Evaluating the Benefits of an Updated Blood Ordering Process

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ABSTRACT

Evidence-based medicine optimizes patient care to provide appropriate patient oversite. By providing the patient with treatment that has benefits, blood management programs have decreased blood component utilization[1,2] and stimulated treatment plans that span the continuum of care, from prior to hospital admission through patient discharge.[2] Evidence-based medicine is not a new concept nor is the concept of providing the patient with tailored care. In the 1970's, the concept of matching cross-matched red cell inventory to the needs of the patient stimulated studies that led to the maximum surgical blood-ordering schedule.[3,4] Also, by pairing cross-match inventory to the patient's transfusion requirements, a blood bank tool was created to assist in patient-care, controlling red cell unit inventory, and reducing cost.[3] Patient-care changes have further evolved since the 1970's. Medical innovations today have minimized surgical blood loss through the use of laparoscopy, hemostatic agents, and improved surgical techniques. The blood bank has also evolved techniques to decrease the time it takes to provide blood to the patient. With the advancement in transfusion service testing and computer technology, blood ordering schedules can be customized to the institution, to the surgical procedure, and to the individual patient. An updated maximum surgical blood ordering schedule can further assist in optimizing compatibility testing orders, minimize component waste, and associated cost based on current evidence-based, best practice patient-care. This article will discuss the benefits of an updated blood-ordering schedule.

ABBREVIATIONS: MSBOS - Maximum surgical blood ordering schedule, NBCUS - National Blood Collection and Utilization Survey, C:T - Crossmatch to Transfusion ratio, THR - total hip replacement; TKR - total knee revision, EBL - estimated blood loss, PSBOS - Patient –specific blood ordering system, SBOE - surgical blood order equation

INDEX TERMS: Blood Loss, Surgical; Cost savings; Anesthesia; Information Management

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INTRODUCTION

Evidence-based blood management programs have successfully decreased the utilization of red cell components.[1] The decrease is evident in the 2011 National Blood Collection and Utilization Survey (NBCUS) which reports a decrease in red cell utilization from 2008 to 2011 by 8.2%.[2] The survey contributes the decrease in red cell utilization to programs that assist in managing the patient pre-operatively, intra-operatively, and post-operatively. However, appropriate blood utilization is only one branch of blood management. As highlighted in the 2011 National Blood Collection and Utilization Survey, blood management reviews and evaluates all aspects of patient care to ensure the transfusion is necessary and appropriate for the patient. Patient blood management is an optimization of patient care through evidence-based principles.

Applying evidence to optimize care is not a new concept. Optimal use of the cross-match order is the foundational structure of the maximum surgical blood ordering schedule.[3] Therefore, a maximum surgical blood ordering schedule (MSBOS) is an evidence-based and a patient-centered approach to allow for the alignment of the cross-match order to the transfusion needs of the patient.

Historical Perspective

During 1973, a 1,000 bed University Hospital in

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Michigan evaluated the mean number of units ordered and the mean number of units transfused for 50 common surgical procedures.[3] After the implementation of the MSBOS, the recommended number of cross-matched units closely equated with the number of units transfused. Since, on average, 70% of the red cell units are administered in the operating room,[4] the benefit of using a MSBOS can have profound importance in the surgical arena. In this early work, the authors effectively decreased waste contributed to on-shelf expiration, decreased cross-matches, and increased blood availability. The study also highlights that a reduction in on-shelf expiration waste can logically facilitate cost containment. The authors logically drew the conclusion that a unit reserved for individual patients was not available for general use. Therefore, the lack of guidelines (MSBOS) in ordering red cells for surgical procedures did result in the blood bank increasing inventory to accommodate cross-matched units assigned but not used.

Additional studies have revealed favorable results when the MSBOS is utilized as guidelines for ordering a cross-match. A prospective study in 1979 concluded that the MSBOS reduced the number of cross-matched units.[4] Additionally, this study contributed the more realistic cross-match order to the decrease in outdating blood and to the decrease in associated cost. In 1998, Richardson, Donaldson, Bradley, and O'Shaughnessy contributed the use of a MSBOS to a reduction in cross-matched blood, decrease in workload for the transfusion service, decrease in blood discarded due to expiry date, and a decrease in cost.[5] The authors of the 1998 study stated, that without standardized compatibility orders, wasteful blood inventory management will exhaust the limited blood supply. This waste can create blood inventory shortages, limit the blood available in emergency situations, and cause a delay in routine surgical procedures. A similar conclusion was drawn in a 2013 retrospective study of one facility's MSBOS proving that the MSBOS was a valuable tool in aligning the cross-match to the transfusion need of the patient.[6] In addition, the MSBOS is a tool to decrease component expiration waste and associated component cost.

