The Cost of Blood: Multidisciplinary Consensus Conference for a Standard Methodology

Participants of the *Cost of Blood Consensus Conference*, Charleston, SC, May 4-5, 2003*

Prior attempts to account for the cost of blood have varied in economic perspective, methodology, and scope and may have underestimated both direct and indirect costs associated with transfusions. To devise a comprehensive and standardized methodology for the United States that will improve upon existing estimates, a panel of experts in blood banking and transfusion medicine was assembled and participated in consensus deliberations using modified Delphi methods. As a first step, a process-flow model that describes all the major steps involved in collecting, processing, and transfusing blood such as donor recruitment and follow-up of transfusion sequelae was constructed. Next, interdependencies were outlined and detailed cost elements within each step were itemized. The relative importance of each element was rated. Personnel, screening for infectious agents, information systems, laboratory evaluations, management of transfusion reactions, and equipment were ranked as the most important factors to capture but, in an effort to be all-inclusive, even minor elements were included. This consensus model is broad-based and should serve societal, provider, and payer perspectives for future cost studies. Recognizing the limitations of process-flow models, the next iteration will use an activity-based approach to more fully account for the cost of blood than present estimates.

BLOOD AND ITS components are vital health care commodities that are becoming increasingly costly and scarce, yet standard methods are lacking to quantitate progressive changes in the economics of blood use. Shrinking donor pools and increasingly stringent donor qualifications are factors that can lead to supply constraints and rising costs.[1-3] Stimulated by society's low tolerance for the risk of disease transmission,[4,5] technologies are being developed to improve blood safety, but such safeguards are expensive to implement and may ultimately restrict supplies even further.[6-11] Nursing and technical personnel shortages, donor recruitment and retention efforts, liability insurance, hospital overhead, and costs of supplies to collect, process, and safely administer blood and blood components are additional factors that contribute to ever-escalating blood costs.

Keeping pace with the complexities of the blood industry and appropriately coding and billing for transfusions and related services present a formidable challenge.[12] Nearly half of transfusion recipients in the United States are Medicare beneficiaries, and Medicare's prospective payment system is said to substantially underreimburse hospitals for the costs associated with transfusions.[12] Although the current systems of diagnosis-related groups and producer price indexes[13] will require time and effort to effect, a tool to calculate blood costs would eventually benefit institutions seeking adequate reimbursement.

Cost comparisons of blood and transfusion alternatives or improvements in blood safety have used variable methods to account for costs associated with blood component preparation and administration.[9,14,15] Cost-effectiveness studies express results as a ratio of cost to clinical benefits,[17] and a numerator in this ratio that addresses all relevant inputs is needed. A consistent framework that reflects the current state of health care economics and accounts for costs across institutions, payer types, delivery systems, and countries is also needed. Recognizing these needs, the Society for the Advancement of Blood Management (SABM) proposed and assembled a consensus conference to help define this numerator and framework. A multidisciplinary panel of

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* *Listed in Appendix A.*

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experts representing blood collection facilities, government agencies, academia, hospitals, and practitioners in transfusion medicine was invited to participate. Using the model proposed by the Lewin Group as a starting point,[13] the panel was charged with defining a set of key elements associated with whole blood collection, transfusion processes, and follow-up. The proceedings of the first *Cost of Blood Consensus Conference* represent an important step toward creating an all-inclusive reference methodology that can be used to calculate the cost of single-donor blood components.

CONSENSUS CONFERENCE MISSION AND SCOPE

Given the enormity of the challenge to arrive at the ultimate bottom line (ie, blood costs in dollars), the panel took a stepwise approach. The goals of the first meeting were to identify the various elements that contribute to the cost of collecting and transfusing red cells (primarily) and other single-donor blood components and to work toward establishing a standard methodology for estimating costs. Conference discussions encompassed a comprehensive vein-to-vein (eg, donor-to-recipient) approach, including activities that take place before the act of blood donation, extending through short- and long-term posttransfusion follow-up. The group considered all "cost elements," defined as activities, materials, and service inputs relevant to donors, transfused patients, and providers of transfusion services. The economic perspective is a societal one, representing the entire cost of the transfusion event.[17,18] Morbidities associated with transfusions were included but were not a primary focus. Plasma derivatives (eg, albumin, gamma globulin, and antihemophilic factor), generally produced by for-profit corporations by fractionation, were excluded. Although discussion regarding cost-effectiveness comparisons was beyond the scope of the 2-day conference, participants understood that they were building the foundation necessary for such comparisons.

