

## BACTERIAL CONTAMINATION OF BLOOD COMPONENTS

Bacterial sepsis is the leading microbial cause of transfusion mortality today in the United States—accounting for 46 (17%) of 277 reported transfusion deaths from 1990-1998.<sup>1</sup> The sources of bacteria in blood components include contamination from skin organisms at the phlebotomy site due to ineffective disinfection and skin plugs introduced to units during phlebotomy, transient bacteremias in donors, and rarely, contamination during handling and processing of components.

Prevention requires proper screening by the blood collection facility to avoid ill donors, selection of phlebotomy sites with attention to skin hygiene and scarring from prior donations, and scrupulous adherence to effective skin disinfection procedures. Techniques to inactivate pathogens in blood are in clinical trial, but currently are unavailable for routine use.

The Assessment of the Frequency of Blood Component Bacterial Contamination Associated with Transfusion Reaction (BaCon) project is a prospective study of the incidence of bacterial contamination conducted by the American Association of Blood Banks (AABB), the American Red Cross, the Armed Services Blood Program and the Centers for Disease Control and Prevention.<sup>2</sup> BaCon data suggest that the frequency of clinically-evident bacterial contamination in platelet units is 9-16 per million units, and the case fatality rate is 0.25-1/million units.<sup>3</sup>

Combined data from prospective studies in which blood components were cultured suggest that random donor platelet concentrates are contaminated at a rate of over 1 per 3,000 units, apheresis platelets at almost 1 per 800 and red cells at 1 per 50,000 (with a large variation between institutions).<sup>4</sup> These risks are 50- to 250-fold higher than the risk of transfusion-related infection per unit associated with HIV-1, HCV, HBV and HTLV-I/II. The data suggest that apheresis platelets carry a lower risk than pooled random donor platelets—presumably due to the reduced number of potentially-contaminated phlebotomies per therapeutic dose.

The variance between the contamination detected by culture and that detected by clinical events probably is due to the passive nature of surveillance, lack of consideration of the diagnosis and the lack of a standardized approach to evaluating instances of suspected transfusion-associated sepsis.

Nearly three-fourths of deaths due to bacterial contamination of blood components reported to the Food and Drug Administration are associated with the transfusion of platelets, and one-fourth with red cells.<sup>1</sup> Septic reactions associated with red cells may receive greater attention because the multiple confounding sources of fever and clinical sepsis in patients requiring platelet support obscure recognition of bacterial contamination events. The longer platelets are stored, the greater the risk of clinical sepsis. Fatalities most commonly are associated with gram-negative bacterial contamination, but gram-positive bacterial contamination of platelets also has been associated with lethal reactions. The medical literature during the past ten years is replete with case studies of apparent sepsis predominantly due to gram-positive bacteria from normal skin flora. To a lesser extent, gram-negative bacteria from transient bacteremia are implicated.<sup>1</sup> Skin organisms

### Prevention of Septic Reactions

- Conservative indications for transfusion must be disseminated and adhered to.
- Blood components—especially platelets—must not be transfused beyond expiration.
- Visual examination of blood components for abnormal appearance prior to issue (for example, cloudy or discolored plasma) may be of value on occasion and always should be performed.

### Recognition of Septic Reactions

- Symptoms and signs can include fever, hypothermia (may be delayed), rigors, tachycardia, hypotension or hypertension, and mental status changes. Shock and multiple organ dysfunction syndrome can occur.
- Nurses supervising transfusions should be familiar with procedures for recognizing and managing transfusion reactions and for collecting appropriate samples for bacterial evaluation when indicated.
- If bacterial contamination of a component is suspected, the transfusion must be stopped immediately. Institutional criteria for interrupting a transfusion must be explicit and adhered to.
- A diagnosis of bacterial contamination must be considered whenever a compatible clinical syndrome occurs in temporal proximity to transfusion.
- Initial treatment involves managing the hemodynamic consequences of toxemia and intravenous administration of antibiotics active against pathogens associated with bacterial contamination, both facultative gram-negative bacilli and *Staphylococcus* sp.

include, but are not limited to: *Staphylococcus aureus*, *Staphylococcus epidermidis*, *Micrococcus* sp., *Corynebacterium* sp., and *Bacillus* sp. Gram-negative organisms include, but are not limited to: *Yersinia enterocolitica*, *Pseudomonas fluorescens*, *Escherichia coli*, *Enterobacter aerogenes*, and *Salmonella* sp.<sup>5</sup> The frequency of bacterial contamination reported in studies examining platelets ranges from 0% to 10% depending on the study cited. The published studies differ significantly with respect to many factors, including blood product storage temperature, when the culture was taken, the volume cultured, culture media used, and incubation temperature.<sup>6</sup> Furthermore, some of the isolates commonly found in contamination studies (e.g., *Corynebacterium* sp. and *Propionibacterium acnes*) rarely are implicated in septic reactions. Finally, not all bacterial contaminants are clinically significant, especially when present in low numbers. Contamination studies that have quantitated bacterial isolates frequently report <10 CFU/ml in the blood products.

