Balloon pump–induced pulsatile perfusion during cardiopulmonary bypass does not improve brain oxygenation

To the Editor:

We read with interest the article by Kawahara and associates regarding the effects of pulsatile versus nonpulsatile perfusion on internal jugular venous oxygen saturation and regional cerebral venous oxygen saturation during normothermic cardiopulmonary bypass (CPB) in 22 patients.[1] They have concluded that when compared with nonpulsatile flow, pulsatile perfusion generated by an intra-aortic balloon pump had no beneficial effect on cerebral protection.

The authors stated that although many methods have been used to generate pulse pressure during CPB, no general definition and no criteria have been reported for pulsatile perfusion. In contrast, the literature reports that several investigators have attempted to establish a common criterion for pulsatile and nonpulsatile flow.[2-6] Shepard, Simpson, and Sharp[2] suggested that the energy equivalent pressure (EEP) formula may be used to quantify pulsatile and nonpulsatile waveforms. The generation of the pulsatile flow depends on the energy gradient rather than the pressure gradient. EEP contains both pump flow and arterial pressure waveforms. The following formula is used to define the EEP:

$$EEP = (\int fpdt)/(\int fdt)$$

where p is the arterial pressure, f is the pump flow, and dt is the change in time at the end of flow and pressure cycles. The units for EEP are millimeters of mercury. EEP is the ratio of the area under the hemodynamic power curve ($\int fpdt$) and the flow curve ($\int fdt$) at the end of flow and pressure cycles.

Recently, we have quantified pulsatile and nonpulsatile waveforms in terms of EEP.[7] With an identical pump flow rate and mean arterial pressure, the pulsatile roller pump (Stöckert SIII, Munich, Germany) generated significantly higher EEP than did conventional nonpulsatile perfusion. In addition, we have shown that this increase in EEP maintained higher regional and global cerebral, renal, and myocardial blood flow in a neonatal piglet model.[8] In a separate study with a different pulsatile roller pump (Jostra HL-20, Jostra USA, Austin, Tex), we have shown that regional cerebral venous oxygen saturation increased during normothermic and hypothermic CPB in a neonatal piglet model.[9] In this particular study, EEP was significantly higher than mean arterial pressure.

Our experience leads us to the conclusion that EEP is the most complete formula to quantify pulsatile and nonpulsatile waveforms for direct comparisons.

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Reply to the Editor:

We appreciate the interest and comments of Drs Ündar and Fraser. Several investigators[1] have tried to establish common criteria for pulsatile flow, but it is not clear which type of pulsatile waveform has positive effects on cerebral circulation and improves outcome of patients.[2] As stated by Ündar and associates,[3] it is impossible to compare the results of different investigations in which different types of pulsatility were used.

We can see that the concept of energy equivalent pressure introduced by Shepard, Simpson, and Sharp[4] is useful for understanding the quality of pulsatile perfusion. Wright[5] believes that hemodynamic considerations were fundamental to resolve the controversy of the pulsatility waveform. We hope that further clinical investigations will determine the best pulsatile form and will be supported by logical theories, such as energy equivalent pressure.

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Is the use of topical vancomycin to prevent mediastinitis after cardiac surgery justified?

To the Editor:

Patients undergoing cardiopulmonary bypass (CPB) are at substantial risk of acquiring infections because of the increased number of potential ports of entry of pathogens in the presence of CPB-induced impairment of immune responses.[1] Despite regular use of prophylactic intravenous antibiotics, postoperative mediastinitis occurs in 0.4% to 5% of patients undergoing cardiac operations.[1] This complication is associated with a 14% to 47% risk of in-hospital mortality.[1]

Gram-positive bacteria are the most common isolates from patients with mediastinitis; *Staphylococcus aureus* and *Staphylococcus epidermidis* are identified in 70% to 80% of cases.[1] In a prospective randomized controlled study, Vander Salm and associates[2] found that topical vancomycin applied during wound closure after median sternotomy was associated with a significant reduction in the rate of sternal wound infection. Although this study has not been repeated, its findings were accepted by a number of cardiac surgeons who have adopted the routine use of topical vancomycin powder to prevent mediastinitis after CPB (unpublished data).

The risk of vancomycin resistance has been a concern of those who have adopted this approach. However, 2 factors have supported the use of vancomycin for this purpose. First, the drug is instilled in a confined space, which prevents free movements of organisms in and out of the area at risk. Second, topical application of vancomycin was believed to result in insignificant serum levels. We have studied the pharmacokinetics of vancomycin powder instilled between the edges of the sternum during closure of the median sternotomy in 4 patients undergoing CPB. Contrary to the common belief that topical vancomycin powder is poorly absorbed, levels up to 4.4 mg/L were found in the patients' serum within 3 to 4 hours after topical application of 1 g of vancomycin powder (Fig 1).

Recent emergence of vancomycin resistance in methicillin-resistant *S aureus*[3-5] could raise doubts regarding the wisdom of continuing this approach. The first report of vancomycin resistance in methicillin-resistant *S aureus* occurred after a cardiac operation in a 4-month-old boy.[3] More recently, Smith and colleagues[4] have identified 2 more cases of *S aureus* with intermediate resistance to vancomycin. The mechanism of resistance, however, is not due to the acquisition of the feared *vanA* or *vanB* resistance genes that have been isolated from vancomycin-resistant enterococci.[5] *S aureus*–intermediate resistance to vancomycin is believed to be mediated by accumulation of cell wall components, with possible alternative vancomycin-binding pathways that divert vancomycin from its target site.

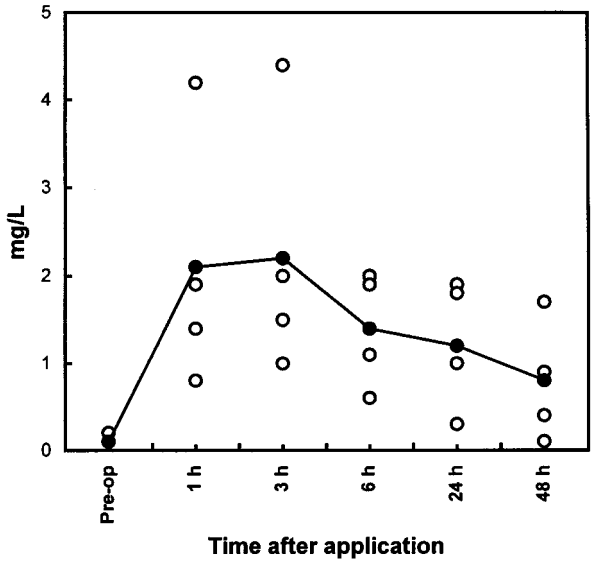

Fig 1. Vancomycin levels before and after instillation of 1 g of vancomycin powder between the sternal edges during wound closure. Vancomycin serum levels were measured before the operation and 1, 3, 6, 24, and 48 hours after instillation of vancomycin. The *solid line* represents the mean value of vancomycin levels in milligrams per liter obtained from 4 patients. The mean values are 0.1, 2.1, 2.2, 1.4, 1.2, and 0.8 mg/L, respectively.

We wish to debate this issue among the cardiothoracic surgeons and the experts in the field of antibiotic resistance. Such a debate will undoubtedly help to determine the risks versus the benefits of using topical vancomycin to prevent mediastinitis after median sternotomy.

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