Transfusion-associated Circulatory Overload or Degassing?

To the Editor:

Clifford *et al.*[1] presented a careful case-controlled study of 163 patients who underwent noncardiac surgery and met National Healthcare Safety Network or International Society of Blood Transfusion criteria for transfusion-associated circulatory overload (TACO). They identify emergency surgery, isolated fresh-frozen plasma, and mixed product transfusion along with increasing intraoperative fluid administration as risk factors for TACO.[1]

The term *TACO* carries the intuitive message that too much fluid/blood has been given. How the fluid is given may be equally important. As Varga *et al.*[2] point out, fluids stored at below body temperature release dissolved gas when warmed. Packed red blood cells and plasma hold more dissolved gas due to their lower storage temperature before intravenous administration. Using Henry's law, they calculated that fluid (saline) at room temperature and then raised to 37°C must outgas 4.7 ml/L, and fluids (packed red blood cells, fresh-frozen plasma) stored at 4°C must outgas 11 ml/L. Using a standard infusion system with a bubble trap, they infused fluids into a warm water bath and were able to collect less than half the gas anticipated to be released based on their calculation. The remaining unreleased gas is carried invisibly in the infusion stream. Prewarming of fluid reduced outgassing.

Conventional intravenous infusion systems pass fluids through a drip chamber. When conventional infusion equipment is manually pressurized to increase the speed of fluid administration, turbulent flow through drip chambers creates microbubbles that can be visualized by echocardiography. Adequate prewarming of fluids and venting of the outgassed bubbles can be facilitated by use of mechanical infusion devices (Hemonetics Rapid Infusion System, REF 400, Hemonetics, USA; Belmont Fluid Management System FMS 2000, Belmont Instrument Corp., USA). These devices are expensive and are used when massive blood loss is anticipated or demonstrated (liver transplantation, trauma, *etc.*). The accompanying editorial by Roubinian and Murphy[3] refers to work by Kor and colleagues (clinicaltrials.gov ID: NCT02094118) using washed blood to elucidate cytokine effects. It may be worth pointing out that washing of blood will at least partially degas stored blood.

The consequences of infusion of intravenous gas[4,5] can be difficult to distinguish from the TACO criteria.

Competing Interests

The author declares no competing interests.

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References

1. Clifford L, Jia Q, Subramanian A, Yadav H, Schroeder DR, Kor DJ: Risk factors and clinical outcomes associated with perioperative transfusion-associated circulatory overload. Anesthesiology 2017; 126:409–18
2. Varga C, Luria I, Gravenstein N: Intravenous air: The partially invisible phenomenon. Anesth Analg 2016; 123:1149–55
3. Roubinian N, Murphy EL: Adjusting the focus on transfusion-associated circulatory overload. Anesthesiology 2017; 126:363–5
4. Mirski MA, Lele AV, Fitzsimmons L, Toung TJ: Diagnosis and treatment of vascular air embolism. Anesthesiology 2007; 106:164–77
5. Ma K, Kahn SR, Hirsch AM, Akaberi A, Anderson DR, Wells PS, Rodger M, Solymoss S, Kovacs MJ, Rudski L, Shimony A, Dennie C, Rush C, Hernandez P, Aaron SD, Granton JT: N-terminal of prohormone brain natriuretic peptide predicts functional limitation one year following pulmonary embolism: Results from the ELOPE study. Thromb Res 2017; 153:47–9

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In Reply:

We thank Dr. Boucek for his insightful review of degassing as it relates to blood product transfusion and its clinical comparisons with transfusion-associated circulatory overload. Certainly, we acknowledge that the clinical diagnosis of transfusion-associated circulatory overload is one that remains a challenge for clinicians, both in real time and in retrospective clinical research. Indeed, this has been demonstrated by multiple authors in the field and has compounded the difficulties in studying this important transfusion-related complication.

As we learn with interest more about the intricacies and challenges associated with blood product transfusion, the concept of degassing is certainly relevant, and studies directly addressing this phenomenon would be a valuable contribution to the literature. Unfortunately, the present study is not able to effectively address the issue raised.

Once again, we thank Dr. Boucek for his thoughtful insights.

Competing Interests

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