The rise and fall of preoperative autologous blood donation

Stimulated by the emergence of HIV as an infection transmissible by blood transfusion, interest in the use of autologous blood for transfusion soared in the 1980s and early 1990s (Fig. 1). In 1987, a national multicenter study estimated that as much as 10 percent of all RBC transfusions could be preoperatively donated by and transfused to patients undergoing elective surgery.8 Similarly, in 1995, a study of a community population in Olmsted Count, MN, concluded that the total potential effect of preoperative autologous blood donation (PABD) on the blood supply could amount to a maximum of 9.7 percent of all transfused units of RBCs.9 Despite such predictions, nationwide, the percent of PABD has never approached 10 percent for either collection or transfusion. In fact, apparent interest in PABD peaked in 1992 (8.5% collected, 5.0% transfused) and has declined in recent years (4.7% collected, 3.0% transfused in 1999). It is interesting that academic interest, as reflected by the number of publications per year on autologous blood, has also followed a similar rise and fall pattern (Fig. 2).

Why has there been this recent decline in interest in autologous blood? Have we failed, and should we be alarmed? Has it simply served its purpose? To answer these questions, it is important to briefly review what we have learned in recent years and how changes in transfusion medicine have affected the relevance of autologous blood use.

RISK AND PERCEPTION

Clearly, the driving force behind the increased interest in PABD in the 1980s was a fear of transfusion transmission of viruses (most notably, HIV). In the early 1980s, in some regions of the United States, up to 1 percent of units were infected with HIV.10 Similarly, during that period, approximately 0.5 percent of units were also contaminated with HCV.11 The development of progressively improved virus-screening tests and stringent donor selection criteria has led to a remarkable decline in viral risk from blood components over the last two decades. The current estimates of the risk per unit of blood in the post-NAT era are 1 in 1,900,000 for HIV and 1 in 1,600,000 for HCV (Stramer SL, AuBuchon JP, written communication, September 2001).

Despite such remarkable numbers, a substantial portion of the public remains skeptical about the safety of the blood supply. In 1997 and 1998, a national survey of 1204 persons in the United States found that only 36.2 percent of the population felt the blood supply in the United States is safe, and only 33.3 percent responded that they would accept blood if hospitalized.12 A second survey conducted in May of 2000, with 501 respondents from the 48 contiguous states, found that, when queried regarding the choice of blood for elective surgery, 53 percent preferred to receive autologous blood, 33 percent preferred directed donations,
and only 8 percent preferred the community blood supply. Estimates of the risk of transfusion transmission of HIV or hepatitis were almost uniformly distributed from 1 in 100 to 1 in 100,000. These studies suggest that there remains a high level of public concern about the safety of the blood supply, but little knowledge of the current risks of hepatitis or HIV transmission.

In this current issue of TRANSFUSION, Segal et al. show that blacks, Hispanics, women, and patients on Medicaid appear to receive fewer autologous transfusions than the rest of the population. Paradoxically, in the public perception surveys, it was many of these same groups—women, non-whites, and less educated persons—who tended to perceive the greatest personal and public risk from blood transfusions. Thus, there is a perplexing disconnect, in that those who are most fearful of the blood supply participate the least in PABD.

**PABD IS CHRONIC HEMODILUTION**

The original premise underlying PABD was that RBC volume would be removed before elective surgery, and sufficient time would elapse to allow the patient’s marrow to reconstitute all or significant portion of the donated RBC volume, therefore providing additional RBC volume at the time of surgery. However, in the United States, PABD units are generally collected in the few weeks just before surgery. Typically, such donations do not allow time for complete RBC reconstitution from erythropoiesis. For example, in a study of 372 two-unit autologous donors at the University of California, San Francisco, the number of days from the first donation to the day of surgery was correlated with the mean number of RBC units regenerated. Intervals of 6 to 13, 14 to 20, 21 to 27, 28 to 34, and 35 to 41 days from the first donation to the day of surgery were associated with the regeneration of 0.52, 0.54, 0.75, 1.16, and 1.93 mean RBC units, respectively. Thus, when the donations are made in the 2 to 3 weeks before surgery, only a fraction of the donated RBC volume is regenerated. For many patients donating autologous blood in the few weeks immediately before surgery, the only result is chronic hemodilution, and the benefit would be expected to be comparable to benefits seen with acute normovolemic hemodilution.

**MODELING**

Mathematical and computer modeling of autologous blood collection and transfusion has been particularly insightful. Modeling has shown us that hemodilution (acute or chronic) results in relatively small gains, typically equivalent to a fraction of a unit of RBCs. One model stressed the need to consider the individual patient and the effect of donation on the patient’s Hct. For patients undergoing PABD, it was shown that, with normal initial Hct (>40%), large blood losses (>2 L) must occur before a minimum Hct for transfusion (<28%) is reached. If the PABD units are not transfused, PABD can actually result in a decreased postoperative Hct (with enhanced risk of ischemia). The model predicted that preoperatively donating patients would be more likely to receive transfusion(s) earlier and more frequently than nondonating patients. The truth of such predictions have been confirmed in multiple clinical settings. Because the current estimated risks of death due to hemolysis secondary to an ABO-incompatible transfusion (administrative error) far exceed the risk due to virus transmission, one could argue that PABD actually increases (rather than decreases) transfusion-related mortality.
Historically, approximately one-half of all PABD units collected in the United States are never transfused and are discarded (Fig. 1). Such large wastage is inevitable, as PABD units are frequently collected on the basis of surgical blood-ordering schedules. Such schedules are derived from a cumulative percentage analysis of blood use for a given surgical procedure. Typically, the number of units is chosen to accommodate 90 percent of cases. However, in PABD, the average patient (the 50th percentile patient) will preoperatively donate excess blood with a schedule based on the 90th cumulative percent. In the United Kingdom, it has been recommended that autologous donation should be considered only if the likelihood of transfusion exceeds 50 percent. As health care costs rise, it has become increasingly difficult to justify this continued wastage of units.

