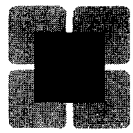

Computer-assisted audits of blood component transfusion

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■ Comprehensive review of clinical blood transfusion practice at a tertiary-care medical center is complicated by the extraordinary number of patients that receive such therapy. Computer-assisted review of the key objective data used in making the decisions about transfusion is necessary to evaluate the process. Use of 15,873 units of red blood cells, 3,641 units of plasma, 2,619 pools of platelets or pheresis units, and 259 pools of cryoprecipitate was screened by comparing pre-transfusion and post-transfusion blood counts with the medical staff's evaluation criteria. On this basis, 81.4% of transfusion episodes (TEs) were considered fully justified. Medical records were selected for audit from the cases in which the transfusion decisions could not be justified by on-line information. Abstracted data subsequently justified 82 of 139 audited cases; 68.4% of the comments pertaining to the remaining 57 cases adequately explained the transfusion decision. Thus, nearly 96% of the TEs were justifiable as determined by peer review.

□ INDEX TERMS: ALGORITHMS; BLOOD TRANSFUSION; MEDICAL AUDIT; PROFESSIONAL STAFF COMMITTEES; QUALITY ASSURANCE, HEALTH CARE; UTILIZATION REVIEW □ CLEVE CLIN J MED 1989; 56:267–272

BLOOD TRANSFUSIONS save lives. Many surgical procedures and cancer therapies would be impossible without the immediate availability of effective blood components. There is a small but measurable risk to blood transfusion, however. Good medical practice requires that the benefits of hemotherapy outweigh its risks.

The quality-assurance program at the Cleveland Clinic includes regular monitoring and evaluation of blood usage. This program is implemented by the Transfusion Committee. One element of this activity is regular measurement of the appropriateness of blood component therapy, according to a systematic plan.

■ *See the editorial by Keating (pp 282–284)*

Comprehensive review of blood transfusion practice is logistically difficult in any clinical setting, but it is especially complicated in a tertiary-care medical center. Approximately 75,000 components are transfused to more than 7,000 patients yearly at the Cleveland Clinic. Unpublished pilot studies had previously indicated that the propriety of the great majority of blood transfusions at the Cleveland Clinic would be affirmed by peer re-

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view. In early 1987, the Committee recognized that a strategic approach was needed to focus its review upon the unusual segments of the staff's hemotherapy practice that might not be justified on careful analysis. Detailed evaluation criteria were defined. These criteria included references to the patient's hemoglobin concentration, platelet count, or coagulation test results. The on-line availability of hematologic parameters and blood transfusion data was the basis for a computer-assisted review strategy. The review process described in this report is *comprehensive* because the transfusion of all blood components to all patients can be included. At the same time, it is *selective* in that the review focuses on the transfusion decisions that are least likely to coincide with the group's majority opinion. This paper summarizes the method, the initial results of the process, and its applicability to other transfusion services.

MATERIALS AND METHODS

Evaluation criteria

The detailed list of criteria established by consensus of the Transfusion Committee for evaluation of the usage of blood components is shown (*Table 1*). (An abbreviated form appears on the reverse side of the physicians' Blood Component Order Form, which is in regular use in both the hospital and the clinic.)

Case selection

Between August 10, 1987 and February 22, 1988, 8,917 transfusion episodes (TEs) were studied. (One TE is defined as one calendar day's transfusion therapy for one patient.) All blood components transfused on study days were evaluated by screening criteria, including both inpatient and outpatient transfusions. Twenty-four days were omitted from the study interval. The use of 15,873 of 18,511 units of red blood cells (85.7%), 3,641 of 5,262 units of thawed plasma (69.2%), 2,619 of 3,224 pools of platelets or pheresis units (81.2%), and 259 of 520 pools of cryoprecipitate (49.8%) was evaluated.

