Outcomes of Heart Transplantation in Small Children Bridged With Ventricular Assist Devices

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Background. Ventricular assist devices (VADs) have been used with increasing frequency to bridge small children to heart transplantation (HTx), but outcomes in large cohorts are not well established.

Methods. Small children (≤10 kg) bridged to HTx with VADs between 2004 and 2010 were identified in the United Network for Organ Sharing database. Survival was modeled using the Kaplan-Meier method, and 2:1 propensity matching was used to compare outcomes with a well-matched control cohort of nonbridged HTx recipients.

Results. Of the 803 small children who underwent HTx during the study period, 59 (7%) were bridged with a VAD. The proportion of recipients that were bridged with a VAD increased from 3% in 2004 to 9% in 2010 (p = 0.03). Kaplan-Meier 30-day, 6-month, and 1-year survival was comparable between those bridged with a VAD and 118 well-matched nonbridged children. Rates of postoperative renal failure, reoperation, infection, and rejection were also comparable. Those bridged with a VAD had a significantly higher rate of postoperative stroke (8.5% vs 0.9%; p = 0.008).

Conclusions. Small children bridged to HTx with a VAD have early survival rates that are comparable to nonbridged children; however, this is achieved at the expense of a higher rate of stroke. Identifying the risk factors for early death and stroke in small children bridged to HTx with VADs is prudent as more experience with this patient population accumulates.

Mechanical circulatory support options are limited for small children. For the last 20 years, extracorporeal membrane oxygenation (ECMO) has been the primary bridging modality for children with end-stage heart failure. Outcomes of bridging with ECMO have been suboptimal, with high waiting list mortality rates and hospital discharge rates of approximately 50% [1–6]. The development of the Berlin Heart EXCOR (Berlin Heart AG, Berlin, Germany) pediatric ventricular assist device (VAD) has offered an alternative to traditional methods of mechanical support in small children being bridged to heart transplantation (HTx). Outcomes of HTx in VAD-bridged small children have been limited to small series. The aim of this study was to evaluate nationwide outcomes of HTx in small children bridged with a VAD.

Patients and Methods

The study was approved The Johns Hopkins Hospitals Institutional Review Board.

Study Population

The United Network for Organ Sharing (UNOS) registry was used for this study. The UNOS database contains deidentified patient-level data on all thoracic organ transplants performed within the United States. The study population consisted of UNOS status 1 small children weighing 10 kg or less undergoing HTx between January 1, 2004, and December 31, 2010. We excluded children weighing more than 10 kg, those undergoing redo HTx or multivisceral transplantation, and those bridged with ECMO. Primary stratification was based on bridging vs no bridging. More specifically, we compared outcomes of HTx in small children bridged with VADs vs UNOS status 1 small children not bridged with VADs or ECMO.

Outcomes

The primary outcome was 1-year survival. All causes of death were incorporated into the survival analyses. Secondary outcomes included 30-day and 6-month survival, as well as rates of postoperative complications. The complications examined included renal failure requiring dialysis, stroke, all-cause reoperation, infection, and rejection. Postoperative was defined as occurring during the same admission as the HTx.

Data Analysis

A trend analysis was initially performed examining annual rates of nonbridged HTx, bridge to HTx with...
VADs, and bridge to HTx with ECMO in small children in the United States. Baseline recipient, donor, and transplant characteristics were compared between small children bridged to HTx with VADs and nonbridged children. Propensity matching was performed with a 2:1 ratio of nonbridged to VAD-bridged children. These cohorts were matched on 14 clinically relevant variables that had biologic plausibility in influencing the likelihood of VAD implantation or on affecting outcomes after HTx. These variables were age, sex, etiology of heart failure, weight, serum creatinine, serum bilirubin, intensive care unit before HTx, mechanical ventilation, donor age, donor sex, mechanism of donor death, donor weight, donor-to-recipient weight ratio, and ischemic time.

After propensity matching, Kaplan-Meier 30-day, 6-month, and 1-year post-HTx survival rates were compared between VAD-bridged and nonbridged children using the log-rank test. Postoperative complication rates were also compared between bridged and nonbridged children. The χ² test was used for categoric data and the Student t test for continuous data. Categoric data are presented with number and percentage and continuous data as mean ± standard deviation. Statistical analyses were performed using STATA 11 software (StataCorp LP, College Station, TX).

