Innovations in Care

Practical Implementation of the Coronary Revascularization Heart Team

Carlos E. Sanchez, MD; Vinay Badhwar, MD; Anthony Dota, MD; John Schindler, MD; Danny Chu, MD; Anson J. Conrad Smith, MD; Joon S. Lee, MD; Sameer Khandhar, MD; Catalin Toma, MD; Oscar C. Marroquin, MD; Mark Schmidhofer, MD; Jay Bhama, MD; Lawrence Wei, MD; Sun Scolieri, MD; Stephen Esper, MD; Ashley Lee, MD; Suresh R. Mulukutla, MD

Goals and Vision of the Program
Multidisciplinary decision making has been shown to be highly effective in various aspects of medicine, most notably with the concept of tumor boards and transplant committees.1 2

The most updated guidelines for percutaneous coronary intervention (PCI), published jointly by the American College of Cardiology Foundation, American Heart Association, and the Society for Cardiovascular Angiography and Interventions, assign a class IC recommendation for the use of a collaborative Heart Team approach in the treatment of patients with complex coronary artery disease (CAD).3 The guidelines assert that this recommendation is based on retrospective analyses showing that patients with complex CAD referred for revascularization based on a Heart Team consensus have improved mortality compared with patients merely assigned to a particular strategy in the context of their trial enrollment. Despite the suggestion of improved mortality in this retrospective comparison, the Heart Team approach has not been adopted widely in the current clinical practice of cardiovascular medicine. This multidisciplinary innovation remains in its infancy, and numerous questions remain about its practicality, feasibility, and efficacy.

For several reasons, there remains significant variability in the care delivered to patients with complex CAD.4 Numerous reports show that although differences in patient characteristics may explain some of the variability in revascularization decisions, much of this variance is physician driven, such as practicing in a fee-for-service model or high-risk anatomy.5 6 As emphasis grows on informed decision making and patient-centered care, a critical evaluation of these difficult questions will be essential to discovering whether there is a clinically meaningful effect of the Heart Team approach on patients with complex CAD.

Although the longstanding use of tumor boards in the field of oncology represents a functioning model of interdisciplinary care on which the Heart Team may be based, it is critical to gather data on the types of patients who could be discussed in a Heart Team. Although the convening of tumor boards to provide prospective care in oncology is supported by the American College of Surgeons guidelines, recent data suggest that the use of tumor boards may have little impact on quality of care and survival across a large sample of patients in the Veterans Affairs Healthcare System.6 Accordingly, if the Heart Team model of care is to be adopted, more evidence needs to be established in the literature on the details of how to implement such a system.

Challenges in Implementation
Substantial barriers do exist and have been identified previously.3 The most significant barriers include the challenge of integrating multiple opinions into a final treatment decision systematically, engaging patients and families in decision making, communicating recommendations accurately and efficiently, and, finally, addressing the issue of remuneration for services. Also, time is a frequently cited limitation to adopting this process that encompasses both the time dedicated to discussing patient care and identifying an optimal meeting time that is compatible with competing schedules. Another unique challenge that is often encountered is how to achieve a balance between the thoughtful formulation of treatment plans and the urgency of the clinical situation. For instance, performing PCI immediately after the diagnostic coronary angiogram, also known as ad hoc PCI, is quite common in contemporary clinical practice. Ad hoc PCI is certainly appropriate in settings such as acute coronary syndromes and cardiogenic shock.8 However, in more stable clinical situations, making a rapid therapeutic decision reduces the opportunity for collaboration with other physicians, discussion with the patient and family members, and weighing the options of medical therapy versus revascularization strategies. Hence, in these cases, it may be beneficial to stop on completion of the diagnostic angiogram to consider carefully all available treatment options and to allow time for a Heart Team to convene.9 Although ad hoc PCI has been established as safe and effective compared with delayed...
PCI, its appropriateness has been questioned in patients with complex CAD. Therefore, when angiographic findings are unanticipated and the most appropriate treatment strategy is not clear, it may be beneficial to allow input from the Heart Team so as to maximize the opportunity for multidisciplinary discussion and decision making and to afford patients a greater opportunity to make a truly informed decision on their healthcare.

Despite these significant obstacles, we think that a functioning Heart Team is not only reasonably achievable but will also prove to serve an integral and meaningful role in the treatment of patients with complex CAD and severe valvular disease. In our experience in a large, single academic medical center, we found that the aforementioned challenges could be overcome and also provide invaluable contributions to the final treatment decision for individual patients. Although all of the obstacles were not addressed, such as remuneration, a discussion among all the key physician stakeholders in advance of implementation of the initiative allowed us to move forward without having to find a solution to all obstacles.

