Kidney Medicine

Peritoneal Dialysis After Cardiac Surgery: Time for a Change of Heart

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Patients receiving maintenance dialysis face cardiovascular mortality rates 20 times higher than those of the general population, and a large proportion will require some form of surgical cardiac intervention.[1] These patients

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are at high risk for adverse events. A review of 16 articles investigating outcomes of patients receiving dialysis undergoing cardiac surgery, defined as coronary artery bypass grafting (CABG) or valve replacement, found that dialysis patients had a 3-fold risk of in-hospital mortality, higher rates of complication, and longer lengths of stay compared with the general population.[2]

With changes in dialysis reimbursement aimed at incentivizing the use of home dialysis over center-based dialysis coupled with the recent Advancing American Kidney Health Initiative executive order that set a goal of having 80% of new patients treated with home-based dialysis or kidney transplantation by 2030, a growing number of US patients in need of cardiac surgery will be receiving peritoneal dialysis (PD). Historically, there have been concerns on the part of surgeons, nephrologists, intensivists, and cardiologists that patients receiving PD, compared with those receiving hemodialysis (HD), are at increased risk of postcardiac surgery complications, such as inadequate volume control, perioperative bleeding, pericardial effusions, and sternal wound infections. The following question is often raised: should we be converting our patients receiving PD to HD perioperatively in an effort to minimize their risk of these postoperative adverse outcomes?

In this issue of *Kidney Medicine*, Bassil et al[3] indirectly tackle this question by conducting a single-center retrospective analysis of 590 patients receiving maintenance dialysis who underwent CABG and/or valve replacement at the Cleveland Clinic between October 2009 and October 2019. Their objective was to determine whether the 62 patients receiving PD had better outcomes than the 528 receiving HD. Notably, the PD cohort had a lower prevalence of heart failure and history of prior CABG and less time on cardiopulmonary bypass during surgery, while having a higher prevalence of dyslipidemia compared with their HD counterparts. Patients receiving PD were also more likely to have had a CABG (39% vs 25%) and less likely to have valve-only surgery (32% vs 49%). Elective surgery was slightly more common in the PD cohort. Patients receiving PD were admitted for a shorter period before surgery compared with patients treated with HD (median 2 days vs 5 days). The median postoperative length of stay was similar in both groups.

Bassil et al[3] found no differences between the PD and HD cohort with regards to the primary outcomes of in-hospital death (2% vs 5%, $P = 0.51$) or 30-day survival (98.2% vs 95.7%, $P = 0.30$). Furthermore, a lower proportion of patients receiving PD (1.6% vs 14.2%, $P = 0.005$) experienced the composite outcome composed of 4 in-hospital events (death, cardiac arrest, pericardial effusion, and sternal wound infection). However, in stratified analyses, this difference appeared driven by patients who underwent combined CABG and valvular surgery and among those with heart failure. There were no statistically significant differences in the length of stay, time in the intensive care unit, number of intraoperative packed red blood cell transfusions, sepsis, or each individual postsurgical complication (pericardial effusion, gastrointestinal bleed, cardiac arrest, and sternal wound infection).

This study builds on the limited and conflicting existing literature on the association of dialysis modality with outcomes after cardiac surgery. Previous studies, similar to the current report from Bassil et al,[3] found no additional harms associated with PD compared with HD. In one of the earlier studies on the topic, Kumar et al[4] retrospectively compared the perioperative outcomes and 2-year survival among patients receiving PD and HD who underwent CABG, valve replacement, or both between 1994 and 2008 at a single US center. They matched 36 patients receiving PD with 72 patients receiving HD based on age, diabetes status, and Charlson comorbidity index and found no difference in the 2-year survival between the 2 groups. However, patients receiving HD did have a statistically significant higher incidence of postoperative complications (infection, prolonged intubation, and death) compared with patients receiving PD (50% vs 28%, $P = 0.05$). However, given the small sample size, the authors cautiously concluded that patients receiving PD did not experience a higher risk of early complications or lower 2-year survival. Similarly, Bäck et al[5] studied a cohort of 30 patients receiving PD and 106 receiving HD who underwent either CABG or valve surgery from 1998 to 2015 in 2 regions of Denmark and found no difference in 30-day, 1-year, or 5-year mortality rates.

In contrast, a retrospective analysis by Zhong et al[6] explored outcomes of dialysis patients who underwent CABG at a single Canadian hospital between 1997 and 2006. Only 1 of the 65 patients receiving HD (1.5%) died compared with 7 out of the 40 patients receiving PD (17.5%). Among the patients receiving PD, one died of gastrointestinal bleeding, 2 died of sepsis, and 3 died of vascular causes. Notably, 6 of the 7 patients receiving PD

who died were converted to HD before they died; however, the reasons for conversion was not clear. A more contemporary study by Li et al[7] also found a higher risk of death for patients receiving PD. Among 12 patients receiving PD and 122 receiving HD who underwent a CABG between 2005 and 2015 at a single center in Taiwan, patients receiving PD had greater in-hospital mortality (58% vs 15%) and lower 1-year survival (33% vs 57%) rates compared with patients receiving HD. The major cause of death among PD patients was septic shock. Of the 7 patients receiving PD who died, 5 had been transitioned to HD, although again the reason for transfer was not stated.