**COST-EFFECTIVENESS**

Cost utility studies of autologous blood have been performed for a variety of surgical procedures. Such studies are expressed as a cost per quality-adjusted life year (QALY), in which QALY is a measurement of the additional life years available to a person, as adjusted by the quality of health (usually measured on a scale of 0 to 1) that the person will enjoy during those years. Cost per QALY provides a common measure for comparing all medical interventions, including widely disparate interventions such as coronary artery bypass graft surgery, autologous blood collection, and dialysis. A medical intervention is generally considered effective at a QALY of $50,000 or less. Estimates of the cost per QALY for PABD units have been reported for total hip arthroplasty ($235,000-$740,000), total knee arthroplasty ($1,146,000-$1,147,000), coronary artery bypass graft ($494,000-$508,000), transurethral resection of prostate ($1,358,000), prostatectomy ($531,000), and hysterectomy ($23,643,000). The high cost per QALY for PABD units is driven by the low frequency of virus transmission and the low requirement for transfusion in some surgeries (which leads to discarding). Given the further decrease in viral risk realized in recent years (particularly after the implementation of NAT), it would be expected that the cost per QALY would be even higher today.

**RISK OF DONATION**

It has been reported that 1 in 16,783 autologous donations results in a very severe outcome (an adverse event that leads to hospitalization), a rate that is 11.8 times higher than the risk associated with healthy volunteers. Even a small increase in morbidity or mortality associated with PABD could negate any benefit associated with an autologous donation.

**AUTOLOGOUS BLOOD AS A STANDARD OF CARE**

With all of the above recognized limitations for PABD, it is noteworthy that medicolegal issues, and the concept of informed consent support continued, and perhaps even increased, participation in this blood-conservation strategy. PABD is an option that should be discussed with any patient as part of the informed consent for a scheduled elective surgical procedure for which a blood transfusion is likely. In some state (e.g., California), discussion of the option of PABD is mandated. A survey of 1000 hospitals in 1997 found that PABD was identified by 83 percent of respondents as the most commonly practiced blood-conservation method. Patients undergoing total joint replacement surgery best illustrate this practice: a 1996-97 audit found that the proportion of patients who underwent PABD ranged from 47 percent (unilateral knee replacement) to 70 percent (bilateral knee replacement) of all patients, with similar percentages for primary and revision hip replacements. PABD in those settings reduces, by approximately two-thirds, the likelihood of allogeneic blood transfusion to the patients who are not anemic at the time of first donation.

With the evolution of knowledge gained in PABD, what should be our approach to its going forward? An effort should be made to identify and treat patients who are anemic (Hct <39%) at the time their surgery is scheduled. Bierbaum found that 35 percent of patients undergoing PABD for total joint replacement were anemic at the time of first donation; for these patients, allogeneic blood exposure ranged from 11 percent (unilateral knee replacement) to 33 percent (hip revision), despite PABD. For these patients, clinical trials utilizing PABD coupled with erythropoietin therapy and/or newly available and safer IV iron preparations are clearly needed.

Finally, another reason to support the utilization of PABD is blood inventory. With the recent increases in the demand for blood frequently outpacing the increases in blood collections, elective surgeries have had to be postponed at some institutions. If stricter screening criteria for potential blood donors (e.g., travel in Europe) become a reality, the loss of donors may make the desirability of PABD in connection with elective surgery even more compelling or possibly a necessity.

**CONCLUSION**

Over the last 20 years, we have gained experience and carefully analyzed many of the ramifications of PABD. We now recognize that, in many cases, PABD is simply hemodilution and may actually place our patients at higher risk of leaving the hospital with a lower Hct than if they had not engaged in PABD. We recognize that, in general, the use of PABD alone provides only a relatively small benefit and is not cost-effective. We now know that to maximize the PABD benefit, re-
generative erythropoiesis must occur, and it may require a longer interval before surgery or the use of erythropoietin. Judicious use of PABD in concert with other blood-conservation methods in specific cases remains appropriate; however, automatic referral of all patients for PABD is overly simplistic and should be discouraged. The fact that we never achieved a 10-percent rate of PABD unit collection or transfusion merely reflects our changing times.

Ten or 15 years ago, the most convincing argument for PABD was the reduced transmission of viruses. Today, however, such an argument is less compelling; in effect, the pendulum has swung. When blood was less safe, the blood banking community accommodated and in many cases actively supported a rising interest in PABD. Now that blood for transfusion is virtually free of HIV and hepatitis, it is to be expected that we would experience a decline in interest in PABD. Should another risk of transfusion-transmitted disease be identified (e.g., CJD or new variant CJD associated with bovine spongiform encephalopathy), or if blood collections fail to keep pace with the demand for blood, the pendulum may swing back again, and we would expect a resurgence in interest in autologous blood.

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