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Utilization Management in the Blood Transfusion Service

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Abstract

The scope of activity of the Blood Transfusion Service (BTS) makes it unique among the clinical laboratories. The combination of therapeutic and diagnostic roles necessitates a multi-faceted approach to utilization management in the BTS. We present our experience in utilization management in large academic medical center.

Keywords

Blood Transfusion; Transfusion Medicine; utilization management

1.0 Introduction

Among the clinical laboratories, the Blood Transfusion Service (BTS) holds a unique niche in that it has three facets: activity devoted to collection and manufacturing (the Blood Donor Center and Processing Laboratory), a component devoted to resource banking, allocation and diagnostics (the Transfusion Service), and a clinical and therapeutic component (the Transfusion/Infusion and Apheresis unit). In addition, unlike other Pathology subspecialties, the primary activity of the BTS is therapeutic and not diagnostic. Delivery of health care is a costly endeavor. Assessment and reassessment of areas for improvement present opportunities for enhancing clinical care, coupled with cost savings. Because of its complexity, a large BTS requires a multi-pronged approach to utilization management.

We present elements of our experience at a large academic hospital, the Massachusetts General Hospital (MGH), in Boston, as an example of this multifaceted approach. As part of utilization management, we considered the landscape of hemotherapy presented as risk versus cost of select blood products (see Figure 1), allowing us to prioritize areas of focus.

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2.0 Sources of Cost in a Blood Transfusion Service

The MGH is a large academic general hospital (approximately 900+ beds) with an annual Pathology operating budget of about \$ 105 million. Within the Department, Anatomic/Surgical Pathology accounts for 21% of the budget while 50% is allocated to the Clinical Laboratories, other than the Blood Bank. The BTS itself accounts for almost a third (~29%) of the entire Pathology department budget.

Most clinical laboratories use 60–65% of their budget for labor and only 35–40% for consumables. In contrast, only 30% of the MGH BTS budget is used for labor while 70% is allocated for consumables and blood products. The approximate costs of blood products at MGH are presented in Table 1.

Considering that the annual MGH BTS operating budget, excluding labor, is ~\$30 million, it makes sense that cost containment strategies should consider blood product usage.

3.0 Data Harvesting and Analysis

In all areas of utilization management, it is important to acquire multiple pieces of information and then analyze the data. Reviewing Blood Bank data allows for understanding costs and identifying potential areas of improvement in the transfusion service [1].

At MGH, we have made investments in data acquisition and analysis, including dedicated staffing for the BTS information system, to facilitate utilization management. Data are harvested within the blood bank electronic database (HCLL™ and LifeTrak™) using Crystal Reports. This allows us to monitor and characterize blood usage for any individual patient, a particular time period or a category/type of blood/component or a combination thereof. A drawback of our current BTS database is the limited interface with the hospital/clinical data repository. The MGH BTS developed a homegrown software, called the Blood Utilization Report (BUR) [2] that can access information from within the general laboratory databases and generate reports about blood orders along with relevant clinical and laboratory data that clinicians may use in deciding to administer a blood product.

An effective blood utilization program should be targeted at the highest yield areas. Two potential ways of identifying what might be high yield areas is to ask the questions: “Who is ordering the blood?” and “What blood products are being ordered?” Table 2 shows the number to components transfused at MGH over a three-year period.

Blood usage by clinical service is identified by the hospital location since most clinical services have associated hospital locations. This is more informative than tracking blood use by individual patients as patient may move from one clinical service to another. The intensive care units (surgical, medical, cardiac and pediatric), operating rooms (ORs) and Hematology-Oncology/Bone marrow transplant unit are some of the biggest users of blood products. Notably, cardiac surgery and the cardiac ICU are major users of red cell and plasma units while the bone marrow transplant service is a major users of platelet (PLT) concentrates. Blood transfusion guidelines targeted towards these units is a high-yield area for utilization management (see **Blood Management Program**, below).