SELECTION OF PARTICIPANTS

Two independent and objective searches of contemporary literature databases as well as internet searches of blood foundations and academic, governmental, and private organizations were performed. Invitations were extended to one fifth of the 105 individuals initially identified, with the intent of including a representative sample of persons knowledgeable about (1) the economics and microeconomics of the "transfusion encounter," relating specifically to the procedural steps of acquiring, storing, preparing, and infusing blood and the steps involved in preparing for the next transfusion; (2) "stakeholders" in the transfusion process, including administrators of blood collection services, hospitals, and health maintenance organizations that acquire blood, blood bankers who function as administrators of cost centers, third-party payers, or staff of government agencies that set reimbursement standards; and (3) scholars, academicians, or clinicians who have published works about the economics of the transfusion encounter, including leaders of professional and academic societies and clinical leaders in blood banking, hospitals, health maintenance organizations, and related organizations. The conference was facilitated by 2 health services researchers (Zynx Health, Inc).

PRECONFERENCE ACTIVITIES AND CONSENSUS DEVELOPMENT

Before the actual conference, the participants received background reference materials[12,15,19-28] and a series of 10 preliminary worksheets. Worksheets had been prepared based on a modified conceptual model[13] of steps involved in the whole blood collection and blood transfusion process and contained lists of proposed elements associated with each major step in the model. Participants reviewed the worksheets for completeness and ranked each of the elements in order of its perceived importance to the process. Comments and rankings from the preconference activities (87% participation) were compiled anonymously and redistributed when the conference was convened.

A modified Delphi method was used to develop consensus, with an iterative process to refine the data collected on the worksheets.[29] All participants were allowed equal input. The compiled worksheets pertaining to steps of the model were divided among 4 working groups, and panelists developed and agreed upon the cost elements that each step contained. After a general group discussion that was facilitated by the health services

researchers, all worksheets were revised and redistributed.

PROCESS FLOW MODEL

The 9-step process flow model (Fig 1) captures both direct (variable supply elements and fixed elements of personnel and facilities) and indirect (related services and facilities) cost elements. These steps fall into 2 major categories: one reflecting the cost elements associated with a blood collection facility (left panel) and the other reflecting the transfusion service (right panel). On the blood collection side are cost elements associated with donor recruitment and qualification, whole blood collection, blood processing, testing, tracking, blood destruction and associated notifications, and inventory management, storage, and transport. On the transfusion side, cost elements relate to inventory management within the hospital or clinic, pretransfusion activities, transfusion administration and short-term follow-up, and long-term outcomes tracking. When determining transfusion costs from a provider's perspective, costs incurred by donors, patients, or by their employers are generally excluded, but the cost elements listed on the bottom part of Figure 1 are to be included in any model that takes a societal perspective. To thoroughly account for each activity outlined in Figure 1, the group defined the beginning and end of each step and substep in the process flow (summarized in Table 1).

In addition to the sequential progression from steps 1 to 9, interdependencies between steps also exist, as indicated by the dashed arrows in Figure 1. For example, blood components that do not pass screening tests are destroyed but also involve other direct cost elements (confirmatory testing before donor counseling) as well as additional direct and indirect donor cost elements to replace the lost unit (ie, for tracking and subsequent donor recruitment and/or qualification). Another example of an interdependency occurs if a transfusion recipient of blood from a seronegative donor subsequently seroconverts. This individual must be tracked and followed, and information derived from long-term outcomes tracking must be fed back into the donor recruitment and qualification database.