Results

Trends in Bridging to HTx With VADs

During the study period, 803 small children underwent HTx. Of these, 653 (81%) were not bridged with a VAD or ECMO, 91 (11%) were bridged with ECMO, and 59 (7%) were bridged with a VAD. Of 46 VAD children with available data, 45 (98%) were bridged with the Berlin Heart VAD, and the remaining child was bridged with the MEDOS VAD (MEDOS Medizintechnik GmbH, Stolberg, Germany). The types of support in the 58 children in the VAD group with available data were left ventricular in 35 patients (60%), biventricular in 19 (33%), and right ventricular in 4 (7%). Rates of VAD bridging increased significantly from 3% in 2004 to 9% in 2010 (p = 0.03), with a significant decrease in the use of ECMO for bridging (13% in 2004 to 3% in 2010; p = 0.01; Fig 1).

Baseline Characteristics

In comparing baseline recipient characteristics, the 59 children bridged to HTx with a VAD were significantly older, had a higher proportion of cardiomyopathy and lower proportion of congenital heart disease, weighed more, and were in the intensive care unit more frequently than the 653 nonbridged HTx recipients (Table 1). At the time of waiting list registration, 4 of the bridged children (7%) were being supported with ECMO. Bridged children also had older donors, heavier donors, and shorter ischemic times than nonbridged children (Table 1). After 2:1 propensity matching, 118 well-matched nonbridged small children had recipient, donor, and transplant characteristics comparable to the VAD cohort (Table 2). In the subset of patients with congenital heart disease, a similar proportion of the bridged and nonbridged children had prior corrective or palliative operations that excluded VAD implantation (89% vs 80%; p = 0.54).

Post-HTx Survival

Kaplan-Meier 1-year survival was 86% in the VAD cohort, which was comparable to the 91% observed in the nonbridged matched cohort (p = 0.39; Fig 2). The 30-day (94% vs 98%; p = 0.17) and 6-month (89% vs 92%; p = 0.17) Kaplan-Meier survivals were also comparable between the VAD and non-VAD patients, respectively. The overall 1-year mortality rate in patients with sufficient follow-up was 18% vs 11% in the bridged and nonbridged groups, respectively (p = 0.28).

Rates of Postoperative Complications

Rates of postoperative renal failure requiring dialysis, reoperation, infection, and rejection were comparable between children bridged with a VAD and those not bridged (Fig 3). Postoperative stroke was observed in

Fig 1. Annual rates of heart transplantation (HTx) in small children stratified by no bridging, bridging with extracorporeal membrane oxygenation (ECMO), and bridging with ventricular assist devices (VADs). The percentages reflect the proportion of heart transplantations performed after bridging with ventricular assist devices.
5 children (8.5%) bridged with a VAD, which was significantly higher than the 1 patient (0.9%) with stroke in the nonbridged group \( (p = 0.008) \). None of the children who were supported with ECMO at the time of registration and subsequently supported by a VAD before HTx had a stroke after HTx.

### Causes of Death

Overall, there were 12 deaths (20%) at a mean follow-up of 642 ± 610 days in the VAD group. Causes of death included cardiac arrest in 3 (25%), acute rejection in 2 (17%), and primary graft failure, chronic rejection, acute respiratory distress syndrome, seizure, hemorrhage, and multiple organ failure in 1 patient each (8%). The cause of death was unknown in 1 patient.

### Outcomes of Children Bridged With ECMO

Although children bridged to HTx with ECMO were excluded for propensity-matching purposes, we conducted a secondary analysis of outcomes in this specific subset. Compared with VAD-bridged children, the 91 children bridged with ECMO had higher risk characteristics, including younger age, lower weight, more congenital heart disease, higher serum creatinine and bilirubin, a higher proportion of mechanical ventilation, and longer average ischemic time. Survival at 30 days (77% vs 94%; \( p = 0.006 \)), 6 months (63% vs 89%; \( p = 0.007 \)), and 1 year (58% vs 86%; \( p < 0.001 \)) was significantly lower in the ECMO vs VAD cohorts. Patients bridged with ECMO also had a higher rate of post-HTx renal failure (27% vs 0%; \( p < 0.001 \)). The rates of other postoperative complications, including stroke (4.5% vs 8.5%; \( p = 0.32 \)), were comparable.