**Design of the Initiative**

At our institution, we began to convene a Heart Team meeting each weekday at 7:00 am since May 2012 to discuss referred cases. Appropriate cases were defined as patients who had any of the following features: (1) unprotected left main CAD, (2) 3-vessel CAD, (3) 2-vessel CAD involving the proximal left anterior descending artery, (4) proximal left anterior descending artery disease in patients with diabetes mellitus, and (5) any other cases where the initial treating physician felt that revascularization of complex CAD could be reasonably approached by either a percutaneous or surgical strategy. Cases discussed included both those that were referred directly to cardiologists and those referred initially to cardiac surgeons. The meetings involved open discussions using the most recent evidence-based management of patients with complex CAD with or without severe valvular disease. At each meeting, there were a minimum of 3 physicians present, including an interventional cardiologist, a non-invasive cardiologist, and a cardiac surgeon. The referring physician or physician who takes care of the patient in the hospital must be present during the Heart Team meeting, and his opinion is highly valued and incorporated into the decision. Whenever the referring physician cannot be physically present, a conference line is opened for her or him to call into the meeting.

This level of participation can be contrasted with the structure of the Heart Team called for within the current guidelines, which require only a cardiac surgeon and an interventional cardiologist. All coronary angiograms were reviewed within 72 hours of completion of the diagnostic angiograms, and the vast majority (>80%) of cases were discussed within 24 hours. The Synergy Between Percutaneous Coronary Intervention With Taxus and Cardiac Surgery (SYNTAX) scores were calculated for all patients based on analysis of the angiographic data. Because the SYNTAX score has been identified as a reasonable surrogate for determining the extent and complexity of CAD, these scores were then weighed against the corresponding Society of Thoracic Surgery (STS) morbidity and mortality values for each patient. Additional pertinent clinical data, patient characteristics, and functional status were also discussed and reviewed by the team to adjudicate the optimal treatment strategy. Final recommendations were made based on a consensus decision among the group.

**Implementation of the Initiative**

As with any new initiative, there is potential for a great degree of heterogeneity in its structure and operation. Hence, defining how the program would function and assigning specific responsibilities were central to successful implementation. To do this, we first established a dedicated chair of the Heart Team. The chair was primarily responsible for preparing the agenda for each meeting and vetting all appropriate patients who were referred for discussion. A schedule was then communicated to all team members by the chair via email with special attention to ensure the primary physician responsible for the patient would be present. The chair also served a primary role during each Heart Team meeting in facilitating discussions of each patient. A conference line was also made available to allow physicians to call into the meeting if they could not physically be present. Our next innovation was to elaborate a Heart Team data collection sheet. Documentation within the data sheet was the responsibility of the patient’s treating cardiologist who performed the initial coronary angiogram. The main components included a brief summary of the clinical presentation, comorbid conditions, calculated SYNTAX and STS scores, measurement of left ventricular function, and subjective commentary on the patients’ overall functional status and frailty. The Heart Team data collection sheet is illustrated in Figure 1. These data augment the complete set of data fields that we already collected through the National Cardiovascular Data Registry’s Cath-PCI Registry, allowing us to have a robust set of clinical data variables.

After presentation of the Heart Team data collection sheet, each patient’s coronary angiogram was reviewed with the group. Open dialogue would then ensue and address several issues, including whether revascularization would be appropriate with regard to published guidelines and the technical feasibility of revascularization both percutaneously and surgically, in the context of any coexistent aortopathy and valvular disease. Minimally invasive direct coronary artery bypass and hybrid procedures were also considered if there was felt to be potential benefit given the clinical circumstances. The treatments being considered were all discussed relative to the best available evidence-based practice with a focus on either alleviating symptoms or improving mortality. It is important to recognize that not all cases correlated with a distinct guideline or specific study, and in these instances, the group attempted to define a patient-specific best care practice pertaining to each particular clinical scenario. Finally, all data are integrated independently by each individual, and an optimal treatment strategy is selected based on a majority decision by the group.

Ultimately, to provide patient-centered care, recommendations must be discussed with the patient. In our Heart Team model, both the treating cardiologist and the cardiac surgeon would meet the patients individually to summarize the available evidence-based practice with a focus on either alleviating symptoms or improving mortality. It is important to recognize that not all cases correlated with a distinct guideline or specific study, and in these instances, the group attempted to define a patient-specific best care practice pertaining to each particular clinical scenario. Finally, all data are integrated independently by each individual, and an optimal treatment strategy is selected based on a majority decision by the group.
Success of the Initiative and Outcomes

The benefits of implementing the multidisciplinary Heart Team at our institution have been readily apparent. The success of the Heart Team is evident in the growing number of patients treated according to professional guidelines. Since May 2012, we convened a Heart Team meeting on an average of 3.5 days/wk to discuss evidence-based management of patients with complex CAD. The average number of physicians present with each meeting of the multidisciplinary team was 4. This comprised ≥1 cardiovascular surgeon, ≥1 interventional cardiologist, ≥1 noninvasive cardiologist, and occasionally internists and cardiac anesthesiologists.