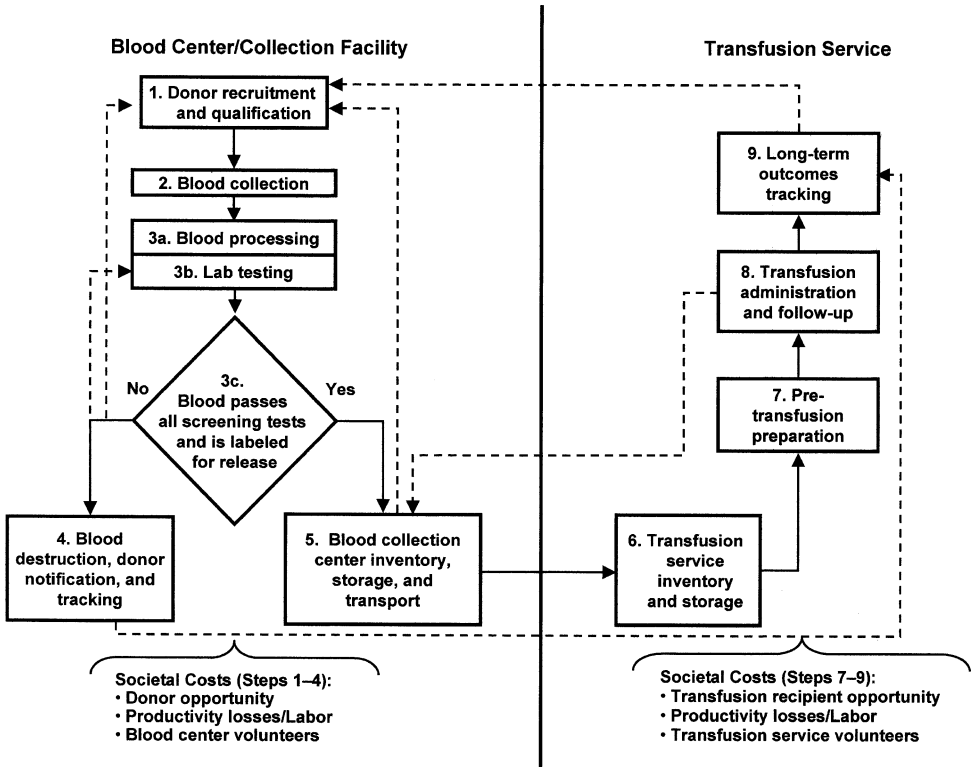

Fig 1. Blood collection and transfusion flow chart.

Table 1. Process-Flow Model Steps

Step	Begins	Ends
1. Donor recruitment and qualification	Need for blood	Donor ready to sit in donor chair
2. Blood collection	Donor seated in donor chair	No sooner than 24 hours postdonation
3a. Blood component processing	Receive donated component at initial processing center	Quarantine storage of all components
3b. Laboratory testing	Laboratory receives tubes for testing	Complete laboratory results transmitted to processing center
3c. Decision step to release unit	Blood component passes all tests *or* fails any screening test, including donor history	Label and release blood to collection center inventory *or* prepare for destruction
4. Blood destruction, donor notification, and tracking *OR*	Blood component unacceptable and earmarked for destruction	Blood destroyed, donor counseled and routed to follow-up ± patient lookback/notification
5. Blood collection center labeling, inventory, storage, and transport	Blood component is deemed suitable and released for transfusion	Delivery to transfusion service
6. Transfusion service storage and inventory	Component arrives at transfusion service	Component order is received for transfusion evaluation (ABO type and screen)
7. Pretransfusion preparation	Decision is made that transfusion may be necessary	Transfusion unit ready at point of care
8. Transfusion administration and follow-up	Transfusion ready to administer	Completion of episode of clinical care and monitoring for short-term transfusion reaction
9. Long-term outcomes tracking	Workup for transfusion outcome or tracking for lookback and notification	Completion of outcomes/lookback tracking and notification

Abbreviations: ABO, standard blood groupings.

Cost elements required for maintaining the infrastructure of a blood collection center or transfusion service were named "generic cost elements" (Table 2). These elements apply to each step of the process flow, with the weight of each generic cost element adjusted for each step or collection of steps.

ACTIVITIES ASSOCIATED WITH IDENTIFIABLE COSTS

To arrive at a comprehensive conceptual model, the panel agreed that nothing is to be ignored, recognizing that care must be taken to ensure that cost elements are not "double counted." The final working equation must therefore separate labor, activity, and material costs to avoid duplicate charges. A general narrative description of what each step entails is provided below, and corresponding lists of cost elements that were agreed upon during the consensus conference are provided in Appendix B.

Table 2. Generic Cost Elements

General Administrative
Information systems
Purchasing/contracting
Inspections/licenses
Capital expenditures
Quality assurance/compliance
Training
Insurance/legal
Physician oversight
Facilities
Human resources
General amenities (housekeeping, etc)
Other
Research and development

Donor Recruitment and Qualification

This step begins with generating public awareness of the need for more first-time donors and continued repeat blood donations. Activities include encouraging business and community leaders to sponsor blood drives among their constituents, education regarding general requirements of donor suitability and the need for blood, and calling to remind, encourage, and schedule blood donations. Groups and individuals require education regarding specific blood donor suitability criteria, greeting presenting donors, and providing informational materials. Checking donor identification and verifying their absence from the donor deferral list must be performed. Assessing donor acceptability also includes taking vital signs, screening for adequacy of hemoglobin level, asking relevant

personal history questions, and obtaining consent. If not eligible, deferred donors are given an explanation. This group of activities ends as each donor is either found to be suitable and prepared for venipuncture or found unsuitable and deferred (Table B1).

Whole Blood Collection

Documentation of the donor suitability assessment and donor identity are first reaffirmed before preparing the venipuncture site. The blood is routinely mixed with an anticoagulant during collection, and the donor is observed for a good flow rate of blood as well as for any adverse reaction. After the requisite amount of blood is collected and the venipuncture site is dressed, the donor is escorted to the recovery area for fluid replacement and a snack. The donor may be asked to indicate confidentially whether his or her donated unit should be used or discarded, is instructed in postdonation care, and given a number to call back if he or she does not feel well over the next 24 hours or later. Immediate care and support are provided for any adverse reaction. If, after a period of observation, the donor appears to be in good health, he or she is released and encouraged to make an appointment for a next donation. With regard to the blood collected, the numbering on all labels, bags, and tubes is reviewed and compared with the questionnaire for consistency. The whole blood is then transported to the processing area (Table B2).