On an average day, 53 patients (range, 14 to 90) undergo transfusion at the Cleveland Clinic. The number of blood components transfused to each patient during a 24-hour interval is summarized on a worksheet. The worksheets are started on a Vax 8200 that runs the blood bank and transfusion service's information management system (Sunquest Information Systems, Inc., Tucson, Arizona). The most recent pre-transfusion blood hemoglobin concentration and the first post-transfusion hemoglobin measurement are entered manually onto the worksheet for each patient who received red blood cells during the TE. Pre-transfusion and post-transfusion blood platelet counts are recorded for patients who receive platelets. The prothrombin times and the activated partial thromboplastin times bracketing the transfusion are recorded for patients who receive plasma or cryoprecipitate.

Medical review: level one

A physician compared the displayed data for each TE with the evaluation criteria. Each TE was coded either as "Justified—Level One" (JL1) or as "Insufficient Information for Decision" (IID). All screening evaluations were performed by a physician-member of the Transfusion Committee.

Medical review: level two

One or two cases were selected each day for Level Two review from the IID group. Cases that were the most aberrant were preferred. For example, if there were two TEs, both of which included red blood cell therapy, the case with the higher pre-transfusion and post-transfusion hemoglobin levels was more likely to be selected. A physician reviewed the chart and prepared an abstract. The data abstracted included significant medical history, relevant clinical conditions, estimated blood loss during surgery, concurrent fluid replacement, and any comments written in the chart that pertained to the rationale for the transfusion. Review was not limited to the TE; all transfusion therapy for the patient was described. If the majority of the members of the Transfusion Committee agreed with the transfusion decision as summarized in the abstract, the case was recoded as "Justified—Level Two" (JL2). The abstract of each remaining case was referred to the attending physician with a request for additional information.

Medical review: level three

Each physician's response was reviewed by the Committee. On the basis of majority opinion, a case was finally coded either as "Justified—Level Three" (JL3) or "Not Justified" (NJ).

RESULTS

A total of 7,254 of the sampled TEs (81.4%) were considered fully justified on the basis of screening criteria alone (JL1). One hundred thirty-nine cases were selected for chart review from the remaining 1,663 (8.4%); 50 of these were single-unit transfusions, 59 were two-unit transfusions, and 30 were cases in which ≥3 units were transfused during the TE. The 139 cases

TABLE 1
THE CLEVELAND CLINIC FOUNDATION TRANSFUSION COMMITTEE CRITERIA FOR JUSTIFICATION FOR BLOOD TRANSFUSION*

Red blood cells
- Preoperative transfusion
  - Hgb <9g/dL if anticipated blood loss >500 mL
  - Hgb <10g/dL if anticipated blood loss >500 mL and there is evidence of COPD, CAD, CID, hemoglobinopathy, or sepsis
  - Symptomatic anemia
  - Acute hemorrhage
  - (However, the post-transfuion† Hgb should not exceed 10 g/dL‡)
- Intraoperative transfusion
  - Any preoperative criterion
  - Blood loss >750 mL (preoperative and intraoperative total)
  - (However, the post-transfusion Hgb should not exceed 11 g/dL§)
- Postoperative transfusion
  - Symptomatic anemia or acute hemorrhage
  - Hgb <8 g/dL
  - Hgb <10 g/dL if there is evidence of COPD, CAD, CID, hemoglobinopathy, or sepsis
  - (However, the post-transfusion Hgb should not exceed 9 g/dL")
- Nonoperative transfusion
  - Acute hemorrhage defined as
    - Measured or estimated blood loss >750 mL or
    - Bleeding with hypotension and/or tachycardia
    - (However, the post-transfusion Hgb should not exceed 11 g/dL§)
  - Chronic anemia
    - Diagnostic evaulation complete or
    - Undiagnosed but symptomatic
    - (However, the post-transfusion Hgb should not exceed 10 g/dL§)
    - Regular transfusion program that follows a written plan
  - Autologous transfusion
    - Any intraoperative or postoperative transfusion in which
      - Estimated blood loss > 200mL or
      - Any measured anemia (Hgb<11)

Leukocyte-poor red blood cells
- All indications for red blood cells and
  - Two or more febrile reactions to red blood cells
  - Dialysis therapy
  - Cardiac, bone marrow, or renal transplantation