Twenty percent of patients received medical therapy, 26.4% underwent PCI, 50% had coronary bypass with or without valve repair or replacement, 0.9% went for minimally invasive direct coronary artery bypass, and 2.7% were treated with a hybrid procedure, including PCI followed by surgery. These results are summarized in Table 1. The distribution of SYNTAX scores in patients discussed at our Heart Team meetings by tertile was 47.8% low risk (SYNTAX, 0–22), 36.3% intermediate risk (SYNTAX, 23–32), and 15.9% high risk (SYNTAX, >32). The average overall STS mortality was 3.3%. Interestingly, when angiographic SYNTAX and STS risk were calculated and grouped according to risk scores, the combination of SYNTAX and STS risk was shown to influence decision making with regard to coronary revascularization in patients with complex ischemic heart disease. Therefore, as shown in Table 2, a Heart Team approach most often resulted in the recommendation for surgical revascularization in patients with low STS risk regardless of SYNTAX score. Conversely, PCI was recommended more frequently in patients with high STS risk regardless of SYNTAX score. Moreover, 6-month mortality was higher in the group with high STS risk independent of the revascularization strategy adopted. Although further studies are warranted to focus on the short- and long-term clinical consequences of these revascularization strategies, it was clear in our initial experience that a Heart Team approach allows for an opportunity to carefully consider angiographic as well as clinical factors in decision making. The combination of both is likely to affect clinical outcomes.

The Heart Team recommendation was adjudicated with the appropriateness for coronary revascularization using the most up-to-date appropriate use criteria (AUC) for revascularization.14 Among patients with stable ischemic heart disease, PCI or coronary artery bypass graft was performed in 85.2% (138/162) of patients, with the rest receiving medical therapy. All patients who were recommended for PCI or coronary artery bypass graft were appropriate for coronary revascularization based on the AUC. Among patients who
These preliminary findings suggest that the Heart Team may complement the AUC for revascularization in clinical decision making, especially in patients with complex clinical comorbidities who have a high surgical risk. We continue to collect prospective data to evaluate AUC adherence among patients discussed in Heart Team and its effect on clinical outcomes.

From the time of initiation of the Heart Team meeting, >80% of patients at our institution with stable ischemic heart disease and complex coronary anatomy underwent a multidisciplinary team approach to assess best treatment strategies. As a direct result, PCI in this subgroup was less likely to be performed during the same session as the initial diagnostic catheterization. In addition to these characteristics of the Heart Team, there were several unmeasurable benefits of the Heart Team. First, there was a notable increase in collaboration between cardiac surgeons and cardiologists, allowing for a greater understanding of the issues that were relevant to each. For instance, cardiac surgeons had a greater ability to understand the capabilities of percutaneous revascularization in complex situations, whereas cardiologists had a heightened appreciation of the issues that may make cardiac surgery more complex. This open communication allowed for active discussion and a truly team-based approach to decision making. Accordingly, the Heart Team was not simply a benefit for patients but an educational experience for all those involved in the discussion. Essential elements of an effective Heart Team are detailed in Figure 2.

### Summary of the Experience and Future Directions

In our experience, we found a structured Heart Team approach to be feasible and effective in formulating revascularization strategies for individual patients. This represents a successful model for the implementation of the Heart Team in routine care, which has great potential to influence positively the quality of cardiovascular care. Providing quality cardiovascular care in patients with complex CAD depends on the informed judgment of the treating clinicians. The Heart Team serves as a medium of communication to integrate the input of numerous specialists. This approach should help to minimize fragmented communication between specialists and eliminate specialty bias in the decision-making process. Numerous additional perceived benefits of a well-structured and efficient Heart Team are summarized in Table 3. A major advantage is the ability to provide detailed informed consent to patients and their families. For example, when ad hoc PCI is performed under conscious sedation, the procedural risks may have been seriously underestimated, especially in the case of complex CAD, and cannot be communicated to the patient intraprocedurally. In these instances, termination of the diagnostic angiogram to allow comprehensive assessment of treatment options can prove valuable. This allows a more thorough and accurate assessment of different treatment alternatives with the privilege of addressing the specific risks and benefits of each.