Blood Component Processing, Laboratory Testing, and Decision Step to Release or Discard Unit

Three separate categories of activities are accounted for in this step, the first beginning with receipt of the collected whole blood to be processed into components (3a). Initial labeling to track the temporarily quarantined unit as well as freezing and glycerolizing red cell units, prestorage leukoreduction, irradiation, and processing for other specialty components are captured here. Activities are performed to ensure proper identification of blood, usually by bar coding or by attachment of radiofrequency detection devices. Additional processing steps may include extended compatibility testing (eg, antigen typing, and human lymphocyte antigen matching) and there are also administrative and contracted activities associated with the reference laboratory. Medical waste is generated for every collected unit that must be discarded and disposal of unsuitable units and outdated components must be tracked. Although not addressed in detail, the group recognized that the various components derived from whole blood units are processed differently and would require separate itemization of cost elements.

Activities grouped in the laboratory testing step (3b) begin and step 3a ends after the sample is transported from the collection facility to the testing facility. Testing costs vary widely; thus, standard blood grouping/Rhesus factor, serology, viral nucleic acid testing, bacterial, and cost elements pertaining to miscellaneous testing are listed separately. For all initially reactive test results, retesting of the sample to verify results (singly or in duplicate) occurs. To account for emerging pathogens for which screening tests are not available, costs associated with implementation of new tests are included here. Once the laboratory test results are received and analyzed, then the decision point (3c) to allow or reject entry of the blood component into the supply chain is reached. This step accounts for activities associated with making and implementing the decision to discard quarantined blood or to label it for release into usable inventory. Review of test results and generating, attaching, and cross-checking the component label are included in the associated tasks (Table B3).

Blood Destruction, Donor Notification, and Tracking

If a blood component fails testing for any reason, both the decision to discard and the destruction process must be documented, accompanied by notification of donors and inclusion in a deferral registry in the event a transmissible disease is detected. Before donor notification, confirmatory testing of the unit is performed. Donors receive counseling about public and private health implications and may be requested to return for additional testing. Actual destruction of rejected units and tracking costs are included. Lookback identification of previously transfused donors is also initiated if indicated. Postdonation illnesses reported by donors after a unit has been tested and has passed and the components released from quarantine may also initiate recalls and transfusion

recipient notification, part of which may be accounted for in step 9 (Table B4).

Blood Center/Collection Facility Inventory, Storage, and Transport

These activities and costs involve taking orders from hospitals, other transfusion services, and blood centers and orchestrating blood center activities to optimize meeting these requests. In times of adequate blood inventory, units are selected for packing and shipping and are then delivered via land or air transport. This step also involves inventory management with triaging, decision making, and medical consultation in times of type-specific shortages of various components. In addition, these functions include receipt of returned units for planned stock rotation as well as for quality control issues, quarantining, potential requalifying, destruction, or determining suitability for reissue. Outdated and unsuitable units must have their disposal properly documented. Control of quarantined units and their ultimate disposition is a key regulated activity of blood centers.

Inventory storage requires validated and specific alarmed controls for room temperature (platelets), refrigerated (red cells), less than −20°C (frozen plasma), and less than −65°C (frozen red cell) storage. Frozen red cells may require acute thawing and deglycerolizing before distribution. Also included in this category is the validation of shipping containers for maintaining temperatures over time, bar code wanding before shipping, and visual inspection of each unit before packing and shipping. Finally, dealing with hospital relations, including formal annual contracting, falls under this group (Table B5).

Transfusion Service Inventory and Storage

Although certain activities and items associated with inventory control and storage within the transfusion service are similar to those described in step 5, inventories at this stage are generally smaller and more tightly managed. Maximum surgical blood order schedules require the preparation and issuance of large volumes of blood units that anticipate the range of blood requirements for 90% of patients in a given surgical category to the operating room. However, because transfusions are ultimately issued according to individual patient needs, this practice results in large shifts of blood inventory in and out of the transfusion service. Demands for specialized blood components are highly individualized to recipients, and variability in order types requires flexibility and on-demand response rates. Specialized components must often be processed with rapid turnaround, which comes at a higher cost and probability of error. Validated equipment for storage may be required in remote areas (eg, operating room, emergency department, and clinics) with stringent space limitations. There may be considerable component wastage due to expiration with remote storage (Table B6).

