

Review

Autologous blood donation

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Abstract

Although preoperative autologous blood donation is employed in elective surgery, this is declining because of the increasingly safe allogeneic blood supply. However, it continues to be used because of the public's perception of allogeneic blood risks and increasing blood shortages. Patients may donate a unit of blood (450 ± 45 ml) as often as twice weekly, up to 72 hours before surgery. Preoperative autologous blood is most beneficial in procedures that cause significant blood loss. It has been determined that preoperative autologous blood donation is poorly cost-effective; the use of this procedure must be based on evidence that it is safe and of value for the patient.

Keywords autologous blood donation, blood transfusion, elective surgery

Introduction

Preoperative autologous blood donation (PAD) was developed and promoted [1] in the surgical arena in response to medical and legal pressures to minimize exposure to allogeneic blood. The role of PAD in surgery continues to evolve, based on improved blood safety, increased blood costs, and emerging pharmacologic alternatives to blood transfusion [2]. PAD became accepted as a standard practice in certain elective surgical settings, such as total joint replacement surgery, so that by 1992 more than 6% of the blood transfused in the USA was autologous [3]. Subsequently, improvements in blood safety have led to a decline not only in the use of PAD (Table 1) but also in interest in exploring other autologous blood procurement strategies. Nevertheless, public perception of blood safety and the reluctance to accept allogeneic blood transfusion in the elective transfusion setting [4], along with emerging blood inventory shortages, render the application of autologous blood procurement strategies a subject of ongoing debate.

Efficacy

Patients undergoing PAD may donate a unit (450 ± 45 ml, or up to 10.5 ml/kg body weight) of blood as often as twice weekly, until 72 hours before surgery. Under routine conditions, patients usually donate once weekly. Oral iron supplements are routinely prescribed. This iatrogenic blood loss is accompanied by a response in endogenous erythropoietin (EPO) levels that,

although increased significantly over basal levels, remain within the normal range. The erythropoietic response that occurs under these conditions is therefore modest [5]. A summary of prospective, controlled trials of patients undergoing such blood loss via autologous phlebotomy is presented in Table 2 [6–11], along with calculated estimates of red blood cell (RBC) volume expansion (erythropoiesis in excess of basal rates). With routine PAD, erythropoiesis of 220–351 ml (11–19% RBC expansion) [6,7], or the equivalent of 1–1.75 blood units, occurs in excess of basal erythropoiesis, which indicates the efficacy of this blood conservation practice.

For patients subjected to more aggressive phlebotomy (up to 2 units weekly), the endogenous EPO response is more substantial [8–11]. In one clinical trial [9], a linear-logarithmic relationship was demonstrated between change in hemoglobin level and the endogenous EPO response [12]. EPO-mediated erythropoiesis in this setting is 397–568 ml (19–26% RBC expansion) [8–11], or the equivalent of 2–3 blood units. When recombinant human EPO therapy is administered during PAD, the equivalent of 5 blood units is generated [10,13].

Patient selection

Preoperative autologous collections are most beneficial to those patients who are undergoing procedures with substantial anticipated blood loss, such as orthopedic joint replace-

Table 1

Collection and transfusion of autologous blood in the USA

| Source | Year | | | | | | | |
|---------------------|--------|--------|--------|--------|--------|--------|--------|--------|
| | 1980 | 1986 | 1989 | 1992 | 1994 | 1997 | 1999 | 2001 |
| Collected | | | | | | | | |
| Autologous | 28 | 206 | 655 | 1117 | 1013 | 611 | 651 | 619 |
| Percentage of total | 0.25% | 1.5% | 4.8% | 8.5% | 7.8% | 4.9% | 4.7% | 4.0% |
| Total | 11,174 | 13,807 | 13,554 | 13,169 | 12,908 | 12,550 | 13,649 | 14,259 |
| Transfused | | | | | | | | |
| Autologous | N/A | N/A | 369 | 566 | 482 | 421 | 367 | 359 |
| Percentage of total | | | 3.1% | 5.0% | 4.3% | 3.7% | 3.0% | 2.6% |
| Total | 9934 | 12,159 | 12,059 | 11,307 | 11,107 | 11,476 | 12,389 | 13,361 |

Values are expressed as thousands of units, unless otherwise stated. N/A, Not available. Adapted with permission from [3].

Table 2

Erythropoiesis during autologous blood donation

| Patients (n) | Baseline RBCs (ml) | Blood removed (donated) | | Blood produced | | | Reference |
|-------------------------|--------------------|-------------------------|-----------|----------------|---------------|--------------|-----------|
| | | Requested/donated units | RBCs (ml) | RBCs (ml) | Expansion (%) | Iron therapy | |
| 'Standard phlebotomy' | | | | | | | |
| 108 | 1884 | 3/2.7 | 522 | 351 | 19% | po | [6] |
| 22 | 1936 | 3/2.8 | 590 | 220 | 11% | None | [7] |
| 45 | 1991 | 3/2.9 | 621 | 331 | 17% | po | [7] |
| 41 | 1918 | 3/2.9 | 603 | 315 | 16% | po + iv | [7] |
| 'Aggressive phlebotomy' | | | | | | | |
| 30 | 2075 | ≥3/3.0 | 540 | 397 | 19% | None | [8] |
| 30 | 2024 | ≥3/3.1 | 558 | 473 | 23% | po | [8] |
| 30 | 2057 | ≥3/2.9 | 522 | 436 | 21% | iv | [8] |
| 24 | 2157 | 6/4.1 | 683 | 568 | 26% | po | [9,10] |
| 23 | 2257 | 6/4.6 | 757 | 440 | 19% | po | [11] |