In selecting which blood products to target, we select products used in large quantities and products with high adverse event profiles or a combination of both (see Figure 1). For instance, we have specifically targeted IVIg and rVIIa as highyield targets for blood utilization management (*see section 5.0 Blood Management Program*, below). Both are used in relatively lower quantities than pRBCs, PLT or FFP. However, both are expensive and their adverse event profile is significantly higher than all three traditional blood components combined.

4.0 Managing the Inventory

Balancing supply and demand is particularly challenging when a product has a short shelf life and the demand varies from day-to-day as is the case with PLT concentrates. Because blood products are perishable, utilization management must also include an analysis of the blood needs of the hospital and the available supply. Overstocking perishable products is wasteful and reduces availability for patients in other hospitals who depend on a common blood supply. On the other hand, it is probably worse to have an insufficient supply of blood products for lifesaving therapy.

Although a full cost analysis of our Blood Donor Center and Processing Laboratory activities is beyond the scope of this manuscript, it bears mentioning that selection of what blood products to produce and what types of tests to perform is dependent on hospital utilization patterns. Intrinsic costs for the production of blood components include marketing to attract donors, blood collection, processing, testing and storage.

One third of our annual pRBC inventory and half of our PLT and FFP units are produced by the MGH Donor Center and processing laboratory activities. All other blood products and derivatives are purchased from manufacturers or blood centers (such as the American Red Cross).

For blood transfusion services that do not make their own blood components all blood units are purchased from a vendor. In this case there is limited opportunity to request non-leukoreduced units, as only leukoreduced products are offered for sale by our vendor. Leukoreduction (LR) is useful in reducing the risk of some adverse events associated with blood transfusion, including febrile non-hemolytic (FNH) transfusion reactions [3], HLA alloimmunization [4], and transfusion-transmitted CMV infections [5]. However, there is no evidence of benefit of LR applied to every patient. For example, a randomized control trial (RCT), performed at MGH, showed that patients without FNH reactions and whose medical issues did not necessitate prevention of HLA alloimmunization or CMV infection, did not benefit from LR in terms of mortality, length of stay and cost of care [6]. In our hands, the additional cost of pre-storage leukoreduction (the filter) is about \$50/unit. In the most recent three years (2010–12), we produced ~36,000 red cell units or about 12,000/year. By rough calculation, this is an annual savings of \$600,000.

Coupled with a donor program, come costs associated with infectious disease testing. In order to decrease such costs, pooling strategies have been shown to have some cost benefit in both HIV and HCV testing [7, 8]. Another alternative is to determine the cost of infectious agent testing in-house versus sending the specimens to a reference laboratory.

Until 2009, the MGH BTS performed HIV, HCV, HBV and HTLV-1/2 testing on all in-house manufactured units. Following a cost analysis, it became clear that in-house infectious agent assays would cost more than sending out blood segments to a reference laboratory in the region.

Germane to inventory management, is the ongoing question of whether fresher blood is better than older blood. Because red blood cells can be stored for up to 42 days following collection, inventory management would become far more complex should the expiration date of red blood cells be substantially shortened [9]. To date, the data are equivocal regarding the superiority of short-duration storage versus longer-duration storage of blood [10]. A number of randomized controlled trials (RCTs) are attempting to address this issue, including the ABLE [11], RECESS and RECAP trials [12]. The MGH is a participant in the latter two trials and is leading another RCT in children with malaria (NCT01586923, Transfusion in Malaria). More recently, an RCT found no difference in outcomes among premature low birth weight infants who received ‘fresh blood’ versus standard storage-age blood [13].

5.0 Blood Management Program

Transfusion practices vary from institution to institution. In coronary bypass procedures, for instance, transfusion rates of pRBC, plasma and PLTs are highly variable, an observation that has not changed in the last two decades [14, 15]. More recently, this observation of variability in transfusion practice has been shown to occur in non-cardiac surgery [16]. Hemotherapy should be evidence-based to optimize patient care. Utilization management should focus on the development of a multi-pronged, multi-disciplinary blood management program. An excellent review of implementation of a blood management program has been previously described by Yazer [17].