Pretransfusion Preparation

Beginning with the transfusion decision, physician, clerical, transport, laboratory, phlebotomist, and nursing time is required to process orders, prepare and transport samples, obtain patient consent, and perform standard or special testing. Multiple work shifts and on-call provisions for staffing in different locations must be considered. Supplies for order processing, as well as specialized bedside transfusion-related equipment, are needed. When applicable, resources must be allocated for thawing and pooling components (Table B7).

Transfusion Administration and Follow-up

Once the transfusion is ready to be administered to a recipient, there are costs of transfusion-related supplies (variable), including bedside leukoreduction filters, and equipment costs (fixed) to consider. Routine follow-up of hemoglobin or platelet levels and other laboratory tests should be included. Programs for error management involve staff time, training, and computer equipment and software. Costs of posttransfusion adverse reactions must be incorporated using probabilities of occurrence; these will vary by the type of reaction, intervention required, and rate of resolution. Adverse reaction reporting requires clerical as well as professional attention and has implications for risk management and administrative resources (Table B8).

Tracking of Long-term Outcomes

General and targeted lookback notifications of transfusion recipients, triggered by either the donor center or transfusion services and conducted by transfusion services, as suggested or mandated by regulatory agencies, are included in this step.

Long-term activities of risk management staff, legal counsel, and hospital administration account for additional resources consumed. Database development and maintenance, process evaluation, and long-term treatment of adverse transfusion sequelae involving professional, clerical, and administrative staff also contribute to this category (Table B9).

IMPORTANCE RANKING OF MODEL COMPONENTS

Participants generally ranked personnel as the most important type of cost element to capture. Screening and testing for infectious agents, laboratory evaluations for typing and crossmatch, and management of transfusion reactions were felt to be among the most important activities. Information systems and capital equipment were other types of high-ranking cost elements. Early in the consensus-building process, however, it became apparent that ranking the relative importance of individual items in such a highly integrated process was impractical. That is, despite having vastly different dollar impacts, all elements are important to capture. Importance rankings were subsequently eliminated from consensus discussions.

SOCIETAL COSTS

Conference participants agreed that costs incurred by donors or transfusion recipients should also be included in any comprehensive estimate of the cost of blood. The elements include lost donor wages or time from family (donor opportunity costs) as well as those associated with lost productivity borne by the donors' employers. Volunteers at blood collection facilities have similar opportunity losses that should be captured. A parallel set of cost elements incurred by the transfusion recipient or volunteers working at the point of transfusion should also be included.

EXISTING ESTIMATES OF BLOOD COSTS

How blood cost should be measured is an open question. Although some panel members expected to depart the conference proceedings with a dollar figure of blood cost in hand, the single most important discovery was that costs estimates are neither simple nor straightforward. First, the full cost of blood is not always reflected in the price charged by blood collection agencies in the United States. This is because these organizations can use revenue generated from the sale or use of excess plasma for fractionation into plasma derivatives to offset collection and production costs associated with individual transfusable blood components (personal communication, PL Page, October 2003). In addition, most whole blood collection agencies in the United States are not for-profit.

Past efforts to determine the cost of blood have been limited in scope, focusing primarily on the provider's perspective.[20,21,23,25,30] Costs related to donor recruitment, qualification, research, registries, and associated tasks have, for the most part, been overlooked when calculating blood costs. Using data from the National Blood Service (NBS) in the UK, Varney and Guest[31] recently estimated the cost of blood from a broader, societal perspective, but costs incurred by a nationalized system are not likely to apply to the rest of the world; thus, the generalizability of their estimate is limited.

In their study of outpatient transfusion costs in patients with cancer, Cantor et al[20] noted that differences in perspective, lack of published detail, or variability in the breadth of activities captured make published cost estimates difficult to compare. Using a provider's perspective, these investigators began with identification of the transfused patient and ended with cleanup after transfusion. From start to finish, there were 25 steps identified in their process, and costs and volume of supplies used in the hospital, diagnostic tests, and tests associated with the blood transfusion itself were included. Adjusted for 2001 dollars (for ease of comparison with the latest published studies), per-unit costs of blood estimated by Cantor et al[20] ($314) were higher than those estimated by Forbes et al[23] ($221), Lubarsky et al[30] ($191), and Tretiak et al[32] ($257) but lower than those of Crémieux et al[21] ($510). The number of activities considered in these analyses differed, as did methods for estimating fixed and general overhead costs. Going a step further, Varney and Guest[31] used a societal perspective and estimated costs inclusive of blood collection through transfusion administration. Their 2000-2001 estimate of cost per unit of red blood cells to the UK-NBS was £235 or $391 (exchange rate from October 2003), approximately 25% higher than the 2001 adjusted estimate of Cantor et al.[20] Direct and indirect donor costs contributed an additional 10%. However, because there is no United States correlate to the UK-NBS

that uniformly traces costs incurred by blood collection and transfusion services, and, because activities were not outlined, it is unclear if these estimates are generally applicable.