### Comment

In this study we compared outcomes of 59 small children bridged to HTx with a VAD with a well-matched, nonbridged cohort. The principal finding was that early post-HTx survival rates and the rates of postoperative complications were comparable, with the exception of stroke, which was observed at a much higher frequency in the bridged cohort. We also demonstrated that the use of VADs as a bridging modality for HTx in small children has tripled during the last several years in the United States, with a concomitant decrease in the use of ECMO as bridging therapy.

### Choice of Bridging Modality

These post-HTx outcomes compare favorably with bridging with ECMO, which has been the primary mechanical bridging modality in children for the last few decades. A multicenter study of 773 children listed for
HTx and supported with ECMO demonstrated that only 45% reached HTx and only 47% survived to hospital discharge [5]. A UNOS analysis of more than 2,500 pediatric HTxs demonstrated that ECMO bridging was associated with a more than twofold increase in the 30-day mortality risk after HTx in multivariable analysis [7]. Prior studies have similarly shown suboptimal post-HTx results with ECMO bridging [1–4].

An additional limitation to ECMO bridging is durability of support. Although ECMO is a highly effective bridging modality in the short-term, it has limited applicability as long-term mechanical support. In the aforementioned study of 773 ECMO-supported children, for instance, the median duration of ECMO was 10.3 days, which is 15% of the median waiting time for an infant awaiting HTx [5].

Nonetheless, ECMO remains an important therapy in the treatment of heart failure in children. It has particular utility in cases where ventricular recovery is expected in the short-term (expected mechanical support of less than 2 weeks), where renal function is preserved, and in children with cardiomyopathy [5]. In these instances, waiting list and post-HTx outcomes are favorable with ECMO. However, children requiring longer support or with end-organ dysfunction are likely better served with a VAD.

At our institution, we typically use ECMO as a rescue modality as a bridge to recovery, VAD, or HTx in children presenting with hemodynamic instability or in cardiac arrest. Many of these patients can be successfully weaned from ECMO, and if needed, a VAD can be implanted electively. We attempt to make the decision on VAD implantation before there are mounting morbidities from ECMO. More specifically, our criteria for VAD implant include inotrope dependency and evidence of compromise to at least one other organ system (eg, respiratory failure, worsening renal function, hepatic dysfunction). Factors that may shift the “window” earlier or may result in an earlier transition to a VAD include cardiomyopathy as the etiology of heart failure, asystole, difficult ECMO run, and worsening coagulopathy. Factors that may shift the “window” later include congenital heart disease, slow end-organ recovery, an uncomplicated ECMO run, and uncertain transplant candidacy.

**Early Survival After Bridging to HTx With VAD**

One could postulate that VAD bridging would be associated with a significant decline in early survival after HTx due to the increased complexity of the transplant operation. In adults, certain types of VADs have indeed been shown to diminish early post-HTx survival [8].

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**Table 2. Baseline Characteristics of the Propensity-Matched Nonbridged Cohort and the Ventricular Assist Device Cohort**