There is a relative paucity of randomized control trials to detail appropriate blood transfusions in specific patient settings, making it a challenge to develop and implement transfusion guidelines. A few studies have resulted in some harmonization of transfusion guidelines particularly in critical care and cardiac surgery [18, 19]. Seven prospective RCTs (see Table 3) have examined outcomes in cohorts of patients randomly assigned to liberal or conservative triggers for red cell transfusion. These studies address a broad range of recipients—from premature infants to the elderly. Of particular note, no study has found any advantage to the more liberal use of blood. Despite the findings from these RCTs, some physicians who care for critically ill patients still utilize liberal transfusion triggers [20].

At MGH, BTS-led initiatives, related to development of transfusion guidelines, are made in conjunction with the hospital Transfusion Committee. The Transfusion Committee is an interdisciplinary committee with representation from different clinical specialties including medicine/hematology, emergency medicine, pediatrics, nursing, surgery, anesthesiology and the BTS [25]. The Transfusion Committee reviews available literature and develops algorithms to optimize positive patient outcomes while minimizing unnecessary blood transfusions. In order for guidelines to have the desired effect, the intended audience (i.e. ordering clinicians) should be educated and able to access these documents. Both general

and clinical service-specific or patient-specific guidelines are made available by posting key documents in an online handbook. Along with these guidelines the publications that were used to develop the MGH institutional guidelines are also made available. As part of the education process, the MGH BTS also takes advantage of an electronic ordering system. When a blood transfusion is ordered, the clinical indications for transfusion are displayed, reminding the ordering clinician about the transfusion guidelines, similar to what has been previously described [17].

5.1 Improving Communications and Transfusion Guidelines

As noted earlier, the cardiac surgery service and cardiac ICU are major users of blood products. Using the best quality evidence as well as benchmarking for comparison against similar institutions, the BTS participated in a multidisciplinary group, which developed a blood conservation program for cardiac surgery, especially in coronary artery bypass grafting. Prior to the cardiac redesign effort, the MGH had a relatively high use of Prothrombin complex concentrate (PCC) and albumin in cardiac surgery. PCC was apparently used as a hemostasis tool in the post-pump period while albumin was used for volume replacement. Additionally, the MGH transfusion rate for pRBC transfusions was near the median but above the median for both FFP and PLT transfusions when compared to a national benchmarking study [15]. Finfer *et al* reported that the use of saline versus albumin for volume resuscitation in an ICU setting resulted in no difference in 28-day mortality, length-of-stay, or organ failure [26]. Local changes in surgical transfusion practice resulted in elimination of albumin and PCCs in coronary bypass procedures and increased use of anti-fibrinolytics to control bleeding. The use of anti-fibrinolytics has been shown to decrease bleeding in cardiac surgery [27, 28].

An often-overlooked aspect of utilization management is outdated and wastage. Blood products require specific storage conditions that can be maintained by the use of coolers as the blood is transported and kept at the bedside. It is not uncommon that excessive amounts of blood are ordered to a specific location. Often the explanation for this by the care team was to ensure sufficient blood would be available at the bedside, if needed. This practice is known as stockpiling. Stockpiling reduces the supply of units available for other patients, requires an increase in inventory, and results in increased staff effort to issue and then later restock units which are unused and returned. Poor communication is common in settings where stockpiling occurs. Therefore, liaisons between the ORs and the BTS were set-up. Establishing better lines of communication decreased blood wastage, ensuring that other patients had access to the blood inventory. In 2013, an electronic ordering system was implemented between the ORs and the Blood Bank. Blood requests are electronically transmitted to the Blood Bank. The anesthesiologist, in real-time, can see on the operating room computer at the bedside that the blood request was received and acknowledged by the blood bank. When the blood is issued by the laboratory, the component is scanned triggering automatic notification to the operating room computer that the blood has left the Blood Bank.

