

Commentary

It is generally acknowledged that ultrafiltering the cardiopulmonary bypass (CPB) perfusate is beneficial. Routine ultrafiltration during CPB, especially during rewarming before separation from CPB, has been widely practiced for decades. In the past several years, "modified ultrafiltration" has been recommended by some groups as a technique that has benefits beyond those of conventional ultrafiltration. The filtration process is the same in both conventional and modified ultrafiltration, the difference being that conventional ultrafiltration is performed during CPB and modified ultrafiltration is performed after separation from CPB.

Like most nonessential practices, modified ultrafiltration has its enthusiasts and its skeptics. It seems clear, nevertheless, that modified ultrafiltration does have certain benefits. This is hardly a profound conclusion, given the observation that filtration (of some variety) of the CPB perfusate has been widely used for many years. On the other hand, the modified ultrafiltration process can be cumbersome, or worse. More quantitative information than that which currently exists will be necessary before we can determine whether the benefits outweigh the risks.

The current dilemma can be characterized in the following way. Conventional ultrafiltration filters the CPB perfusate while the patient is still being supported by CPB. No additional extracorporeal circulation is necessary, and when the patient is separated from CPB, no additional maneuvers are required. Conventional ultrafiltration, therefore, is "invisible" to the surgeon. The distraction factor and the annoyance factor are both zero. Risk is essentially absent, and the surgeon can give full attention to addressing issues that are occasionally of critical importance in the immediate post-bypass period, such as physiologic stabilization of a patient whose condition is marginal or control of serious hemorrhage. Modified ultrafiltration filters the CPB perfusate in exactly the same way as conventional ultrafiltration, except the filtration process is performed after separation from CPB. The modified ultrafiltration process is a form of extracorporeal circulation, and there must be risks related to this second bypass run. Moreover, the surgeon must pay careful attention to the modified ultrafiltration process at a time when many other issues require attention.

It is not clear how much weight the surgeon should assign to each of these various competing factors when deciding whether or not to use conventional or modified ultrafiltration. Furthermore, it is not really a question of either/or. Probably the most important questions are how much incremental physiologic benefit does a

period of additional modified ultrafiltration provide to a given patient beyond that achieved with aggressive conventional ultrafiltration, and is that incremental benefit worth the added risk, distraction, annoyance, and delay that to some degree attend the modified ultrafiltration exercise. After all, if the same or nearly the same benefit can be obtained with the conventional technique, why bother? Each surgeon must come to his or her own decision. At the current time, the quantitative information necessary to make an informed decision in this regard is lacking. The necessary information can only be obtained through carefully designed clinical studies.

The study by Keenan and associates was designed to add to our understanding of modified ultrafiltration. It examines the effect of modified ultrafiltration on pulmonary function in a series of infants requiring cardiac surgery, an issue of some significance. Unfortunately, the study provides us with little data in support of modified ultrafiltration. The study shows that there were no differences in the change of either static or dynamic pulmonary compliance in both the control and the modified ultrafiltration groups, when examined before the operation, immediately after the operation, and 24 hours after the operation. Additionally, there were no differences between control and modified ultrafiltration groups when clinical outcome variables, such as time to extubation and length of intensive care unit stay, were examined.

One part of the analysis did demonstrate significant findings. Static and dynamic pulmonary compliance were both shown to improve when values taken immediately before the modified ultrafiltration period were compared with values taken immediately after the modified ultrafiltration period. The authors conclude that the modified ultrafiltration itself was the cause of this improvement. Unfortunately, these data are open to numerous interpretations. The values taken before modified ultrafiltration were measured immediately after separation from CPB. The values taken immediately after modified ultrafiltration were taken presumably about 30 minutes later, after a 20-minute period of modified ultrafiltration. Similar static and dynamic pulmonary compliance values were not taken at similar time points in the control group, leaving open to question whether the improvement in the modified ultrafiltration group was due to the filtration itself or to any one of a number of other rapidly changing variables that exist in the first hour after separation from CPB. During CPB, total lung collapse is present for up to several hours. Microatelectasis and macroatelectasis may gradually resolve in the early post-CPB period,

causing significant changes in serial measurements of static and dynamic pulmonary compliance during this period. Resolution of airway secretions, improvement in airway reactivity, partial removal of interstitial edema with positive airway pressure, and fluctuating amounts of intrapleural fluid collections could equally well explain serial changes in pulmonary compliance in the first hour after CPB.

Additionally, as in many of the other studies examining the potential benefits of modified ultrafiltration, the control group consists of patients undergoing no ultrafiltration whatsoever. Given the widespread use of conventional ultrafiltration, it would seem that the most pertinent comparisons would be obtained if con-

ventional ultrafiltration were used in the control group.

In the final analysis, the study by Keenan and colleagues does not provide a better understanding of the effects of modified ultrafiltration on pulmonary function in infants, and in the bigger picture we are no further along in our knowledge with respect to whether modified ultrafiltration is really worth the effort, especially when conventional ultrafiltration is aggressively performed as the alternative strategy.

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