Whole blood
- All indications for red blood cells and one or more of the following:
  - ≥20% fall in blood pressure
  - Systolic blood pressure <100 torr
  - Pulse ≥100/min
  - ≥20% blood loss

Fresh frozen or single-donor frozen plasma
- Procoagulant deficiency
  - Congenital
  - Liver disease
  - Warfarin therapy with evidence of bleeding or during surgery
  - Massive transfusion
    - Frozen plasma is <25% of volume replaced
- Antithrombin III deficiency
- Thrombotic thrombocytopenic purpura
- Disseminated intravascular coagulation

Platelets
- Most recent platelet count $\geq 50 \times 10^9$/L (for prophylaxis)¶
- Count $\leq 100 \times 10^9$/L and documented bleeding or surgery‡
- Documented platelet dysfunction and petechiae, purpura, bleeding, or surgery

Platelets, pheresis or platelets, leukocytes removed
- All indications for platelets and
  - Previous febrile reaction to platelets
  - Absence of a satisfactory increment following platelets on two or more occasions
- Bone-marrow transplantation
- Donor-specific transfusion
- Blood bank substitution for platelets for inventory management purposes

Cryoprecipitate
- Documented procoagulant deficiency of one of the following types:
  - Factor VIII deficiency (hemophilia A or von Willebrand's disease)
  - Fibrinogen deficiency
  - Massive transfusion (1 blood volume/24 h)
  - Disseminated intravascular coagulation

Irradiation of any blood component
- Bone marrow transplantation or potential bone marrow recipient
- Pediatric liver transplantation or potential liver recipient
- Cardiac transplantation
- Cyclosporine administration
- Congenital immunodeficiency, such as severe combined immunodeficiency disease
- Immunosuppressive anti-neoplastic therapy

CMV-negative blood products#
- Bone marrow transplantation patients and candidates with anti-CMV titers ≤1:16
- All cardiac transplantation patients and candidates with anti-CMV titers ≤1:16
- All pediatric liver transplantation patients and candidates with anti-CMV titers ≤1:16

*Revised 7/88
COPD = chronic obstructive pulmonary disease, CAD = coronary artery disease, CID = cerebral ischemic disease, and CMV = cytomegalovirus
†Generally speaking, the measurement of interest in the "post-transfusion" period is that of the first blood count that follows the transfusion. However, the "post-transfusion" blood count may be chosen any time within the subsequent 48 hours
‡11 g/dL in case of COPD, CAD, CID, hemoglobinopathy, or sepsis
§12.3 g/dL in the case of COPD, CAD, CID, hemoglobinopathy, or sepsis
"10 g/dL in the case of COPD, CAD, CID, hemoglobinopathy, or sepsis
¶Except where the bone marrow is hyperplastic as in idiopathic thrombocytopenic purpura or thrombotic thrombocytopenic purpura
#Products from donors with no detectable antibody to CMV as determined in a latex-agglutination test

included Level Two review of 239 units of red blood cells, 41 pools of platelets or pheresis units, 30 units of plasma, and two pools of cryoprecipitate. Eighty-two cases (59.0%) were judged by the Committee to have been justified (JL2). Staff physicians provided 38 written comments concerning the remaining 57 TEs in response to the Committee's requests for additional information. The Committee agreed that hemotherapy had been ap-