<table>
<thead>
<tr>
<th>Variable</th>
<th>No Bridging (n = 118)</th>
<th>Bridging With VAD (n = 59)</th>
<th>p Value&lt;sup&gt;b&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recipient</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age, mo</td>
<td>5.2 ± 7.8</td>
<td>5.9 ± 7.2</td>
<td>0.56</td>
</tr>
<tr>
<td>Male</td>
<td>60 (51)</td>
<td>29 (49)</td>
<td>0.83</td>
</tr>
<tr>
<td>Diagnosis</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Congenital heart disease</td>
<td>30 (25)</td>
<td>10 (17)</td>
<td>0.54</td>
</tr>
<tr>
<td>Cardiomyopathy</td>
<td>85 (72)</td>
<td>46 (78)</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>3 (3)</td>
<td>3 (5)</td>
<td></td>
</tr>
<tr>
<td>Weight, kg</td>
<td>6.8 ± 2.1</td>
<td>7.3 ± 1.6</td>
<td>0.10</td>
</tr>
<tr>
<td>Serum creatinine, mg/dL</td>
<td>0.58 ± 2.20</td>
<td>0.36 ± 0.16</td>
<td>0.45</td>
</tr>
<tr>
<td>Serum bilirubin, mg/dL</td>
<td>1.37 ± 3.22</td>
<td>0.87 ± 1.20</td>
<td>0.27</td>
</tr>
<tr>
<td>Mechanical ventilation</td>
<td>39 (33)</td>
<td>18 (31)</td>
<td>0.73</td>
</tr>
<tr>
<td>Intensive care unit</td>
<td>101 (86)</td>
<td>50 (85)</td>
<td>0.88</td>
</tr>
<tr>
<td>Donor</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age, mo</td>
<td>10.4 ± 14.8</td>
<td>13.6 ± 17.0</td>
<td>0.19</td>
</tr>
<tr>
<td>Male</td>
<td>73 (62)</td>
<td>34 (58)</td>
<td>0.59</td>
</tr>
<tr>
<td>Mechanism of death</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trauma</td>
<td>54 (46)</td>
<td>24 (41)</td>
<td>0.29</td>
</tr>
<tr>
<td>Cardiovascular or asphyxiation</td>
<td>26 (22)</td>
<td>11 (19)</td>
<td></td>
</tr>
<tr>
<td>Cerebrovascular</td>
<td>15 (13)</td>
<td>5 (8)</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>23 (19)</td>
<td>19 (32)</td>
<td></td>
</tr>
<tr>
<td>Weight, kg</td>
<td>9.8 ± 4.0</td>
<td>10.7 ± 3.9</td>
<td>0.15</td>
</tr>
<tr>
<td>Transplant</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Donor-to-recipient weight ratio</td>
<td>1.48 ± 0.50</td>
<td>1.48 ± 0.47</td>
<td>0.93</td>
</tr>
<tr>
<td>Ischemic time, h</td>
<td>3.4 ± 1.3</td>
<td>3.3 ± 1.2</td>
<td>0.59</td>
</tr>
</tbody>
</table>

<sup>a</sup> Continuous data are presented as mean ± standard deviation and categoric data as number (percentage).  
<sup>b</sup> Based on the Student t test for continuous variables or the χ² test for categoric variables.

VAD = ventricular assist device.
data are encouraging, demonstrating excellent short-term survival in small children bridged to HTx with VADs, with rates that are comparable with well-matched children not bridged with mechanical support.

The favorable overall survival rates may be partly related to patient selection. Most small children bridged with a VAD in our study had cardiomyopathy rather than congenital heart disease and had shorter ischemic times than nonbridged children before propensity matching. These are favorable factors with regards to post-HTx survival and likely reflect careful patient selection because the cumulative experience with implanting VADs in small children is still relatively new [9, 10].

Complication Rates

No postoperative renal failure requiring dialysis was documented in children in the VAD cohort. The renal failure rate was also low in the control cohort. A UNOS analysis of pediatric HTx in more than 3,500 patients demonstrated a post-HTx dialysis rate of 6.2%, with risk factors including ECMO, mechanical ventilation, inotropic support, and congenital heart disease [11].

The rates of reoperation, infection, and rejection could also each be postulated to be higher in the VAD group for multiple reasons. For instance, bleeding risk from a lengthier and more complex operation requiring VAD explantation could theoretically result in higher rates of early reoperation. Infectious complications remain a significant issue in patients supported with VADs and may translate to higher rates of post-HTx infection in a subset of patients [12]. With regards to rejection, prior studies have demonstrated sensitization in pediatric HTx recipients bridged with a VAD [13, 14]. Despite this, we found comparable rates of each of these
complications between children with and without VAD support.

Neurologic complications after pediatric VAD implantation represent a significant concern. A study from Argentina of the Berlin Heart EXCOR VAD demonstrated a stroke rate of 17% [15]. Similarly, 29% of children enrolled in a prospective trial had a stroke after EXCOR VAD implantation [16]. A study of 96 short-term and long-term VADs in children demonstrated stroke rates of 35% and 13%, respectively [17].