Single facility MSBOS has proven to facilitate appropriate cross-match orders. A study of characteristically similar hospitals was completed to facilitate the creation of a comparison MSBOS.[4] The study included cross-match and transfusion data from 535,031 surgical patients. From the analysis of the blood requirements for these surgical patients, the study was able to create a single MSBOS. The author acknowledged that an MSBOS based on a particular facility's blood utilization is optimal, but concluded that a maximum surgical blood ordering schedule collating data across multiple hospitals can be a tool that is valuable in comparing single facility MSBOS or used as a guideline for those who want to develop a MSBOS.

Blood ordering schedules have now been developed specifically for a single facility and for a group of facilities. Benefits of the MSBOS are realized in a decrease in the crossmatch to transfusion ratio (C:T). The decrease in cross-match has been associated with cost containment through the decrease in component waste and decrease in component acquisition.[7] With advancements in medicine and surgical procedures, continuous review of the existing MSBOS will provide up-to-date guidelines. The purpose of this review is to determine if an updated MSBOS can further reduce unnecessary compatibility testing, reduce component on-shelf expiration waste, and decrease associated transfusion services cost. For the purpose of this review, compatibility testing is defined as type and screen, with and without cross-match testing.

DISCUSSION

Optimizing patient care through evidence-based blood management programs has decreased transfusions.[2] Maximum surgical blood ordering schedule (MSBOS) also use evidence-base techniques to align the number of cross-matched red cells units with the transfusion requirements of the patient for elective surgery.[4] Friedman, Oberman, Chadwick, and Kingdon illustrated that the MSBOS eliminates wasteful compatibility testing when there is no patient benefit, and creates an avenue for the blood bank to more effectively control inventory levels.[3]

Evidence-Based and Patient-Specific MSBOS

Maximum surgical blood ordering schedules were historically developed based on procedure type and transfusion evidence. In 2005, a retrospective study evaluated specific surgical implants, pre-operative hemoglobin, surgical blood loss, and transfusion rate.[8] The study included patients (N = 286) receiving a surgical implant for fractured femur neck. During the study, the implants used were correlated to their post-operative hemoglobin concentration. The study found a

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clinically significant hemoglobin concentration decrease ($p < 0.05$) among the implant types used. The study also evaluated the number of cross-match units requested and the number of transfusions in each of six implant groups. From this data, the transfusion index (number of units cross-matched divided by the number of units used) and cross-match to transfusion ratio (C:T) were calculated. This analysis identified the implants with an elevated transfusion index (0.3) and elevated C:T ratio (>1.0). By utilizing the pre-operative hemoglobin, surgical blood loss, and specific implant transfusion needs, an evidence-based and patient specific MSBOS was created for this type of orthopedic patient. In another orthopedic study, Mahadevan, Challand, Clarke, and Keenan formed an evidence-based MSBOS for total hip replacement (THR) and total knee revision (TKR).[9] The analysis retrospectively reviewed 397 surgical patients who had THR or a TKR over four years. The groups were stratified into elective revision, emergency surgery, and revision for infection. Transfusion index (number of units transfused divided by the number of patient having the procedure) and cross-match to transfusion (C:T) ratio was calculated. A transfusion index (TI) less than 0.5 was considered an indicator for not needing a cross-match. The study resulted in an evidence-based MSBOS. After this MSBOS was put into use, the C:T ratio for elective TKR and THR decreased 85% and 33% respectively. The study also completed a four year retrospective cost analysis using the updated evidence-based MSBOS to determine projected savings and test volumes. Using the updated MSBOS, the authors projected that 580 fewer cross-matches would have been completed with a cost saving of £80,000. This study acknowledges several limitations with its MSBOS. Importantly, the pre-operative hemoglobin was not used as part of the evidence to create the MSBOS. This is unlike the 2005 study of surgical implants for fractured femur neck which did use patient specific preoperative hemoglobin to form an MSBOS. A third orthopedic study used patient specific factors and specific surgical procedure to define the MSBOS for patients having spine fusion with spinal instrumentation.[10] The results of this study by Nuttal, Horlocker, Santrach, and et. al. reported an improvement to the MSBOS schedule by incorporating patient's pre-hemoglobin value and average blood lost for the type of procedure in an equation to calculate the number of units required for the specific patient. In their calculation, any patient with a negative value or a transfusion value less than 0.5 unit would have only an order for type and screen without a pre-surgical cross-match. The use of this patient specific calculation – surgical blood order equation (SBOE) – resulted in reducing cross-matched red cells by 31.9% when compared to the MSBOS. The same study projected that the SBOE resulted in a cost saving of 24.7%. The study compared total cost reduction of the SBOE with MSBOS. The SBOE resulted in 20.6% further reduction.

Orthopedic services are not the only specialty lines to see improvement in cross-match orders based with the implementation of guidelines. The obstetrical service line recognized a lack of standardization for ordering antibody screen and/or cross-match testing.[11] The study conclusion came after consensus among a group with representatives from obstetrics, anesthesiologists, and transfusion services. The group developed algorithms for ordering compatibility testing based on the potential of the patient to require a transfusion. The standardized algorithm approach decreased antibody screens by 55% with a cost reduction of 24% for all transfusion services testing.