5.2 Benchmarking using the Issue-to-Transfusion Ratio

A benchmarking process using the “issue to transfusion ratio” (I:T ratio) was adopted to monitor stockpiling. The I:T ratio is the number of blood units that are issued to the patient over the actual number of units that are transfused. Very high I:T ratios suggest stockpiling. We believe the I:T ratio may be a more modern and applicable benchmarking tool than the crossmatch-to-transfusion ratio (C:T ratio) especially in the era of electronic crossmatching.

We reviewed the I:T ratio in the five months preceding implementation of electronic blood ordering system in the ORs. The I:T ratio for pRBCs was 2.8. An I:T ratio of 2.8, this means that for every 2.8 units issued, only 1 was transfused; therefore 1.8 units would need to be returned to the blood bank and either placed back into inventory or discarded. In the five months after implementation of the OR electronic blood ordering system, the pRBD I:T ratio decreased to 2.3.

5.3 Audits and Gatekeeping of Selected Blood Products

Outside of the operating rooms, ICUs and emergency departments, we have employed an audit and gatekeeper approach. Audits review blood transfusion patterns but do not prohibit a transfusion from occurring. Audits can occur prior to transfusion, immediately after transfusion, or retrospectively (i.e. once daily or weekly review). Haspel provided a description of audits in the BTS [29]. At MGH a sampling of high volume blood components are audited each day. We adopted a process used by the Blood Transfusion Service of the University Health Network, Toronto, Canada in which all units that are investigated for suspected transfusion reactions are also audited for the appropriateness of blood usage. Transfusions not meeting hospital guidelines are flagged and the ordering physician is notified and offered follow up educational material. This serves to educate physicians about decision making in transfusion in the more compelling context of a transfusion-related adverse event.

In contrast, the gatekeeper function of the BTS requires approval of a BTS staff physician before the blood product is released. At MGH, this is reserved for products with a high risk and high cost profile. Two products in this category are IVIg and rVIIa (see Figure 1). As part of the gatekeeper function, these products may be requested by any physician, but released for transfusion only after a BTS physician has reviewed the indication and dose requested. Not all requests are approved.

Platelet transfusions are managed by both audit and gatekeeper functions when necessary. In general, PLT transfusions are not monitored until the PLT inventory falls below a specific level. Prior to a true shortage, PLT requests require BTS approval. In locations not subject to the gatekeeper function, an audit is used. The Blood Bank staff notifies the BTS physician of any patient in these locations that has used significant blood products. The BTS physician can then communicate with the care team to determine the blood needs of the patient and the clinical support needed.

5.4 Point-of-care Tests for Transfusion Decision Support

Incorporation of point-of-care (POC) testing as part of the MGH BTS blood management program is being reviewed, implemented and refined to assist in acute hemotherapy decisions. POC devices offer the potential advantage of a more rapid turn-around-time than centralized laboratory testing [30]. The major drawback to POC testing are the challenges related to standardization and quality control [30]. In situations such as cardiac surgery more rapidly available laboratory test results might prove useful. These settings are a logical target for POC testing. In one study, patients undergoing complex cardiac surgery were supported with the use of either routine coagulation tests or with (POC) platelet aggregometry and thromboelastometry [31]. Patients who were managed with POC testing used significantly less red cell, plasma and recombinant factor VIIa. However, the transfusion rates for PLT and PCCs were not affected [31]. Mortality was lower and control of hemostasis was superior in the POC-managed group as measured by chest-tube output in the immediate 24 h post-operative period. Finally, the average cost associated with blood product use in the POC-managed patients was half that of patients managed with routine laboratory coagulation tests [31]. In contrast, a review by Cochrane showed that the use TEG and ROTEM in the setting of massive transfusion to guide hemotherapy did not result in decreased morbidity or mortality but there was a suggestion of decreased bleeding [32]. After a review of the literature, an expert panel was convened as part of a Canadian consensus on massive transfusion. The panel could not recommend the use of such viscoelastic monitoring over routine central laboratory coagulation testing [30].