This meeting of a multidisciplinary and noncommercial panel represents the first step to develop a template method to capture all the costs associated with blood collection and transfusion. The group identified nearly 250 cost elements and recognized more interdependencies in the processes than have previously been acknowledged.[13] Despite the considerable detail captured in the conceptual model and worksheets, further iterations of the model are necessary before dollar values can be assigned. Because much of the variability among previous cost estimates can be attributed to insufficient accounting for indirect costs, the model must be able to adequately describe these costs. According to Crémieux et al,[21] incorrect allocation of overhead and fixed costs can lead to *undervaluation* of blood costs by up to 50%. Two examples illustrating deficiencies in traditional cost accounting systems are instructive. First, the cost of treating rare adverse events has been estimated on the basis of remote probabilities, but the routine activities associated with *preparing* for such events with appropriate readiness are often ignored (eg, assembling and maintaining crash carts, quality control processes, training, event review). A second example relates to lookback notification, which has a direct impact on short- and long-term staffing hours, but also affects the direct and indirect costs of additional donor recruitment, counseling, and inventory. A suitable methodology that completely describes and correctly allocates all the contributing elements is needed.

THE FUTURE OF BLOOD COST ACCOUNTING METHODS

To date, only conventional cost accounting systems have been used to compute blood costs. Following these conference activities, this group acknowledged that constructing an activity-based costing (ABC) model such as the one depicted schematically in Figure 2 would improve upon blood cost accounting methods. The ABC methods involve 6 steps[33] (A through F), summarized as follows:

A. Identify a cost object, also known as a demand for a service (eg, the provision of adequate tissue oxygenation in the form of a red cell transfusion).
B. Outline the process by breaking it down into all activities and subactivities that must be performed to deliver this service.

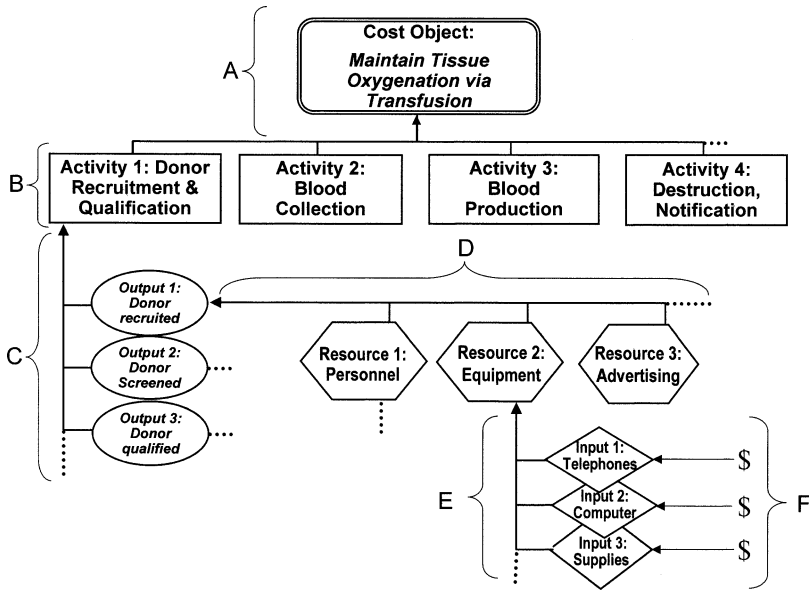

Fig 2. Activity-based costing model. A, cost object (ie, demand for service); B, activities and subactivities to provide service; C, outputs—also known as "cost drivers"; D, resources required to produce outputs; E, resource inputs; F, cost data.

C. Define the outputs, or cost drivers, for each activity (eg, the number of tests performed or the number of donors recruited).
D. List the resources needed to produce all the defined outputs (ie, type of labor, equipment, supplies). These resources may be either fixed or variable.
E. Identify resource inputs (eg, labor hours, supplies) that each of the identified resources require to perform the activities. Capacity constraints such as staffing hours, inventory limitations, and equipment can be built into this part of the model.
F. Input cost data to calculate the bottom line cost.

The participants of this consensus conference made significant progress toward this end, as outlined in the conceptual model and detailed in the appendices. Using the ABC approach, step E has only just begun. Work is ongoing to complete all the steps required to construct this framework. Data will then be entered and the model tested for general applicability. As each step in the process becomes more clearly defined using an ABC approach, the results are expected to be comprehensive and generalizable. Each institution or investigator will still need to identify which pieces of the model are most relevant to their purpose and locate appropriate numbers to populate the model. This will require an initial investment of time on the user's part, but the end product will be customizable and reflect the unique circumstances of each institution.