Since the advent of MSBOS, several facilities and surgical procedural groups have reported benefit in optimizing compatibility testing, with special attention related to a reduction of the cross-match test. Other facilities and specialties, customized the MSBOS to specific patient values. In a 2003 study, Palmer, Wahr, O'Reilly, and Greenfield retrospectively tested the accuracy of the patient–specific blood ordering system (PSBOS) and its ability to more closely correlate the cross-match test to the patient surgical blood needs.[12] The premise of the five- month study was that transfusion variability was largely due to patient variables not surgical procedure. The formula used to calculate the units using the PSBOS was patient's blood volume, expected blood loss, and the lowest tolerated hematocrit allowed before a transfusion would be given. The ability to correctly predict patients who would not receive a transfusion was 89% accurate. Whereas, the MSBOS predicted all would have needed a transfusion and had components cross-matched. The PSBOS had a positive predictive value (probability a patient would receive a transfusion) of 55%. The authors did conclude that in surgical cases where blood loss is unpredictable, the use of the MSBOS is appropriate. The use of the PSBOS could more closely correlate transfusion requirements to those cross-matched in the

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blood bank.

The Use of Computer Technology

Since the first MSBOS in the 1970's, computer technology has advanced, and with this advancement, the ability to extract a large amount of data with accuracy. Today, the advancement in computer technology can allow an anesthesia information management system to assist in the creation of up-to-date MSBOS. In a 2013 study, Frank, Rothschild, Masear, and et. al. used the anesthesia computer system to review blood utilization data from 53,526 surgical patients with a total of 1632 different surgical procedures.[13] These surgical procedures were grouped into 135 different categories based on transfusion rate. Next, an algorithm was developed based on three variables: 5% probability the patient will receive a transfusion, estimated blood loss was greater than 50mL, and a transfusion index of 0.3 (transfusion index = total number of red cell units transfused divided by the total number of patients having the specific procedure). The algorithm was used to group the 135 categories into five different transfusion services' testing levels: no type and screen and no cross-match, type and screen, type and cross for two red cell units, type and cross for four red cell units, and type and cross for 6-15 red cell units. These five different testing levels were the backbone of the modified MSBOS. The potential cost savings based on this modified MSBOS was projected to reduce hospital charges and reduce the actual costs, $211,448 and $43,135 respectively. In 2012, another group also used the anesthesia information management system to review data from 160,207 non-cardiac cases representing 1,253 different procedures.[14] The purpose of this study was to use evidence-based criteria to develop compatibility-testing criteria for low volume estimated blood loss (EBL) and led to an updated MSBOS. Of the 160,207 cases reviewed, few (2.7%) received any red cell transfusions, but the rate of type and screen testing was 43.7%. The study applied a 5% probability of transfusion to surgical procedures to update the MSBOS. If a procedure historically had less than a 5% probability of needing a transfusion, a type and screen was not ordered. A statistically significant reduction in compatibility testing was achieved ($p = 0.0001$). In 2016, Rinehart, Lee, Kaneshiro, and et. al. also refined the MSBOS from data collected from the anesthesia information system to reduce unnecessary compatibility testing and its associated cost.[15] The MSBOS evaluation was based on an algorithm that took into account transfusion probability of 5%, EBL of > 50mL, transfusion index of > 0.3 (Transfusion index is defined as the total number of cases needing a transfusion divided by the total number of cases.), and risk of bleeding (Risk of bleeding was determined through consensus of the authors.). The authors applied the updated MSBOS to historical ordering practice. The reduction in cost by using the new MSBOS was approximately $57,335 annually. Like the previous study reported in 2013 by Frank, Rothschild, Masesar, and et. al., this study used historical information about the transfusion probability, but unlike the Frank, Rothschild, Masesar, and et al. study, patient-centered evidence was included to revise the MSBOS. Both studies achieve cost reductions by updating the MSBOS.

CONCLUSION

The use of a maximum surgical blood ordering schedule has helped decrease unnecessary compatibility tests since it was introduced in the 1970s. The advancements in transfusion service testing and surgical techniques demand continual review and updates to the MSBOS to ensure optimization of laboratory testing and component use. With the improvements in computer technology, MSBOS can be customized to the institution, the surgical procedure, and to the patient. The importance of optimizing the crossmatch test has shown remarkable benefits in standardizing care, optimized red cell allocation, and cost containment. With the future of medicine focusing on evidence-based best practices and cost containment, future refinement of the maximum surgical blood order schedule and patient blood management should utilize computer technology to customize and optimize each patient's treatment throughout the continuum of care. Future research and studies on ordering practices, use of computerized smart phases, computer generated ordering hard stops, and utilization of clinical decision support for computerized physician order entry will be needed to further guide providers. With the assistance of computer technology, the MSBOS can be improved for compatibility orders and provide surgical ordering guidelines for plasma and platelet use.

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