Patient blood management initiatives in the perioperative setting

Linley Bielby - DipApSc, BN, Grad Cert Tran Prac, MHA, Blood Matters Program Manager
Chris Akers - RN, BN, Grad Cert Tran Prac, Grad Cert Apheresis, Grad Cert Cancer Nurs, Blood Matters Transfusion Nurse
Jo Perillo - DipNurs, BN, Grad Cert Onc/PallCare Nurs, Blood Matters Education Coordinator
Nicole Sieradzki - RN, BN, Dip Nurs Periop Care, Anaesthetic Resource Nurses, Austin Health, Vic
Claire Pollock - RN, BN, Dip Nurs Periop Care, Anaesthetic Resource Nurses, Austin Health, Vic
Faye Nasra - RN, Grad Dip Perianaes, Anaesthetic Resource Nurses, Austin Health, Vic
Caroline Polack - RN, Grad Cert Tran Prac, Transfusion Trainer, South West Healthcare, Vic
Susan McGregor - RN, Grad Cert Iron Tran, Transfusion Clinical Nurse Consultant, Western Health, Vic
Kaylene Bastin - RN, BEd, Grad Cert Crit Care, Grad Cert Tran Prac, Transfusion Nurse, Melbourne Health, Vic
Bronwyn Pearse - RN, MClinPract (Acute Cardiac Nursing), Clinical Nurse Consultant Patient Blood Management, Prince Charles Hospital Brisbane, Qld

Introduction

The concept of patient blood management (PBM) is to individualise patient care to avoid the unnecessary exposure to blood or blood products. In 2012, the National Blood Authority (NBA) released the second of a planned six PBM modules: Patient Blood Management Guidelines: Module 2 — Perioperative.

An update of "Why do we need patient blood management guidelines in the perioperative clinical area?" was published in the autumn edition of the ACORN Journal. The purpose of this article is to build on why we need PBM and to include some examples of what has been done to improve PBM or blood conservation at a variety of Australian health services. Some of these initiatives may be able to be adapted for use within your own health service.

The cornerstone principles of PBM or ‘three pillars’ that relate to perioperative setting are:
1. Preoperative optimisation of blood volume and red cell mass.
2. Minimisation of perioperative blood loss, including meticulous attention to surgical haemostasis.
3. Tolerance of postoperative anaemia.

Preoperative anaemia optimisation at Austin Health

The following example highlights the optimisation of blood volume and red cell mass that has been implemented at Austin Health (Victoria).

To identify patients requiring anaemia optimisation prior to surgery, the existing workflows for elective surgery patients at Austin Health were modified to identify patients with iron deficiency. The focus was on patients undergoing major surgery such as cardiac, hip or knee joint replacement, or colorectal surgery. From 1 July 2013 to 30 June 2014 patients in the above categories were reviewed in the anaesthesia pre-admission clinic (APAC). Patients were screened for anaemia and haematinsics by the relevant surgical liaison nurses prior to this review. If screening was not performed before the patient attended APAC, then these tests were undertaken at the clinic appointment. The test results were reviewed by the anaesthetic resource nurses (ARN) and those patients who were found to be anaemic and/or iron deficient were triaged to receive either intravenous or oral iron therapy, depending on the surgery type and urgency. Patients with anaemia and/or low iron stores were also reviewed in the haematology outpatient clinic to ascertain the cause of anaemia and arrange further investigations as required.

From 1 July 2013 to 31 January 2014, a total of 1034 patients have been screened for anaemia and iron deficiency and 42 (4.1%) patients were found to be anaemic. These included 25 (60%) with iron deficiency anaemia, 6 (14%) with possible iron deficiency anaemia (elevated CRP with ferritin 30–100) and 11 (26%) due to other causes (Figure 1). Forty-nine (5%) patients were not anaemic but were found to have iron deficiency and another 11 (1%) had possible iron deficiency.

Preoperative iron supplementation was provided to a total of 96 patients. Of these, 24 patients received intravenous iron and 72 patients received oral iron, including 6 who subsequently received intravenous iron polymaltose due to an inadequate response to oral iron. Further data will explore if preoperative iron replacement in patients with iron deficiency has led to similar reduction in postoperative red cell transfusion.

