The Year in Cardiothoracic and Vascular Anesthesia: Selected Highlights From 2010

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The aortic valve treatment revolution continues with the maturation of aortic valve repair and the dissemination of transcatheter aortic valve implantation. The recent publication of comprehensive multidisciplinary guidelines for diseases of the thoracic aorta has assigned important roles for the cardiovascular anesthesiologist and perioperative echocardiographer. Although intense angiotensin blockade improves outcomes in heart failure, it might further complicate the maintenance of perioperative systemic vascular tone. Ultrafiltration as well as intensive medical management guided by the biomarker brain natriuretic peptide improves outcomes in heart failure. Continuous-flow left ventricular assist devices have further improved outcomes in the surgical management of heart failure. Major risk factors for bleeding in the setting of these devices include advanced liver disease and acquired von Willebrand syndrome. The metabolic modulator perhexiline improves myocardial diastolic energetics to achieve significant symptomatic improvement in hypertrophic cardiomyopathy. A landmark report was also published recently that outlines the major areas for future research and clinical innovation in this disease. Landmark trials have documented the outcome importance of perioperative cerebral oxygen saturation monitoring as well as the outcome advantages of the Sano shunt over the modified Blalock-Taussig shunt in the Norwood procedure. Furthermore, the development and evaluation of pediatric-specific ventricular assist devices likely will revolutionize the mechanical management of pediatric heart failure. A multidisciplinary review has highlighted the priorities for future perioperative trials in congenital heart disease. These pervasive developments likely will influence the future training models in pediatric cardiac anesthesia.

Key words: aortic valve, aortic valve repair, transcatheter aortic valve implantation, thoracic aorta, guidelines, endovascular aortic repair, aortic dissection, aortic aneurysm, heart failure, ventricular assist device, angiotensin, ultrafiltration, natriuretic peptide, model for end-stage liver disease, von Willebrand syndrome, hypertrophic cardiomyopathy, perhexiline, metabolic modulator, cerebral oxygen saturation, near-infrared, spectroscopy, Norwood procedure, Sano shunt, Blalock-Taussig shunt, congenital heart disease, perioperative management

THIS ARTICLE IS the third in the annual series for the *Journal of Cardiothoracic and Vascular Anesthesia*.[1,2] The authors thank Dr Kaplan for the opportunity to continue this series, namely the research highlights of the year that pertain to the specialty of cardiothoracic and vascular anesthesia. The introduction of this article will outline the major themes selected for 2010, each of which is then reviewed in detail in the main body of the article.

The literature highlights in cardiothoracic and vascular anesthesia for 2010 begin with the rapid advances in management of diseases of the thoracic aorta. The aortic valve treatment revolution continues with the maturation of aortic valve repair that is likely to disseminate as a surgical standard of care as has been the evolution in mitral valve repair. Furthermore, in high-risk patients with aortic stenosis, transcatheter aortic valve implantation (TAVI) is now an established therapeutic option. The endovascular revolution contributed significantly to the development and recent publication of comprehensive multidisciplinary guidelines for diseases of the thoracic aorta. The roles of the cardiovascular anesthesiologist and perioperative echocardiographer feature prominently in these landmark guidelines. The role of endovascular intervention likely will contribute significantly to the evolving classifications and management options of thoracic aortic diseases.

Advances in the management of heart failure have been both medical and surgical. Although more intense angiotensin blockade improves outcomes in heart failure, it might further complicate the maintenance of systemic vascular tone in the perioperative period. Ultrafiltration is a promising alternative to

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pharmacologic diuresis for the management of volume overload in chronic heart failure. It is also clear that intensive medical management of heart failure guided by the biomarker brain natriuretic peptide improves overall survival.

A major recent surgical advance in the management of heart failure has been the significant improvement in clinical outcome shown with continuous-flow left ventricular assist devices (LVADs) as compared with pulsatile-flow devices. Furthermore, advanced liver disease, as reflected by the model for end-stage liver disease (MELD) score, is a significant predictor for perioperative bleeding, transfusion, and mortality after ventricular assist device insertion. Acquired von Willebrand syndrome is not only common in patients with these devices but is frequently an aggravating factor in bleeding requiring transfusion in this setting.

The integrated management of hypertrophic cardiomyopathy (HCM) has continued to evolve. A major recent breakthrough was the demonstration that the metabolic modulator perhexilene improves myocardial diastolic energetics to achieve significant symptomatic improvement in HCM. A landmark report was also published recently that outlines the major areas for future research and clinical innovation in this disease. Given these developments, it is likely that significant progress in the management of cardiomyopathy will ensue.