SUMMARY AND CONCLUSIONS

A clinician's decision to transfuse allogeneic blood must be carefully weighed because the implications of unnecessary transfusions have wider-ranging economic implications than just unit acquisition costs. Itemizing and agreeing on all the steps that contribute to the cost of blood are complex tasks, requiring a multidisciplinary team effort. This first step resulted in a model that allows all cost elements to be considered, including, but not limited to, collection, testing, and storage by the collection facility and the storage, administration, and follow-up associated with blood transfusions. It is anticipated that this detailed process flow for itemized cost accounting will be a starting point to develop activity-based modeling that will prove useful to payers, hospitals, and society, all of whom and which bear the costs of blood. For those who are developing blood transfusion alternatives or technologies aimed at improving blood safety, these methods will assist in the future design and analysis of cost-effectiveness studies.

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APPENDIX A. PARTICIPANTS OF *COST OF BLOOD CONSENSUS CONFERENCE* IN ALPHABETICAL ORDER

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APPENDIX B

Table B1. Donor Recruitment and Qualification

- Personnel
  - Telerecruiters
  - Recruiters/marketing
  - Schedulers
  - Drive coordinators
  - Screeners and examiners
  - Site supervisor
  - Drivers
- Postage/telephone recruitment
- Donor attrition
- Donor incentives
- Donor recognition
- Blood drive host facility: fixed site, temporary site, mobile unit
- Fleet: cars, trucks, mobile donor centers
- Donor education
- Registration
- Check donor identity vs deferral list and previously qualified donor list
- Screening
  - Physical examination, including equipment
  - Donor deferral counseling
  - Consent
- History deferral impact

Table B2. Blood Collection

- Personnel
  - Professional staff
  - Support staff
  - Volunteers
  - Component pick-up drivers
  - Documentation and independent record reviewers
- Equipment
  - Furniture
  - Scales
  - Refrigeration
  - Sealers
  - Apheresis
  - Resuscitation
- Supplies
  - Arm preparation
  - Collection set
  - Refreshments
  - Biohazard waste
  - Boxes, ice
  - Gloves, gowns
  - Tubes
- Adverse reactions
- Postdonation information
  - Confidential unit exclusion
  - Call back
  - Adverse reaction follow-up

Table B3. Blood Component Processing, Laboratory Testing, and Decision Step to Release or Discard Unit

3a. Blood Component Processing

- Personnel (includes managers, supervisors, quality assurance specialists, medical technicians, and administrative/clerical staff)
- Supplies
- Equipment
- Freeze/glycerolize red cells
- Leukoreduction
- Special plasma components (eg, cryoprecipitate)
- Loss during component preparation
- Initial labels for tracking units and specimens
- Bar coding/radiofrequency ID device
- Irradiation
- Medical waste

3b. Laboratory Testing

- Personnel (includes managers, supervisors, quality assurance specialists, transporters, and laboratory technicians)
- Sample transportation and processing
  - Equipment
  - Reagents
- ABO/Rh; RBC antibody
  - Equipment
  - Reagents
- Extended compatibility testing (antigen typing)
- HLA matching
- Reference laboratory
- New test evaluations
  - Equipment
  - Reagents
- Serological ID
  - Equipment
  - Reagents
- NAT
  - Equipment
  - Reagents
- Bacterial
  - Equipment
  - Reagents
- Miscellaneous (includes retesting of initially reactive samples and confirmatory tests)
  - Equipment
  - Reagents
- Test loss impact

3c. Decision Step

- Review testing results
- Rereview of deferral database
- Label generation
- Label application (2 persons)

Abbreviations: ABO, standard blood groupings; Rh, Rhesus factor; RBC, red blood cell; HLA, human lymphocyte antigen; ID, identification; NAT, nucleic acid testing.

Table B4. Blood Destruction, Donor Notification, and Tracking

Donor notification and deferral
Personnel: counselors
Donor return lost time
Follow-up testing
Postage
Blood destruction
Trigger inventory control and lookback
Create and maintain donor deferral registry

Table B5. Blood Center/Collection Facility Inventory, Storage, and Transport

Personnel
Order takers
Packers
Drivers
Inventory managers
Triage/decision making
Receivers/transferors
Quarantine management
Discarding outdates and unsuitables
Hospital contracting and relations
Supplies
Ice (wet)
Dry ice
Boxes (validated)
Equipment
Refrigerators
Below −20°C freezers
Below −65°C freezers
Room temperature storage
Thaw/deglycerolize frozen RBCs/wash
Bar code readers

Abbreviations: RBC, red blood cell.