**Recognizing a Reaction.** Immediate recognition of a septic reaction caused by bacterially-contaminated components is critical to patient management. Symptoms and signs can include fever, hypothermia (which may be delayed), rigors,

tachycardia, hypotension or hypertension, and mental status changes. Shock and multiple organ dysfunction syndrome can occur. The diagnosis of bacterial contamination must be considered whenever a compatible clinical syndrome occurs in temporal proximity to transfusion. As an example, BaCon's clinical definition includes any of the following symptoms or signs within four hours of blood transfusion: fever (temp  $>39^{\circ}\text{C}$  or  $>2^{\circ}\text{C}$  rise from a pre-transfusion baseline), tachycardia (heart rate  $>120/\text{min}$  or  $>40/\text{min}$  rise from baseline), rigors, nausea and vomiting, shortness of breath (resp. rate  $>28$  breaths/min), lumbar pain, or rise or drop in systolic blood pressure ( $>30\text{mmHg}$  from baseline).<sup>2</sup>

**Treatment.** Initial treatment of the patient involves managing the hemodynamic consequences of toxemia and intravenous administration of antibiotics active against pathogens associated with bacterial contamination, both facultative gram-negative bacilli and *Staphylococcus* sp.

**Evaluation.** If bacterial contamination of a component is suspected during transfusion, the transfusion must be stopped immediately. The component should be examined for the presence of bacteria by gross examination and a microscopic stain of the bag's contents. The component and the patient's blood should be cultured for aerobic and anaerobic bacteria using sensitive blood culture systems. Red cell cultures should be done at  $37^{\circ}\text{C}$ ,  $25\text{--}30^{\circ}\text{C}$  and  $1\text{--}6^{\circ}\text{C}$ —allowing isolation of psychrophilic bacteria. The lowest of these may be omitted for platelets. Segments should not be used for culture because they can be falsely negative; a sample should be taken directly from the blood container. To identify the implicated component, platelet pooling procedures should include a requirement for retaining the primary bag for culture in the event of a reaction and recording the pooling sequence.

**Monitoring Platelet Concentrates for Contamination.** Monitoring platelets for contamination as they approach outdate is an attractive approach to prevention, for which approaches are used in some institutions or are under study. AABB has recommended that—at a minimum—institutions should evaluate if there is a need to implement an interim measure, and if so, determine if the institution has the capacity to implement such a measure.<sup>7</sup>

Staining and microscopic examination of a smear immediately prior to transfusion is likely to detect products with  $10^6$  or more organisms per mL.<sup>8</sup> Gram's stain, Wright's stain and acridine orange have been used. These are simple, rapid and inexpensive but insensitive—requiring the bacterial density to exceed  $10^5\text{--}10^6/\text{mL}$  for consistent detection.

Automated blood culture systems have been used to culture components and are both highly sensitive and widely available. Culturing on day 2 or 3 of storage would be expected to yield positive results concurrent with or before the bacterial concentration in the unit reaches a critical level.<sup>9</sup> As long as the culture remains negative at this time, the risk of significant bacterial contamination in the unit during transfusion should be minimal. One benefit of this approach is the potential of extending the shelf life of platelets subjected to such surveillance. While the expense and logistics of such an approach demand further analysis, it may be appropriate at institutions that identify significant rates of bacterial contamination.<sup>10</sup>

Changes in pH and glucose content in platelet units that usually accompany bacterial growth can be identified using urine and blood dipsticks.<sup>11</sup> These methods are simple, inexpensive, and rapid. Use of these chemical indicators would be expected to detect bacteria in the concentrations often seen toward the end of storage in a contaminated unit, so sensitivity is similar to staining.

The disappearance of platelet swirling may indicate a bac-

terially-induced pH drop and indicate the need for additional investigation for contamination. While observation for swirling is subjective, the sensitivity and specificity of this technique are similar to biochemical indicators of bacterial growth, and it requires no additional equipment.<sup>12</sup> Other devices for detecting bacterial growth at low concentrations are under development.

**Reporting.** Transfusion services and collection facilities must establish processes to assure that bacterially-contaminated products and associated adverse outcomes are reported appropriately.

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