Although multiple prior studies have established the significant risk of stroke in pediatric VAD patients, there are considerably less data on the effect of VAD bridging on post-HTx stroke rates. Our study demonstrates that the risk remains high in this patient subset and is significantly greater than in a well-matched cohort of nonbridged small children undergoing HTxs. Whereas the increased stroke risk during VAD support is clearly linked to thromboembolic events arising from the pump itself or hemorrhagic events related to anticoagulation, the cause of increased stroke in the post-HTx setting, as observed in our study, is less clear.

Our study has several limitations. One limitation is that we did not evaluate pre-HTx outcomes of VAD support in small children, including duration of support, waiting list morbidity, and waiting list mortality. Although these outcomes are relevant, the focus of our analysis was on the effect of VAD bridging on post-HTx outcomes. Further, we were unable to identify the proportion of patients that had a stroke after VAD implant but before HTx, as this was a limitation of the available data in the registry.

Another limitation was that the UNOS database simply codes the postoperative complications as being present or absent. We were unable to identify the etiology, timing, and severity of these complications. There is also the potential for bias associated with clinicians’ heightened awareness of stroke in VAD patients resulting in a relative underdetection of this complication in the non-VAD group. In addition, there is the possibility of a type II error given the relatively low patient numbers. Therefore, as more data on VAD bridging in small children accumulates, reexamination of these outcomes is certainly prudent. We also did not examine quality of life or functional outcomes. Moreover, we were unable to identify the number of prior sternotomies because this field was poorly coded in the UNOS database. Finally, the specific types and complexity of congenital heart disease were not identifiable.

Future Direction

An important future direction of this work will be to identify predictors of early death and stroke in small children undergoing bridge to HTx with VADs. The low patient numbers in our analysis precluded a multivariable model that could identify such predictors. As worldwide experience with the Berlin EXCOR grows, such analyses will be important in the development of guidelines and treatment algorithms for small children with end-stage heart failure.

In conclusion, this is the largest study to date examining the effect of VAD bridging on outcomes of HTx in small children. We found that overall 30-day, 6-month, and 1-year survival was comparable between bridged children and a well-matched cohort of nonbridged children. In addition, rates of complications except for stroke were similar. These data collectively demonstrate that VADs as bridging therapy in small children is associated with acceptable post-HTx outcomes. Identifying factors associated with early post-HTx death and stroke will be essential as experience with VAD implantation in small children accumulates.

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References


**DISCUSSION**

**DR S. ADIL HUSAIN** (San Antonio, TX). I’d like to inquire into the etiology of these patients that are having a stroke. I am not that familiar with the database, but is there any data you can harvest on these patients in terms of what their course was while they had a ventricular assist device (VAD) in place (ie, thrombotic complications) or issues they had even pretransplant?

And are there any data that give you some assessment of the methods used for anticoagulation, whether they were consistent across institutions in terms of how the VADs were managed and if that has an impact?

**DR KILIC**: Thanks for those questions, and those are certainly relevant questions. Unfortunately, a limitation of the using the UNOS database is that those data points are not available. But I do think a single-institution or other multiinstitutional series will be able to answer some of those questions.

**DR WINFIELD J. WELLS** (Los Angeles, CA): What about the characteristics of the stroke? Does the database have any information on that? Were these hemiplegias? Were they just simple seizures? How much do you know about that, and did they resolve?

**DR KILIC**: Unfortunately, again, that is another limitation. Essentially, the postoperative strokes are simply coded as present or absent, and they are defined as occurring prior to discharge from the transplant admission. Beyond that, there is no description of exactly what the severity of the stroke was or if there was any type of functional recovery.

**DR ANDRE RUFFER** (Erlangen, Germany). Maybe I missed it, but what was the longest duration for bridge to transplant?

**DR KILIC**: The longest duration that they were on a VAD before they underwent transplant?

**DR RUFFER**: Yes.

**DR KILIC**: Again, that happens to be another limitation of the UNOS database. We don’t have the actual VAD duration prior to transplantation. We just have if they were bridged with a VAD or not.

**DR RUFFER**: Just as a comment, in Europe, especially in Germany, the mean duration on the waiting list is much longer than in the United States. Currently in our department, we are holding the world record with a 2-year-old child getting on Berlin Heart support and receiving transplantation after 877 days without any complication.