Values are expressed as means. iv, intravenous; po, oral; RBC, red blood cell. Data from Goodnough and coworkers [5].

ment, vascular surgery, cardiac or thoracic surgery, and radical prostatectomy. Autologous blood is unnecessary for procedures that seldom require transfusion, such as transurethral resection of the prostate, cholecystectomy, herniorrhaphy, vaginal hysterectomy, and uncomplicated obstetric delivery [14]. A hospital's maximal surgical blood order schedule for blood cross-match can provide estimates of transfusion rates for specific procedures; the generally accepted cutoff at which transfusion is 'unlikely' and autologous blood procurement should not be recommended is 10% [15].

Collection of units should be scheduled as far in advance of surgery as possible for liquid blood storage (up to 42 days),

to allow compensatory erythropoiesis [5] to correct the induced anemia. If the erythropoietic response to autologous blood phlebotomy is not able to maintain the patient's level of hematocrit during the donation interval, then the pre-deposit of autologous blood may actually be harmful. A study of patients undergoing hysterectomy [16] found that PAD resulted in perioperative anemia and an increased likelihood of any blood transfusion.

Even though national trends indicate a decline in PAD for all surgical patients in the USA, this practice remains a standard of care for patients undergoing total joint replacement surgery. A multicenter retrospective audit of 9482 patients

Table 3**Advantages and disadvantages of autologous blood donation**

| Advantages | Disadvantages |
|--|--|
| Prevents transfusion-transmitted disease | Risk of bacterial contamination or volume overload remains |
| Prevents red cell alloimmunization | Does not eliminate risk of administrative error with ABO incompatibility |
| Supplements the blood supply | More costly than allogeneic blood |
| Provides compatible blood for patients with alloantibodies | Wastage of blood not transfused |
| Prevents some adverse transfusion reactions | Causes perioperative anemia and increased likelihood of transfusion |

Data from Goodnough and coworkers [2].

undergoing these procedures [17] found that 60% underwent PAD. For non-anemic patients, PAD reduced allogeneic blood exposure by two thirds as compared with patients who did not undergo PAD. For anemic (hemoglobin <13 g/dl) patients, PAD reduced allogeneic blood exposure by only one third.

For procedures such as total joint replacement surgery, discard rates of up to 50% of collected units are common [17]. When autologous blood is collected for procedures that seldom require transfusion, such as vaginal hysterectomies, up to 90% of units collected for these procedures are wasted [16]. The additional costs associated with the collection of autologous units and the inherent 'wastage' of these units, along with advances in the safety of allogeneic blood, now render the pre-donation of autologous blood poorly cost-effective [18]. Cost-effectiveness models serve to illustrate the potential risks associated with autologous blood donation; even a very remote risk for death in patients with ischemic heart disease may entirely negate the benefits of having autologous blood available before coronary artery bypass grafting [19]. Key factors include the estimated postoperative lifespan of the patient and the likelihood of transfusion [20,21]. In a study of autologous blood donation before coronary artery bypass grafting [19], the preoperative donation of 2 units was estimated to have a cost of US\$500,000 per quality-adjusted life year. In comparison, most commonly accepted medical and surgical interventions have a cost of less than US\$50,000 per quality-adjusted life year. The risk for exposure to a hepatitis virus or to HIV has declined by at least an order of magnitude since the calculation of this estimate, and the current cost-effectiveness would be significantly worse.

Some suggestions to make autologous blood programs less costly include abbreviating the donor interview for autologous collection, utilizing only whole blood and discontinuing component production, limiting the use of frozen autologous blood, applying the same transfusion guidelines for autologous and allogeneic blood, and testing only the first donated autologous blood unit for infectious disease markers. Attempts to stratify patients into groups at high and low risk

for transfusion, based on the baseline level of hemoglobin and on the type of procedure, show some promise. In a study using a point score system, 80% of patients undergoing total joint replacement procedures were identified to be at low risk (<10%) for transfusion, so that autologous blood procurement for these patients would not be recommended [22].

Safety considerations

Autologous blood donation and the transfusion of autologous blood are each associated with risks. One in 16,783 autologous donations is associated with an adverse reaction severe enough to require hospitalization, which is 12 times the risk associated with community donations by healthy individuals [23]. Ischemic events have also been reported to occur in association with autologous blood donation [24]. The transfusion of autologous blood has many of the same complications as transfusion of allogeneic units, including bacterial contamination, hemolysis due to errors in the administration of units, and volume overload. Because mortality from allogeneic blood transfusion is now more likely due to administrative error [25] than to blood-transmitted infection [3], the risks associated with banked autologous blood units are similar to those with banked allogeneic blood units. As summarized above, some advantages and disadvantages of PAD are listed in Table 3.

Conclusion

Increased attention to the costs and safety of health care delivery has caused the relative benefits and costs of both blood transfusion and conservation to be scrutinized. The prospective identification of surgical candidates who will need transfusion and will therefore truly benefit from blood conservation must be based on factors specific to the patient, such as the baseline hematocrit and the anticipated blood loss during surgery. The decision to employ blood-sparing technology may no longer be based on the safety of the blood supply, but on evidence that blood conservation is safe and of value for individual patients.

Competing interests

None declared.

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