJ, Clay B, et al. Transfusing wisely: Clinical decision support improves blood transfusion practices. *Jt Comm J Qual Patient Saf*. 2017;43(8):389-395. doi: 10.1016/j.jcjq.2017.04.003. Epub 2017 Jun 27. PMID: 28738984.