**DR CARL LEWIS BACKER** (Chicago, IL): These are extremely interesting data. One of the primary issues is what are the indications for a ventricular assist device in these small children? I see Dr Leonard Bailey is in the audience. He has been doing heart transplantation in children for a long time. I am going to ask Dr Bailey to come up here and give us his thoughts. While he is coming up to the microphone, I will ask a question. I am thinking about my own career when we started doing transplants 25 years ago. We did not have VADs for these small children, so patients were placed on a ventilator, started on inotropes, we struggled with them and waited and waited, and then finally we would get a donor. If you expand your indications for the ventricular assist device, then yes, you are going to be putting in more VADs. The question is should we be doing that, especially when you see that the survival curves are the same?

I have heard people say that if you have a patient with cardiomyopathy and you have them on inotropes and now they have to be intubated, that that’s two-organ system failure and that’s an indication for a VAD. How many people agree with that statement?

(Audience responds.)

**DR BACKER**: Only a small smattering of agreement. At Lurie Children’s we would intubate the patients, start them on inotropes, and try to keep supporting them without a VAD. We have had many patients who go on like that for weeks and months. It is only when they start to develop problems with a third organ system, like the kidneys or their gut, that we would move to a ventricular assist device.

Dr Bailey, why don’t you give us the final word?

**DR LEONARD L. BAILEY** (Loma Linda, CA): I am not sure that I can do that for you. I am sure I can’t, in fact. We do all we can to avoid an assist device, or any sort of mechanical intervention, before transplantation. I am sure that we have pressed the limit a little too far, and rarely lost with that approach.

That zone is gray. I have seen published criteria that would actually help you with the decision for mechanical circulatory support. In my experience, there always seems to be something more you can do at the bedside without attaching them to as yet prototypic devices. Just my view.

So maybe the bottom line is try to avoid mechanical circulatory support, or at least establish criteria that would help you make the right decision, almost all the time for its use.

I don’t know about Hopkins. You were early into use of the Berlin Heart. How many Berlin pumps have been put in there?

**DR KILIC**: Well, we have done a handful in children overall. In small children, I think it is only been about 3 or so over the last couple of years.
DR BAILEY: So you have basically the same philosophy. Professor Hetzer’s group, from which we just heard, has put in quite a few. I don’t know about the MEDOS device. We have used it only once. Perhaps others are using it more. We are really mostly talking about the Berlin Heart. So, I think Roland Hetzer might agree. Try to avoid it if you can. Short of that, put it in. It can be a lifesaver.

DR HUSAIN: Still not many.

DR BAILEY: We would.

DR BACKER: The other indication, and this was presented yesterday, is that many of these patients having a VAD started on extracorporeal membrane oxygenation (ECMO). They had a cardiac arrest, were placed on ECMO, and then they go to a ventricular assist device. I think we all agree with that strategy.

The question remains: What are the indications for a VAD in a small child with ventricular dysfunction? The answer to this question is that it will probably take some time to sort out all of the variables before we arrive at a unified strategy for placing children on VADs.

The Society of Thoracic Surgeons: Fiftieth Annual Meeting

Mark your calendar for the Fiftieth Annual Meeting of The Society of Thoracic Surgeons (STS) to be held at the Orlando World Center Marriott in Orlando, Florida, January 25–29, 2014. Attend the Annual Meeting to meet the experts, network with colleagues from around the world, participate in a dynamic learning experience, and share an historic moment in the Society’s history—its Fiftieth Anniversary.

This preeminent educational event is open to all physicians, residents, fellows, research scientists, perfusionists, physician assistants, nurses, and other interested individuals who work with cardiothoracic surgeons.

Meeting participants will have the opportunity to attend traditional abstract presentations, invited lectures, surgical forums, Early Riser Sessions, Surgical Motion Pictures, and procedural hands-on courses. Parallel sessions on Monday and Tuesday will focus on specific subspecialty interests. The STS Annual Meeting offers more translational science than any other cardiothoracic surgery conference!

An advance program with information about housing and registration will be mailed to STS members this Fall. Nonmembers may contact the Society to receive a copy of the advance program; however, detailed up-to-date meeting information will be available on the STS website at www.sts.org.

I hope to see you in Orlando.

Keith S. Naunheim, MD
Secretary

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