A 62-year-old woman with a history of lung cancer, prior surgical aortic valve replacement with a 23-mm Hancock (Medtronic, Inc, Minneapolis, MN) porcine valve, and non-ischemic cardiomyopathy supported with a HeartMate II destination therapy left ventricular assist device (LVAD; Thoratec Corporation, Pleasanton, CA) presented with hemolytic anemia (hemoglobin, 6.8 g/dL; lactate dehydrogenase, 1536 U/L) because of LVAD thrombosis and severe insufficiency of the 23-mm Hancock bioprosthetic valve (Figure 1; Movie I in the Data Supplement). Given her comorbidities and multiple prior sternotomies, she was felt to be a poor candidate for combined redo-surgical aortic valve and LVAD replacement via another sternotomy. Peripheral vascular disease precluded transfemoral transcatheter aortic valve replacement (TA VR). Therefore, it was decided that she would be best treated with concomitant redo-surgical aortic valve and LVAD replacement via another sternotomy.

A 5-cm incision was made below the lateral two thirds of the right clavicle to access the right axillary artery, and a 6-mm Dacron graft anastomosed to the axillary artery in an end-to-side manner to be used for cardiopulmonary bypass inflow with the side graft technique. A second incision inferior to the breast covered the apical inflow cannula was removed to expose the Dacron inflow graft of the Heartmate II LVAD. Percutaneous right femoral venous access was obtained, and a 25F Bio-Medicus multistage venous cannula (Medtronic, Inc, Minneapolis, MN) advanced into the right atrium/proximal superior vena cava junction under fluoroscopic guidance. The outflow graft of the LVAD was unscrewed from the pump and then occluded with a 30-mm Coda balloon catheter (Cook Medical, Bloomington, IN; Figure 1). The Dacron inflow graft of the LVAD was divided and clamped and the LVAD pump removed. Because of the short length of the inflow graft, a 12-mm knitted Dacron graft was anastomosed end-to-end to the inflow graft to provide additional working length in which to place a 26F transcatheter heart valve delivery sheath (Figure 2). Use of this Dacron graft extension allowed the graft to be punctured on its anterior surface and serially dilated for large bore sheath placement with minimal blood loss, essentially identical to the standard Seldinger technique used for a native artery. The Edwards 26F Ascendra delivery sheath (Edwards Lifesciences Corporation, Irvine, CA) was then advanced through the Dacron conduit (Figure 3A and 3B) and LVAD inflow cannula into the left ventricular mid-cavity under fluoroscopic guidance (Figure 4).

Next, the 23-mm Edwards SAPIEN valve (Edwards Lifesciences Corporation, Irvine, CA) mounted on its delivery sheath (Edwards Lifesciences Corporation, Irvine, CA) was advanced into the right atrium just proximal to the right atrial appendage under fluoroscopic guidance (Figure 5; Movie II in the Data Supplement). There was trivial central aortic insufficiency and no paravalvular leak (Figure 6; Movie III in the Data Supplement).

Next, the old inflow graft and titanium inflow cannula were removed and the new pump and inflow cannula inserted. Notably, the silastic apical sewing ring from the original Heartmate II implant was left on the heart, and the new inflow cannula was inserted into the old silastic ring and secured with multiple heavy silk ties. Finally, the Coda balloon catheter was removed from the old outflow graft, and the old outflow graft was screwed onto the new Heartmate II pump as we have described previously.

Immediate postoperative transesophageal echocardiogram (Movie IV in the Data Supplement) revealed no aortic valve insufficiency (Figure 7) on full LVAD support. She did well postoperatively, had resolution of her hemolytic anemia, and was discharged 15 days later.

Discussion
This case is the first report of using an existing LVAD inflow cannula to deliver a transcatheter heart valve. There are previous reports of patients either undergoing LVAD implantation or who have had existing LVADs receiving TAVR. However, the vascular access for TAVR has been either transfemoral or transapical.
adjacent to the existing LVAD. Because of the need to exchange the LVAD in this patient, we felt that a combined procedure using the existing inflow cannula as a conduit would be the most feasible route for TAVR. Although the large bore and short working length of the inflow graft posed a challenge, this was overcome by sewing a Dacron graft extension to the end of the inflow cannula. Furthermore, there was good alignment of the LV apical inflow cannula with the left ventricular outflow tract, enabling proper positioning of the TAVR sheath and valve. We think that the novel access method presented herein using the existing in situ LVAD inflow cannula for transcatheter heart valve delivery will provide another useful technique in the armamentarium of practitioners dealing with this challenging clinical problem.

Disclosures
Dr Hughes is a paid consultant for W.L. Gore and Associates and Medtronic. Dr Milano is a paid consultant for Thoratec Corporation. Dr Harrison receives research funding from Edwards Lifesciences and Medtronic. The other authors report no conflicts.

References

Key Words: anemia, hemolytic ▶ aortic valve insufficiency ▶ aortic valve stenosis ▶ heart failure ▶ heart valve prosthesis implantation ▶ thoracic surgery

Figure 1. Intraoperative aortogram showing severe bioprosthetic aortic valve insufficiency. Note the Coda occlusion balloon in the left ventricular assist device (LVAD) outflow cannula (**), LVAD inflow cannula (*) through which the Amplatz Extra Stiff wire can be seen traversing the porcine aortic valve, percutaneous venous cardiopulmonary bypass cannula (arrow), and temporary transvenous pacemaker in the right ventricle (arrowhead).

Figure 2. Twelve-millimeter Dacron graft (arrow) anastomosed end-to-end to the existing left ventricular assist device inflow graft to provide additional working length for large bore sheath placement for transcatheter aortic valve replacement.

Figure 3. A, Transcatheter heart valve delivery sheath of 26F (arrow) placed into the Dacron graft extension (*) as a conduit to the left ventricle. B, Close-up view demonstrating the Edwards Ascendra sheath traversing the anterior surface of the Dacron conduit into the left ventricle.
Figure 4. Positioning of the 23-mm Edwards SAPIEN transcatheter heart valve within the degenerated surgical bioprosthetic aortic valve.

Figure 5. Deployment of the 23-mm Edwards SAPIEN transcatheter heart valve within the Hancock surgical valve.

Figure 6. Aortogram following valve-in-valve transcatheter aortic valve deployment showing the absence of any significant valvular or paravalvular aortic insufficiency.

Figure 7. Short-axis transesophageal echocardiogram following valve-in-valve transcatheter aortic valve deployment showing the absence of any significant valvular or paravalvular aortic insufficiency.
Transcatheter Aortic Valve Replacement Performed via Left Ventricular Assist Device
Inflow Cannula
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