The perioperative management of congenital cardiac disease has witnessed major milestones in the last year. Landmark trials have documented the outcome importance of perioperative cerebral oxygen saturation monitoring as well as the outcome advantages of the Sano shunt over the modified Blalock-Taussig (MBT) shunt in the Norwood procedure. Furthermore, the development and evaluation of pediatric-specific ventricular assist devices likely will revolutionize the mechanical management of pediatric heart failure. Besides all this progress, a recently published multidisciplinary landmark review has highlighted the priorities for future perioperative trials in congenital heart disease. These pervasive developments likely will influence the future training models in pediatric cardiac anesthesia.

The themes selected for this third highlights article only have sampled the advances in the specialty for 2010. If all the significant articles had been included, indeed this review could be developed into a yearbook. Many significant advances in 2010 also have been discussed in the Expert Review section of the *Journal*.

ADVANCES IN MANAGEMENT OF DISEASES OF THE THORACIC AORTA

The Aortic Valve

The aortic valve treatment revolution has 2 major components; namely, aortic valve repair and TAVI. Both these innovations have developed as the understanding of the aortic valve has matured, analogous to the mitral valve paradigm that has been championed by Carpentier and that has evolved into a standard of care in the last 25 years.[3]

Aortic valve repair has developed in response to the clinical imperative to enhance freedom from prosthetic valve complications in the younger patient with surgical aortic regurgitation because of conditions such as bicuspid aortic valve and Marfan syndrome.[4] The El Khoury group based in Brussels has developed a systematic approach to aortic valve repair with a classification of aortic regurgitation based on leaflet mobility within the functional aortic annulus.[5] This classification has integrated the Yacoub remodeling and the David reimplantation aortic root techniques for surgical reconstruction of the dilated aortic root, which typically results in type-I aortic insufficiency characterized by normal leaflet mobility. The further principles of this aortic valve paradigm have been reviewed in detail in a separate expert review for this journal.[5] The El Khoury group also has shown very recently that the techniques of systematic aortic valve repair also apply to bicuspid aortic valves and the failing pulmonary autograft (neoaortic root) after the Ross procedure.[6,7] Analogous to mitral valve repair, comprehensive intraoperative transesophageal echocardiography (TEE) provides pivotal data to guide surgical decision-making in aortic valve repair.[3,5,8] This makes the intraoperative echocardiographer a crucial consultant in the practice of aortic valve repair.[9] The surgical preservation of the aortic valve is likely to disseminate globally and evolve into a standard of care over the next decade.

The TAVI revolution has been described thoroughly earlier in 2010 in a series of detailed review articles.[10,11] Recent case series point out the feasibility of conscious sedation and noninvasive ventilation as an anesthetic option in TAVI.[10-13] Furthermore, the superiority of TEE over computed tomography scanning recently has been shown for the assessment of aortic annulus before TAVI.[14] In this TAVI cohort (N = 187), TEE had superior inter- and intraobserver reliability for aortic annular measurements when compared with computed tomography scanning. Transthoracic echocardiographic measurements changed the implantation strategy in 15.5% of patients without increasing procedural complications.[14] Although there is currently no gold standard for aortic annular measurement in TAVI, transesophageal echocardiographic measurements provide accurate data to guide valve sizing before implantation.[15] Balloon valvuloplasty of the diseased native aortic valve can also complement TEE for clinically adequate sizing of the aortic annulus.[16] Just as in the conduct of aortic valve repair, skilful TEE renders the intraoperative echocardiographer an essential member of the TAVI team.

The evolution of TAVI in patients with aortic stenosis who are judged to be too high risk for conventional aortic valve replacement will have to take into account that current scoring systems may significantly overestimate perioperative risk in this patient cohort.[17,18] Although a recent systematic review showed that TAVI should be restricted to high-risk patients, a landmark randomized controlled trial recently showed that TAVI is significantly superior to the medical management of severe aortic stenosis in patients judged to be at an excessive risk for conventional aortic valve replacement.[19,20] In this trial (N = 358: 21 participating centers), the primary end-point was all-cause mortality at 1 year.[20] As compared with medical management including balloon aortic valvuloplasty, TAVI significantly reduced the incidence of the primary endpoint (30.7% *v* 50.7%; hazard ratio = 0.55; 95% confidence interval, 0.40-0.74; $p < 0.001$). When the primary endpoint was considered with the risk of hospitalization, TAVI also significantly reduced the risk of this composite outcome (42.5% *v* 71.6%; hazard ratio = 0.46; 95% confidence interval, 0.35-0.59; $p <$