The success of this implementation has been the collaboration between the key departments at this health service (anaesthetics, surgery and haematology) and the inclusion of the process within existing workflows.
Blood conservation strategies recommended within PBM Guidelines: Module 2 — Perioperative include the prevention of hypothermia, deliberate induced hypotension, acute normovolaemic haemodilution, intraoperative cell salvage and haemostasis analysis and the use of medications such as tranexamic acid and e-aminocaproic acid.

To support the PBM Guidelines: Module 2 — Perioperative, the NBA has developed the Guidance for the Provision of Intraoperative Cell Salvage (ICS) document. This guidance is intended to inform health care professionals about ICS use for patients undergoing surgery or invasive procedures, and is aimed at supporting hospitals to develop and implement an ICS program. It aims to improve clinical practice and patient outcomes through alignment with the guidelines and can be found at: http://www.blood.gov.au/ics.

Perioperative minimisation of blood loss and appropriate treatment of bleeding were the goals of a multidisciplinary, multidisciplinary bleeding management protocol supported by point of care coagulation testing at the Prince Charles Hospital (Brisbane).

Excessive bleeding is a risk of undergoing 'on-pump' cardiac surgery with multiple factors contributing to altered haemostasis. Bleeding can be either surgical and/or microvascular and the multifactorial nature can complicate diagnosis. Treatment of bleeding often involves empirical transfusion with allogeneic blood products, which is also associated with risk. Successful treatment of bleeding requires diagnosis and treatment to be rapid and appropriate. Laboratory coagulation tests are not always easily accessible or readily available. For that reason point of care coagulation platforms are being utilised to support timely diagnosis of the cause of bleeding, and supporting, if
TPCH Cardiac Surgery ROTEM / Multiplate Transfusion Algorithm

Do not treat patient unless there is clinically significant bleeding

Pre Bypass
(consider with high risk pf’s, anti-platelet therapy, pre-existing haemostatic abnormalities, etc.)

Drug History - Clopidogrel, Prasugrel, Ticagrelor, Aspirin, Fish Oil, Garlic or Ginseng, etc, within the last 7 days?

- Multiplate
  - ADP - AUC < 30
  - ASPI - AUC < 20
  - TRAP - AUC < 50
  - Yes: Poor Platelet Function
  - Yes: Consider pre-ordering platelets for possible transfusion post CPB
  - No: Tranexamic Acid

On Bypass (30 minutes before coming off bypass)

- FIBTEM - MCF < 5mm
  - Yes: Low Fibrinogen
  - Yes: Consider Cryoprecipitate Availability
  - No: Post Bypass (10 post protamine)

- EXTEM A10 < 30mm & FIBTEM - A10 > 10mm
  - Yes: Poor Platelet Contribution
  - Yes: Consider Platelet Availability

Post Bypass (10 post protamine)

- INTEM - CT > 240 secs & HEPTEM - CT / INTEM - CT < 0.8
  - Yes: Heparin Effect
  - Yes: Redosage of Protamine

- EXTEM A10 =/\<40mm & FIBTEM A10 =/\< 10mm
  - Yes: Low Fibrinogen
  - Yes: Cyroprecipitate

- EXTEM - CT > 90 secs OR HEPTEM - CT > 280 secs
  - Yes: Low Coagulation Factors
  - Yes: PCC / FFP

- EXTEM A10 =/\< 40mm & FIBTEM A10 > 10mm
  - Yes: Poor Platelet Contribution
  - Yes: Platelets

- ADP - AUC < 30
  - ASPI - AUC < 20
  - TRAP - AUC < 50
  - Yes: Platelet Dysfunction
  - Yes: Tranexamic Acid

- Lysis Index LI 30 > 15 %
  - Yes: Hyperfibrinolysis

Ongoing Bleeding

- Optimise
  - EXTEM - CT < 60 secs AND A10 FIBTEM > 1.6mm AND A10. EXTEM > 60mm
  - Yes: Continued Bleeding

- Consider surgical haemostasis

Version 3
1/12/13

Figure 2
required, targeted supplementation of deficient coagulation proteins, cellular, and fibrinolytic components.

