the conclusion of increased hemodilution severity is CPB based. If the data are reanalyzed on the basis of the difference between preoperative and postoperative CPB hematocrits, it may be more important that a decrease in hematocrit of more than approximately 10% during bypass is associated with a worse prognosis than discrete values.

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doi:10.1016/j.jtcvs.2003.09.059

Reply to the Editor:

We thank Dr Shuhaiber for his interest in our recent article in the *Journal*.¹ We are encouraged that he concurs with us that low extremes of hematocrit during cardiopulmonary bypass (CPB) should be avoided and that the strong associations we reported between excessive hemodilutional anemia during bypass and adverse patient outcomes argue for a prospective study. He also requested methodologic clarifications and presented several comments that are worthy of addressing.

Our 5000-patient CPB retrospective series¹ (1994–2000) reflects a population in whom asanguinous rather than blood prime fluid was used. In a very small fraction of patients (anemic patients with low red blood cell volume), blood may have been added to the prime at the onset of CPB. These are included as intraoperative transfusions. Aprotinin was used relatively infrequently (<7%), and we believe it had little bearing, if any, on the reported findings. Standard intraoperative cell-saving methods were used routinely, and saved cells were returned to patients during or immediately after CPB. Hemoconcentration during CPB was used in 16% of patients.

Perioperative blood-loss amounts were not prospectively documented in our database and were not reported. Alternatively, excessive bleeding requiring re-exploration (Figure 1 and Table 4 of reference 1) and transfusions (Figure 3 and Table 4 of reference 1) were reported.¹ The “transfusion trigger” was not rigidly controlled during the 7-year period of this retrospective series, and this threshold may have varied slightly among surgeons and depended on the patient age and clinical status. We believe, however, that these variations do not diminish the clear and obviously strong relationship between nadir CPB hematocrit and transfusion rates (Figure 3 of reference 1).

As we reported,¹ low pre-CPB hematocrit is an important predictor of increased hemodilution during standard CPB (Table 2 of reference 1), but a history of congestive heart failure (documented in ~9% of patients in this series) is not. Notably, patients with acute heart failure that is associated with anemia as the result of compensatory plasma volume expansion almost never undergo operation in our practice. Such patient conditions are usually medically reversed before surgery. Alternatively, intraoperative fluid infusions by anesthesia and preoperative blood donation may lead to substantial plasma volume expansion that can contribute to the extent of hemodilution during CPB and should be carefully considered.

Dr Shuhaiber refers to the randomized prospective study by Puskas and colleagues,² which compares off-pump and on-pump bypass operations in 200 patients and states that the role of intraoperative hematocrit in off-pump CABG is minimal

because little or no differences in outcomes are reported. In responding to this point, it is important to note that off-pump and on-pump CABG procedures are different in many ways, one of which is hemodilution as the result of mixing the patient's blood with prime fluid. Although it is true that Puskas and colleagues reported generally similar in-hospital and 30-day mortalities, their data partially support several of our findings.¹ Indeed, they reported less hemodilution, less transfusion requirements, less coagulopathy, earlier extubation, decreased hospital stays, and less myocardial injury (cardiac enzyme levels) for their patients undergoing off-pump CABG versus on-pump CABG. These results are all in concert with our findings. The fact that no significant differences in other important outcome measures (including mortality) were found may be partially attributable to the size of the series.

For the 3,800 isolated patients undergoing CABG in this series, the mean number of grafts per patient was 3.1 ± 1.0 . Moreover, as we report in *Results*¹ on page 1441, operative mortality (defined as in hospital or out of hospital within 30 days of surgery) for isolated CABG was 2.4% (90/3800), a rate slightly lower (rather than higher) than that cited by Dr Shuhaiber in the CABG series.³ The 3.6% operative mortality that he reports reflects the overall rate for all 5,000 patients, including patients undergoing valve and combined CABG and valve operations.

As we stated in our article,¹ late mortality follow-up was based on queries of the Social Security Death Index Database, in which the cause of death is not available; thus we could not report the relationship between hematocrit on CPB and late cardiovascular death. Nonetheless, Dr Shuhaiber's questions about whether graft failure in CABG is linked to the extent of hemodilutional anemia or transfusions is clearly important and worthy of separate future investigation that is well outside the scope of our study.

Intuitively, Dr Shuhaiber's proposition that the decrease in hematocrit should be used as the independent (or predictor) variable rather than the actual low hematocrit is appealing. However, the extent of hemodilution on CPB is multifactorial, as we reported in Table 2.¹ Also, our¹ and DeFoe's⁴ data clearly demonstrated that a decrease of 10% or 15% in hematocrit is

different in patients with pre-CPB hematocrits of 30% as opposed to 40%. Another advantage of this approach is that it provided a means of objectively identifying a threshold for how low nadir hematocrits may be tolerated according to outcome data.

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Microfibrillar collagen hemostat in cardiac surgery

To the Editor:

The September 2003 article of Şırlak and associates¹ extolled the virtues of microfibrillar collagen (MC) as a hemostatic agent. Studies by our own group support the conclusion that this compound is highly effective in cardiac surgery.² However, I must sound more than a word of caution.

When in the early 1980s we have applied MC frequently in the course of heart operations, we encountered cases of unexplained brain injuries. Because we suspected MC as the culprit, the substance was subjected to extensive in vitro and in vivo investigation. We found that MC-containing shed blood, if returned to the circulation by either pump-suction or cell-salvage devices, may readily pass 40-mm pore-size filters and lodge in vital organs, including the brain.³

For this reason, we have recommended that blood contaminated by MC should not be reused. Once MC has been applied, only waste suction should be applied to handle shed blood.

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ing devices. *J Thorac Cardiovasc Surg.* 1986;92:766-70.

doi:10.1016/j.jtcvs.2003.11.068

Reply to the Editor:

Despite the use of filters with a pore size of 20 µm, the combined use of intraoperative autotransfusion and microfibrillar collagen hemostats creates a potential risk for embolization.¹ It has been shown that this risk can be significantly reduced by use of appropriate currently available blood transfusion filters.² Despite this reduction, we share the concern of Dr Robicsek that this substance could pass through different blood-collecting circuits, which could lead to organ damage by either direct or induced embolization, even with the use of commercially available filters.³ For this reason we applied microfibrillar collagen after heparin was neutralized by protamine, and it was not reintroduced into the patient circulation. Moreover, as we stressed in the Methods section, shed mediastinal blood was not transfused into any patient.

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