If the decision is made to incorporate POC testing in acute hemotherapy decisions, the BTS will play an important role in selecting the appropriate POC device or method. The choice of methods has implications for the end-user, who must understand the limitations of each device. For instance, the use of different point-of-care devices for measuring hemoglobin was shown to have varying results [33]. Apart from the specific platform (i.e. central laboratory versus POC assay) the analyte to be assayed should be considered. There is little quality evidence to suggest that coagulation abnormalities, as measured by routine PT/INR and/or PTT, are helpful in predicting bleeding risk [34]. Given this, one might recommend against the use of POC PT/INR devices as screening tools prior to invasive procedures. In short, the selection of the most accurate, reproducible, rapid and clinically meaningful test method and device should be identified. While offering promise, the use of POC devices for hemotherapy decision support requires further study.

6.0 Summary

Utilization management in the BTS requires a multi-faceted approach due to the scope of practice of transfusion medicine. Evaluating the sources of cost, managing inventory and establishing a blood management program based on evidence will lead to improved patient outcomes while reducing costs.

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Abbreviations

BTS	Blood Transfusion Service
CMV	cytomegalovirus
FFP	fresh-frozen plasma
FNH	febrile non-hemolytic
IVIg	intravenous immunoglobulin
LR	leukoreduction/leukoreduced
PCC	prothrombin complex concentrate
PLT	platelets
POC	point-of-care
pRBC	packed red blood cell
RCT	randomized control trial
rVIIa	recombinant activated factor VII

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Figure 1.

Adverse Risk versus Cost of Select Blood Products. We categorize blood products by rendering a plot of relative severe adverse events (Y-axis) against the relative cost per therapeutic transfusion (X-axis). The relative volumes used at MGH are represented by the size of each bubble. Severe adverse risk was extrapolated from multiple sources and expressed as adverse events per 10³ transfusions [35–39]. Adverse events for IVIg and off-label use of rVIIa in this figure were limited to thromboses. Only mortality attributed to RBC, whole blood-derived and apheresis platelets (PLT), FFP and albumin transfusions were considered. Relative costs and volumes transfused are specific to the MGH BTS.

Table 1

Costs of select blood products

High Volume Products	Low Volume Products
- lower price per unit	- higher price per unit
- includes*: pRBC, FFP, PLT and albumin	- includes* derivatives: rVIIa, IVIg, factor concentrates (factor VIII and factor IX)
- cost: \$5.567 million	- cost: \$5.513 million

* pRBC – packed red blood cells, FFP - fresh frozen plasma, PLT – platelets, rVIIa – recombinant activated factor VII, IVIg - intravenous immune globulin.

TABLE 2

The numbers of transfused components at MGH from 2010–12.

Component*	2010	2011	2012
pRBC (units)	37,167	36,468	34,602
FFP (units)	13,093	11,452	10,544
PLT (doses)	8,202	7,153	7,844
Albumin (bottles)	23,949	23,359	24,557
IVIg (grams)	52,085	45,261	44,973
rVIIa (milligrams)	42	19	35

* pRBC – packed red blood cells, FFP – fresh frozen plasma, PLT – platelet, IVIg – intravenous immunoglobulin, rVIIa – recombinant activated factor VII. Albumin is calculated as bottles where 1 bottle is 50 mL of a 25% albumin solution or 250 mL of a 5% solution. Note that these are not corrected for the number of patients or procedures.

Table 3

Randomized control trials involving a variety of patient and clinical settings studying transfusion triggers.

Author	Name	Setting	Trigger*	N
Hebert, 1999 [19]	TRIC	Adult ICU	7 vs 9	838
Kirpalani, 2006 [21]	PINT	Infants <1 kg	10 vs 12	457
Lacroix, 2007 [11]	---	Pediatric ICU	7 vs 9.5	637
Hajjar, 2010 [18]	TRAC	Cardiac surgery	8 vs 10	502
Cooper, 2011 [22]	CRIT	Acute MI	8 vs 10	45
Carson, 2011 [23]	FOCUS	Hip surgery	8 vs 10	2,016
Villaneuva, 2013 [24]	---	UGI bleed	7 vs 9	921

* Trigger was hemoglobin level (g/dL).