Table B6. Transfusion Service Inventory and Storage

Blood bank personnel
QA (errors)
QA (utilization review)
Medical technicians
Clinical laboratory assistants
Clerks
Supervisors
Trainers
Trainees
Medical directors
Reference laboratory staff
Equipment (standard)
Equipment (specialized)
Sterile docking device
Bacterial detection hardware
Bacterial detection software
Tracking software
Electronic crossmatching
Errors management
Utilization review

Table B6. *(continued)*

Inventory management and storage
Allogeneic RBCs
Expiration
Overordering
Maintaining adequate inventory
Directed
Crossover
Special handling/labeling
Additional telephone calls
Wastage
Autologous
Special handling/labeling
Wastage
Platelets
Apheresis
Random/pooled
Directed
Wastage
CMV
Plasma
Thawed and frozen inventory
Order processing
RBCs
Irradiated RBC
CMV-negative RBC
Leukocyte-reduced RBC
Antigen-negative RBC
Washed RBC
Frozen RBC
Platelets
Leukoreduced
CMV-negative
Irradiated
HLA-matched
Crossmatched
HLA-negative/selected
Plasma
Special plasma
Remote storage
RBC
Refrigerators (ED, OR, labor/delivery)
Igloos
MSBOS/T&C for surgery
Satellite blood bank
Platelets
Satellite blood bank
Igloos
Wastage—all components
Maintaining adequate inventory
Overordering/temperature
Expiration
QA tracking of wastage
Storage overhead (fixed sites)
Central labs
Satellite labs
Igloos

(continued on next page)

Table B6. *(continued)*

- Stock rotation
  - RBC
    - Oldest first (in general)
    - Fresh RBCs for selected patient situations
    - Return to sender - restocking
  - Platelets
- Destruction of outdated components
  - Personnel
  - Disposal service
  - Disposal tracking
  - Hospital notification

Abbreviations: QA, quality assurance; RBC, red blood cell; CMV, cytomegalovirus; HLA, human lymphocyte antigen; ED, emergency department; OR, operating room; MSBOS, maximum surgical blood order schedule; T&C, type and crossmatch.

Table B7. Pretransfusion Preparation

- Transfusion decision
  - Physician order
  - Consent
  - Clerical notification of blood bank
  - Sample for laboratory
  - Transport of sample
  - Transportation of unit to ward
- Transportation
  - Tube systems
  - Supplies - Igloos
- Standard crossmatch
  - Type and screen
  - Full/Coombs crossmatch
  - Immediate spin
  - Electronic
  - Tube vs nontube gel
  - Manual vs automated
- Special
  - Phenotype
  - Antibody workup
  - Antigen-negative blood
  - Elutions
  - Direct agglutination test
  - External reference laboratory
- Order processing
  - Electronic
  - Telephone
  - Labels
  - Paper orders
- Work flow shifts
  - Surgery
  - Bone marrow transplant unit
  - Provision for on-call staffing
- Personnel
  - Phlebotomist
  - Intravenous therapy team
  - Nurses-transfusionist
  - Blood runners
  - Blood bank personnel

Table B7. *(continued)*

- Equipment (specialized)
  - Irradiator
  - Cell saver
  - Leukoreduction bedside filters
- Pooling/thawing
  - All components
  - Aliquots

Table B8. Transfusion Administration and Follow-up

- Administration of transfusion (inpatient or outpatient transfusion)
- Personnel
  - Nurse
  - Physician
  - Clerical
  - Technical
- Supplies (general)
  - Crash cart, IV poles, chairs, beds
  - Tubing, needles, swabs, etc
  - Facilities
  - Clinic
  - Cross-check identification
  - Local refrigerators/warmers
- Mistransfusion
  - Blood bank errors
  - Floor errors (clinical)
- Posttransfusion evaluation
  - Nursing
  - Laboratory testing (hemoglobin level, CBC, etc)
  - Laboratory personnel
  - Physician
  - Supplies
- Posttransfusion follow-up
  - Disposal
    - Personnel
    - Supplies
  - Transfusion reactions and sequelae
    - Immediate: mild → severe
    - Delayed
    - Type
      - Bacterial
      - Protozoal
      - Viral
      - GVHD
      - TRALI
      - TRIM
    - Treatment of transfusion reaction
  - Transfusion reaction reporting
    - Personnel
    - Supplies
    - Users (government, blood suppliers, and hospitals)
  - Reaction rate monitoring

(continued on next page)

Table B8. *(continued)*

Blood wastage (laboratory and floor)
Personnel
Supplies

Abbreviations: IV, intravenous; CBC, complete blood count; GVHD, graft-versus-host disease; TRALI, transfusion-related acute lung injury; TRIM, transfusion-related immune modulation.

Table B9. Tracking of Long-term Outcomes

Transfusion surveillance
Adverse events
Efficacy of transfusion
Lookback tracing
Donor notification
Patient notification

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