At Prince Charles Hospital in July 2012 the cardiac, anaesthetic and critical care programs implemented protocolised bleeding management supported by point of care coagulation testing (POCCT), rotational thromboelastometry (ROTEM)\(^4\), and impedance aggregometry (Multiplate)\(^5\). ROTEM provides four independent measuring channels with various assays that can assess extrinsically and intrinsically activated clotting times, platelet and fibrinogen contribution to clot quality, as well as the stability of the clot over time. Multiplate utilises impedance aggregometry and various agonists (ADP, arachidonic acid and thrombin receptor activating peptide)\(^6\), to quantify platelet dysfunction mediated by antplatelet medication. Results from these assays are included in a treatment algorithm (Figure 2) that also includes tranexamic acid and optimising pH, temperature and calcium. These whole blood assays are performed in the clinical environment with useful results available in 15 minutes. ROTEM results are streamed live into the operating room, where diagnosis of the cause of bleeding can be made relative to the patient’s clinical condition.

Patients who underwent on-pump cardiac surgery before (6/2011 – 6/2012) and after (7/2012 – 6/2013) implementation protocolised bleeding management supported by POCCT were retrospectively reviewed. The results indicate substantial reductions in the number of patients transfused (Figure 3) and the actual numbers of units transfused (Figure 4). There was also a substantial reduction in the return to operating room for bleeding/tamponade (Figure 5). The change in practice supports early diagnosis of bleeding with targeted, appropriate treatment in reducing overall transfusion requirements and improving outcomes by identifying the cause of bleeding and treating any detected abnormality appropriately and early.

The use of tranexamic acid is included within the recommendations of the Module 2 perioperative guidelines and the following example demonstrates how tranexamic acid has been used within the orthopaedic setting in at Western Health (Footscray) in Victoria.

Tranexamic acid acts by preventing clot degradation (fibrinolysis), a process that is normally undertaken by the fibrinolytic system. Evidence shows that tranexamic acid therapy significantly reduces the incidence of allogenic transfusion in patients undergoing cardiac surgery (by 31%) and major orthopaedic surgery (by 50%)\(^6\).

Recommendation (Grade A level of evidence): In adult patients undergoing cardiac surgery, the use of intravenous tranexamic acid is recommended\(^6\).

Recommendation (Grade B level of evidence): In adult patients undergoing noncardiac surgery, if substantial blood loss (blood loss of a volume great enough to induce anaemia that would require therapy) is anticipated, the use of intravenous tranexamic acid is recommended\(^7\).

In 2012, the anaesthetic and orthopaedic units at Western Health in a joint initiative developed and implemented a tranexamic acid protocol for adult patients undergoing primary hip and knee arthroplasties or revision arthroplasties\(^8\).

The protocol involved patients without contraindications such as acquired disturbance of colour vision; active intravascular clotting; a history of thrombosis or thromboembolism or a significant intrinsic risk of thrombosis; being given a total of three intravenous doses eight hours apart (TDS regimen). A loading dose was given intraoperatively; prior to skin incision for total hip replacement (THR) and prior to release of tourniquet for total knee replacement (TKR). Two subsequent doses are given postoperatively. Dosage is calculated according to patient weight, that is, mg/kg and patient renal function (eGFR).
Clinical audit of all elective arthroplasty episodes was undertaken to assess the effectiveness of this protocol in reducing the incidence of allogeneic transfusion. The audits captured compliance with the protocol, patient preoperative haemoglobin; co-morbidities; estimated blood loss and whether the patient was transfused perioperatively or postoperatively. To date, the data suggests that the implementation of this protocol has had a positive effect on reducing the incidence of allogeneic transfusions in this patient cohort; however, further data is required for a meaningful statistical analysis and definitive outcome.

Operating suite

Another strategy that has been developed by the NBA to support PBM and reduce wastage of blood and blood products is the National Blood and Blood Product Wastage Reduction Strategy 2013–17. The following examples highlight activities that have been undertaken to reduce wastage of blood either in or associated with the perioperative area.

In 2012, Melbourne Health (MH) had a red blood cell wastage rate of 7% (an average of 95 red cell units per month), mainly due to poor compliance with storage and handling in the operating suite. The problem was found by nursing staff in the operating suite that used temperature monitoring tags as an audit tool; proving poor compliance with red cell storage in this area. To ensure patient safety, a decision was made to discard any units of red cells that could not be confirmed to be stored correctly.

As a result of the wastage rate being above the state average at the time an organisational improvement project, Reducing Blood Wastage, was undertaken. The Lean Six Sigma methodology, which uses the DMAIC (Define, Measure, Analyse, Improve and Control) framework, was followed (Figure 6)10.11.