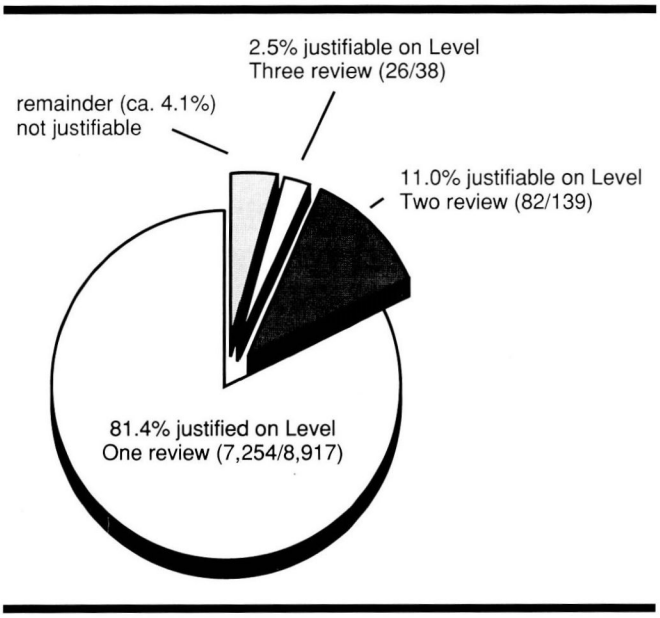

FIGURE 1. Results of review of transfusion decisions made for 8,917 transfusion episodes.

propriate in 26 cases (68.4% of the responses) because of the exceptional circumstances that were described.

DISCUSSION

From these data, we estimated that approximately 96% of the TEs during the study period were justifiable by peer review (*Figure 1*). This mathematical conclusion was based upon the following logic:

1. Assuming that there was no bias in the case selection (and there is no reason to believe that there was because all cases were reviewed on study days and study days were chosen at random), 81.4% were demonstrably justifiable using the computer-assisted comparison of the blood counts with the screening criteria.

2. The 8.4% sample from the remainder that were chosen for Level Two review were among those *least likely* to be justified. The peer-review process accepted 59% of this subset as appropriate on the basis of abstracted data. Thus, at this review level, at least 92.4% of the transfusion decisions were justifiable: (81.4% + [59.0%] [100% – 81.4%] = 92.4%).

3. Physicians' comments were solicited for the cases that remained coded as IID following Level Two review. Replies were received concerning 66.7% of the TEs, of which 68.4% were considered justified, raising the percent of justifiable transfusion decisions to nearly 96% (92.4% + [66.7%] [68.4%] [100% – 92.4%] = 95.9%).

The actual number of transfusion decisions during the study period that would have withstood peer review was very likely >95.9%. The sampling at Level Two was based on a "worst case" strategy. Furthermore, the calculated estimate assumed that the TEs for which there were no physician responses at Level Three were all unjustifiable.

Evidence has been presented to show that unnecessary transfusions are given.[1–5] Most evidence, however, is derived from older data or from selective audits. A comprehensive blood usage review program in which all blood transfusion decisions are studied may show the actual number of improper decisions to be quite small.[6–8] Such felicitous observations reflect both an understanding of indications for blood transfusion as well as an awareness of its infectious hazards. Whether frequent or uncommon, inappropriate transfusion decisions should be identified so that corrective actions can be taken. Such actions commonly include targeted educational activities.

Blood usage review is one of the six medical staff-monitoring functions required for accreditation by the Joint Commission on Accreditation of Health Care Organizations (JCAHO).[9] As shown by JCAHO surveys, blood-use review programs have been inadequate.[10] The JCAHO requires that blood-use review include:

1. Evaluation of the appropriateness of all cases in which patients received transfusions of blood and blood components;
2. Evaluation of all confirmed adverse reactions to blood transfusion;
3. Approbation of the policies and procedures that relate to distribution, handling, and administration of blood components;
4. Review of the adequacy of the transfusion service to meet the needs of patient care; and
5. Review of physician-ordering practices of all blood and blood components.

This study has focused upon the first of these elements. Sampling strategies are appropriate if they include all components; if all departments and services are included; if inpatients, outpatients, ambulatory-surgery patients, and emergency patients are included; if clinically valid, predetermined criteria are employed; if data collection is ongoing and systematic; if screening is properly documented and analyzed; and if the conclusions of the peer review are consistent, discriminating, and valid.[11]

Evaluation of blood use must begin with an accurate and complete set of written criteria. Our criteria, based

in part upon those of other authors,[12,13] were developed by Committee consensus. The detail is intended to be applicable to many different patient-care situations. These evaluation criteria will continue to be modified by Transfusion Committee consensus as our understanding increases.