It bears repeating that all of these previous studies were even more limited in power than the current study by Bassil et al,[3] with no more than 40 and as few as a dozen patients receiving PD. This restricted the number of variables that could be adjusted for, leaving much room for residual confounding, which might explain the discrepancy in the findings among these studies. Notably, except for the Danish study, all these cohorts were drawn from a single center. Some of these centers, such as the center in the study by Zhong et al[6] in Toronto, tend to treat patients receiving PD who are frailer than the PD population in the United States, which may explain the difference in study outcomes. As the PD population grows in the United States and includes patients with more severe frailty, similar differences in outcomes might be seen that may be due to preexisting conditions rather than the dialysis modality chosen. System-wide differences in processes of care and familiarity with patients receiving dialysis, particularly those receiving PD, could also potentially be a major driver of the differences seen in the outcomes of these varied studies conducted in different institutions in different countries.

What then should we make of the theoretical concerns regarding PD after cardiac surgery? The first concern is that of insufficient ultrafiltration leading to volume overload; however, the ultrafiltration volumes that can be achieved using 4.25% dextrose solutions can match that of 24-hour continuous venovenous HD.[8] Moreover, similar to continuous kidney replacement therapy, the continuous rate of PD ultrafiltration often allows for maintenance of hemodynamic stability, an important consideration in postcardiac surgery patients. One of the complications of interpreting these studies is that they do not differentiate between patients who receive intermittent HD versus continuous venovenous HD or hemodiafiltration. PD also avoids the need for central venous access, which may be important in reducing the risk of postoperative bacteremia and endocarditis, particularly among those undergoing valve surgery. PD avoids the need for systemic anticoagulation, which may also be particularly useful in cases of significant postoperative bleeding. Critically, it is difficult to understand how well patients receiving PD are being managed. Staff less familiar with PD may not be able to reliably deliver PD around the clock, limiting the potential ultrafiltration that could be achieved.

Another concern, particularly for a postsurgical patient, is the possibility of higher levels of "azotemia" often seen in patients receiving PD compared with HD, leading to a higher risk of bleeding. This was not borne out in the study by Bassil et al[3]; however, the outcome of blood transfusions were too low to draw any firm conclusions. Still, it is worth considering that there is a potentially higher risk of blood loss among patients receiving HD from circuit clotting or from bleeding vascular accesses.

Physicians may also fear an increased risk of mediastinitis in patients receiving PD post-CABG owing to bacterial translocation from the dialysate into the mediastinum.[9] However, there are no reported episodes of post-CABG mediastinitis in patients receiving PD. This is further underscored in the current study by Bassil et al[3] in which none of the PD patients developed a sternal wound infection. In fact, the only episodes of sternal wound infection in this patient population occurred in patients receiving HD, similar to prior studies.[10] Moreover, although the development of a pericardial effusion is a known potential consequence of cardiac surgery, there is no evidence that the development of a peritoneopericardial communication is enhanced after cardiac surgery. In fact, as was the case with sternal wound infections, none of the in-hospital effusions seen in the study by Bassil et al[3] occurred in patients receiving PD.

An important consideration for PD patients who underwent cardiac surgery in the studies cited is the rate of conversion to HD and PD-related complications. In the study by Bassil et al,[3] 16 of the 62 patients receiving PD (26%) converted to HD postoperatively. One-quarter of those cases were due to surgeon's preference. The remaining cases were due to a combination of catheter malfunction (n = 3), cardiac tamponade (n = 1), hemodynamic instability (n = 7), and gadolinium exposure (n = 1). In the analysis presented by Kumar et al,[4] 2 patients (5.6%) converted to HD, 1 because of dialysate leakage and another for "uncontrolled azotemia." Finally, in the PD cohort of the study by Zhong et al,[6] there were 4 episodes of dialysate leakage and 5 cases of peritonitis. Few of these reasons are absolute indications for conversion to HD. The exception might be dialysate leakage, for which the common practice of holding PD temporarily may not be feasible for fear of precipitating volume overload. In the hands of teams less experienced with PD, however, the other complications might seem daunting and prompt a rapid change in modality. For example, it is unclear whether in the cases of PD catheter malfunction there was troubleshooting to clear the bowels, reposition the catheter, or place a new catheter percutaneously, which would not require general anesthesia. For uncontrolled "azotemia," a nebulous entity, we do not know whether an attempt was made to change the prescription to maximize clearance. In the case of peritonitis, it is unusual to have to convert the patient to HD except in rare cases, such as refractory, relapsing, or fungal peritonitis. It is reasonable to speculate that unfamiliarity with prescribing PD may have precipitated many of these conversions to HD.

Physicians should recall the advantages of avoiding HD. HD vascular access thrombosis and other HD-related complications were observed and reported in the study by Bassil et al.[3] PD allows the patient to minimize blood loss by avoiding directly accessing the bloodstream. Keeping the patient on PD also prevents insertion of a central venous HD catheter, a device that puts the patient at higher risk of bacteremia, which is particularly concerning for someone who has just received a new valve.

Coronary artery disease remains the leading cause of morbidity and mortality in patients receiving maintenance dialysis. Therefore, a significant proportion of these patients will require some form of cardiac surgery during their lifetime. Arbitrarily converting patients who are stably receiving PD to HD because of a provider's preference or a perceived, unsubstantiated risk of adverse events associated with PD is not in patients' best interests. With an increasing focus on patient preference and education when deciding on dialysis modality, we should be doing everything we can to honor patient choice. This includes better educating hospital staff around proper management of patients receiving PD. Although there are circumstances in which modality conversion is medically necessary, presumptive conversion should not be the course of action, and this study adds to a growing body of evidence supporting this position.

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