The operating suite became the main focus of the improvement project as analysis of the usage and wastage data confirmed that 70% of red cell wastage at MH was due to unknown storage conditions in the suite. Additional analysis confirmed that the wastage was due to elective, rather than emergency surgery. A root cause analysis highlighted a lack of accountability, poor compliance with storage and handling procedures and insufficient education as the main contributory factors. This was used to drive potential solutions.

Improvements in accountability were limited to making staff aware of the problem and their contribution to it, and by adding wastage rates to the data provided to the organisation’s executives via various committees. The main improvement implemented was a single unit issue of red cells by the transfusion laboratory as needed, delivered directly to the operating suite. Exceptions could be negotiated. Strategies were introduced as a patient safety measure to ensure blood was available when needed; a priority phone was installed between all operating rooms and the transfusion laboratory, and two units of O negative red cells were provided for the rare circumstances when blood was needed more urgently than the three minutes it took to reach the operating suite from the transfusion laboratory.

Education was provided to all staff utilising the resources of both the transfusion laboratory and the operating suite to ensure maximum communication of the changes.

Although the changes implemented have not resolved the problem, improvements have been made. The average number of red cells issued to the operating suite per month has decreased from 230 per month to 138. The average number of red cell units wasted per month has decreased from 66 per month to 26. Continued vigilance is required as recently the amount of wastage has increased.

The next step in reducing blood wastage at MH involves the use of technology as the Blood 360 blood tracking system trial commences12 (Figure 7).

Reducing red cell wastage by modifying the blood ordering schedule at South West Healthcare Warrnambool (Victoria)

A review of preoperative ordering practices of orthopaedic patients undergoing THR, TKR and fractured neck of femur in 2010 revealed
31 patients in a three-month period had quite varied cross-match requests\(^1\).

- Three surgeons had very different ordering regimes, varying from a group and hold, to a cross-matching of six units and their rationales for transfusion also varied.
- Of the 118 units cross-matched, only 21% were transfused, (two in the operating room and three in recovery). Of the 31 patients, 25% were transfused during their admission.
- Red cell expiry data at this time was averaging 19%, with these cross-matched units being stored for a total 425 nights in the blood fridge.

The transfusion committee, in consultation with the directors of orthopaedics and anaesthetics, implemented the following changes:

- Orthopaedic patients no longer have blood cross-matched preoperatively, a group and hold only to be performed.
- Blood Bank can convert a group and hold to issue cross-matched blood within 10 minutes of receiving a phone request from the operating room.
- Blood Bank to initiate a cross-match of two units of blood for patients if atypical antibodies are discovered, or other technical issues mean this 10-minute time frame is unable to be met.
- If a cross-match is desired due to complicating factors, the requesting medical officer is to contact the Blood Bank to discuss and plan the patient's requirements.
- Cross-match requests received without consultation with Blood Bank are automatically converted to group and hold.

Following the implementation of the above actions, 61 patients were audited over a three-month period in 2011.

- Six patients were cross-matched preoperatively and 83% of the 69 cross-matched units were transfused and 12 of these in the operating room (6 to 1 patient). Of the 61 patients audited, 26% were transfused during their admission.
- Red cell expiry data was reduced to an average of 9% and the total storage nights reduced to 42 nights.
- The 10-minute turnaround time was monitored and met.

In 2013, the transfusion rate for orthopaedic patients was 14%. In addition to a review of ordering schedules, preoperative iron studies including ferritin have been introduced into the NPOF pathway, and the impact of this and other changes in practice will be evaluated in the 2014 review.

Education to support the PBM in the perioperative setting is available through online learning offered by BloodSafe eLearning Australia\(^4\). The course provides the learner with the evidence behind PBM and...
aims to improve the clinical outcomes for all patients who may be at risk of receiving a blood transfusion. The course can be found at: https://www.bloodsafelearning.org.au/node/9

**Conclusion**

Blood and blood products are not without risk and the potential benefits of the transfusion should clearly demonstrate the benefits outweigh the risk. The implementation of PBM activities and the introduction of new technologies have shown to improve the appropriateness of transfusion and impact the blood supplies required to be held by a health service. These PBM initiatives outlined highlight the importance of communication, education and interdisciplinary cooperation to improve patient safety and preserve the supply of blood and blood products.

**References**

8. Western Health Guidelines for the Perioperative Administration of Tranexamic Acid for Orthopaedic Arthroplasty Surgery.
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