It is important that the review include all blood components. Fresh frozen plasma has been identified as one component that is frequently overused.[14,15] Plasma is commonly prescribed for blood pressure support even though there are safer volume expanders.[16,17] At the Cleveland Clinic, the use of plasma often appears disproportionately high in the Level One screens compared to the number of units of homologous red blood cells because intraoperative blood salvage is commonly employed. These saline-suspended erythrocytes were not counted in the initial tally. Intraoperative autotransfusion volumes, as well as crystalloid and colloid fluid replacement, were regularly abstracted during chart review.

The use of platelets has also been criticized as excessive.[18–20] Platelets are far more commonly needed for treatment of thrombocytopenia than for treatment of platelet dysfunction. Our evaluation criteria focus primarily upon platelet particle counts for this reason.

The disadvantage of the blood-use review method is that the decision-making is based on limited information. As useful as objective measurements of hematologic parameters are,[21] blood counts do not tell the whole story. Acute blood loss, the extent of which is unlikely to be reflected well in the hemoglobin concentration, is not tolerated by a patient as well as chronic anemia. A hemoglobin concentration of 7 g/dL may be acceptable in some cases; a hemoglobin concentration of 12 g/dL may be unacceptable in others.[22] Evaluation of the intraoperative use of platelets is especially ineffective when the criteria are based upon platelet counts alone. The administration of antiplatelet drugs and conditions of cardiopulmonary bypass can increase bleeding and induce platelet aggregation defects that will not be apparent.[23,24] Evaluation of platelet transfusions according to detailed but realistic criteria can have a favorable effect upon overall use of platelets by a transfusion service.[25]

Corresponding physicians are asked to critique the evaluation criteria when they are asked to explain the circumstances surrounding the transfusions in question. Creation of specific criteria for defined clinical circumstances is encouraged. The criteria listed in *Table 1* make a realistic distinction between operative and nonoperative hemotherapy; this reflects the fact that patients are more likely to undergo transfusion during surgery. The criteria could be made even more elaborate. It is known, for example, that older females with ischemic heart disease are more likely to undergo transfusion than their male contemporaries.[26] Consequently, criteria could be defined for male and female patients. Also, operative transfusions could be separated by surgical type if the relative differences in hemotherapy demands were measurable and known. Hough et al[27] demonstrated that the blood transfusion requirement for cholecystectomy for treatment of acute cholecystitis is significantly greater than the blood requirement for similar treatment of chronic cholecystitis.

We believe there are several direct and indirect advantages to the blood usage review program described:

1. The process is self-documenting. Documentation of the quality-assurance program is required for hospital accreditation, and accurate records facilitate improvement in the quality of care.
2. These data can be used to improve the management of blood inventories. Identification of trends in blood use can help prevent local shortages of components. Such data can even be used to establish a maximum surgical blood-ordering schedule.[28]
3. Minimizing blood transfusions saves money. Although we are more concerned with the safety of the patient and the efficacy of the component than the dollars saved, such savings are measurable, and they may contribute to better patient care.[29]
4. Educational opportunities are identified. This extends beyond the physicians whose services may be targeted by the process. The Level Two abstracts are usually prepared by resident physicians on the blood banking service. Discussion of these cases is included in teaching rounds. Other resident teaching conferences that center on the proper indications for blood transfusion have occurred in part because of an awareness stimulated by this program. Publication of the evaluation criteria on the reverse side of each Blood Component Order Form contributes to the ordering physician's educational experience.

CONCLUSION

Ultimately, the decision to transfuse blood represents a balance between risk and benefit, supply and demand.[30] Transfusion therapy should be prescribed only when necessary. A proper indicator of the quality of care in a hospital is therefore the extent of adherence to this maxim. We have demonstrated that more than 95% of the transfusion decisions made at the Cleveland Clinic

follow this maxim. It remains to be shown whether the educational activities that result will be able to raise this rate still higher. Educational programs based on such data have significantly improved the quality of care provided to patients who have undergone transfusion.[6,13,31] A hospital's transfusion committee can be an important influence on the focus of these programs.

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