Reduced Red Blood Cell Transfusion in Cardiothoracic Surgery after Implementation of a Novel Clinical Decision Support Tool

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BACKGROUND: Packed red blood cell (PRBC) transfusion can increase short- and long-term adverse outcomes and health care costs. We compared the transfusion practices in cardiothoracic surgery before and after implementation of a novel clinical decision support (CDS) tool.

STUDY DESIGN: The transfusion CDS tool was implemented within computerized provider order entry of a multi-institutional urban hospital system in September 2012. Data were queried for 12 months pre-intervention and for another 12 months post-intervention to compare transfusion practices for all adult patients having isolated coronary artery bypass grafting (CABG) or isolated surgical aortic valve replacement (SAVR).

RESULTS: The total number of patients undergoing either isolated CABG or isolated SAVR was 744 pre-intervention and 765 post-intervention ($p = 0.84$). There was no significant difference in age (64 ± 11.4 years vs 64.5 ± 11.2 years, $p = 0.37$) or sex (30.2% vs 32.2% female, $p = 0.42$) between the 2 groups. The number of postoperative transfusions (374 [50.3%] vs 312 [40.8%], $p < 0.001$), postoperative PRBC units given (1.59 ± 2.9 vs 1.25 ± 2.5, $p = 0.01$), pre-transfusion hemoglobin level (8.09 ± 1.5 g/dL vs 7.65 ± 1.4 g/dL, $p < 0.001$), and incidence of surgical site infection (3.1% vs 1.1%; $p = 0.005$) were significantly reduced after implementation of the transfusion CDS tool. There were no significant differences in intraoperative transfusions (206 [27.7%] vs 180 [23.5%], $p = 0.06$), intraoperative PRBC units given (0.73 ± 1.5 vs 0.65 ± 1.4, $p = 0.28$), ICU length of stay (3.29 ± 3.9 days vs 3.37 ± 4.8 days, $p = 0.74$), or in-hospital mortality (1.3% vs 1.4%, $p = 0.87$).

CONCLUSIONS: Implementation of a transfusion CDS tool was associated with lower pre-transfusion hemoglobin levels, fewer transfusions, decreased infection rates, and decreased health care costs, without an increase in short-term mortality. (J Am Coll Surg 2014;219:1028−1036. © 2014 by the American College of Surgeons)

Packed red blood cell (PRBC) transfusion has been associated with increased short- and long-term adverse outcomes and increased health care costs.[1-10] The increasing cost associated with transfusion[5,11] has motivated many health care systems to investigate mechanisms that improve patient safety and clinical outcomes by facilitating adherence to national transfusion guidelines[12-14] and reducing unnecessary blood product consumption. Pharmacologic and blood management strategies help systems move toward conservative blood use.[2,7,15,16]

Effective clinical decision support (CDS) provides the right information to the right person in the right format, channel, and time such that the person can make evidence-based medical decisions for the right patient.[2,12-14,17-19] By gathering recorded data from a CDS tool, institutions may submit regular feedback on

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Abbreviations and Acronyms
CABG = coronary artery bypass grafting
CDS = clinical decision support
LOS = length of stay
PRBC = packed red blood cells
SAVR = surgical aortic valve replacement

provider adherence to guidelines, which has been shown to improve blood use.[2,18-22]

Because transfusions may be required in an urgent setting, transfusion CDS tools should ideally be designed to provide just-in-time data regarding the patient's current hemodynamics in addition to evidence-based guidelines in a single view. Previous studies on the use of CDS in transfusion are limited[2,18,19] and describe either simple warnings regarding transfusion indications or a series of more complex screens for providers to answer before order placement. The CDS tool in this study provides all institutional PRBC transfusion guidelines and the patient's recent hemodynamic data in a single easy-to-use format, which records providers' reasons for transfusion.

The aim of this study was to compare transfusion practice in a cardiothoracic surgery division and among individual cardiothoracic surgeons before and after implementation of a novel single-view CDS tool within computerized provider order entry (CPOE) coupled with a provider feedback loop.

METHODS

Subjects and sample

In order to evaluate the impact of transfusion CDS tool on transfusion behavior and blood use, patients undergoing cardiothoracic surgery were selected because one of the more common reasons why patients get transfused is cardiac surgery. After obtaining IRB approval, the institution's Society for Thoracic Surgeons (STS)[23] Adult Cardiac Database was queried for medical records of all adult patients (18 years old or older) who underwent isolated coronary artery bypass grafting (CABG) or isolated surgical aortic valve replacement (SAVR) 1 year before (September 1, 2011 to August 31, 2012) (pre-intervention) and 1 year after (September 1, 2012 to August 31, 2013) (post-intervention) implementation of a transfusion CDS tool. The study duration, and therefore the sample size, was selected to account both for an adequate number of patients as well as the known seasonal variation in transfusion practice. A power calculation aimed at an 80% probability of detecting a difference using a 2-tailed comparison, $p < 0.05$, suggested that the number of transfusion events in both 12-month cycles would be sufficient if such a difference existed.

Transfusions of uncrossmatched units were excluded from this study because orders for emergency release units bypass the normal ordering mechanism. Patients less than 18 years old and patients undergoing combination CABG and SAVR procedures were also excluded.

Transfusion clinical decision support design

The transfusion CDS tool (Fig.1) was implemented within computerized provider order entry in the electronic health record (EHR; Cerner Corporation Powerchart v.2012 and v.2013) of a multi-institutional urban hospital system, starting in September 2012 as part of an enterprise blood conservation initiative. After reviewing evidence-based literature, a group of providers from pathology, critical care, surgery, anesthesiology, and hematology-oncology generated the transfusion CDS tool based on institutional transfusion guidelines derived from published transfusion guidelines. The CDS tool made use of available but uncommonly used functionality within the electronic health record that enables a required form to be filled out once an order is placed. This form fires for all patients within our health care system for whom an electronic order for a crossmatched transfusion has occurred, whether inpatient, outpatient, or emergency department patients.

When a provider signs an order for PRBC, the CDS form displays (Fig. 1). The provider must complete the form or cancel the order. The CDS form provides the most recent hemoglobin level as well as other pertinent vital signs (blood pressure, heart rate, central venous oxygen saturation [$ScvO_2$], etc). The provider must indicate a major category for the requested blood transfusion reason (acute hemorrhage, anemia, anticipated blood loss, and other). Some major categories (acute hemorrhage and anemia) require selection of a subcategory using if-then logic (Fig. 1). An "other" category is present to allow for transfusion in unusual circumstances, but this category requires the provider to enter a reason before signing the form. The system records the provider's data entry, name, and position for later review. All data are recorded in the institutional Clinical Data Warehouse for later query.

Data collected

All data entered into the CDS tool were collected on the study patients during the time frames indicated. In addition, the ordering provider's name and position, the timestamp of the transfusion order, and the value and timestamp of the most recent hemoglobin value before the transfusion order were queried for analysis.