We continue to face ongoing challenges with the growth of the Heart Team. Integration of multiple medical disciplines and practical incorporation of the Heart Team within a busy clinical practice on a daily basis has its difficulties. However, Heart Team meetings at our institution are held early in the morning to not interfere with other clinical obligations. This timing also allows the treatment recommendations to be performed in a timely fashion within the same day of the convened meeting.

### Table 1. Cross-Sectional Patient Profile of Patients Referred for the Heart Team

<table>
<thead>
<tr>
<th>Demographics</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diabetes mellitus</td>
<td>38.3 (77/201)</td>
</tr>
<tr>
<td>Hypertension</td>
<td>78.1 (157/201)</td>
</tr>
<tr>
<td>Dyslipidemia</td>
<td>66.2 (133/201)</td>
</tr>
<tr>
<td>Tobacco use</td>
<td>27.9 (56/201)</td>
</tr>
<tr>
<td>Positive family history</td>
<td>30.8 (62/201)</td>
</tr>
</tbody>
</table>

| Prior PCI                                          | 24.9 (50/201) |
| Prior bypass                                       | 6.9 (14/201) |
| End-stage renal disease                            | 7.9 (16/201) |
| Prior heart failure                                | 14.4 (29/201) |
| Peripheral vascular disease                        | 15.9 (32/201) |

<table>
<thead>
<tr>
<th>Coronary anatomy and characteristics</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left main</td>
<td>27.9 (56/201)</td>
</tr>
<tr>
<td>Proximal LAD</td>
<td>52.2 (105/201)</td>
</tr>
<tr>
<td>Two-vessel disease</td>
<td>28.4 (59/201)</td>
</tr>
<tr>
<td>Three-vessel disease</td>
<td>56.7 (114/201)</td>
</tr>
<tr>
<td>Anomalous coronary</td>
<td>2.5 (5/201)</td>
</tr>
<tr>
<td>Low-risk SYNTAX score (0–22)</td>
<td>47.8 (96/201)</td>
</tr>
<tr>
<td>Intermediate-risk SYNTAX score (23–32)</td>
<td>36.3 (73/201)</td>
</tr>
<tr>
<td>High-risk SYNTAX score (&gt;32)</td>
<td>15.9 (32/201)</td>
</tr>
<tr>
<td>STS mortality, mean±SD</td>
<td>3.3±4.2 (n=201)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Presentation</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>No symptoms</td>
<td>6.9 (14/201)</td>
</tr>
<tr>
<td>Stable angina</td>
<td>62.7 (126/201)</td>
</tr>
<tr>
<td>Unstable angina</td>
<td>5.5 (11/201)</td>
</tr>
<tr>
<td>NSTEMI</td>
<td>18.9 (38/201)</td>
</tr>
<tr>
<td>STEMI</td>
<td>4.6 (9/201)</td>
</tr>
<tr>
<td>CCS angina class I or II</td>
<td>35.8 (72/201)</td>
</tr>
<tr>
<td>CCS angina class III or IV</td>
<td>64.2 (129/201)</td>
</tr>
</tbody>
</table>

CCS indicates Canadian Cardiovascular Society; LAD, left anterior descending; NSTEMI: non–ST-segment–elevation myocardial infarction; PCI, percutaneous coronary intervention; STEMI: ST-segment–elevation myocardial infarction; STS, Society of Thoracic Surgery; and SYNTAX, Synergy Between Percutaneous Coronary Intervention With Taxus and Cardiac Surgery.

underwent PCI, 41.3% (26/63) had an appropriate indication, 30.2% (19/63) had an uncertain indication, and 3.1% (2/63) had an inappropriate indication. The remaining 25.4% (16/63) could not be rated on the AUC because of insufficient data. It is important to recognize that the 2 patients who underwent PCI for inappropriate indications had unprotected left main coronary disease, and both were enrolled and randomized to PCI by a revascularization trial for left main coronary disease comparing percutaneous versus surgical revascularization strategies. Moreover, among patients who underwent PCI with an uncertain indication by AUC, >75% had a high SYNTAX score and a high STS mortality risk, with a mean (±SD) score of 38.5 (±4.9) and 8.2% (±3.7), respectively. This underscores the difficulty in decision making among patients with complex CAD with high mortality risk for coronary artery bypass graft. These preliminary findings suggest that the Heart Team may complement the AUC for revascularization in clinical decision
The Heart Team is an individualistic approach that considers the patient as a whole, avoiding the focus of treating coronary disease alone. The Heart Team takes into account the patient’s views and preferences when considering the best plan of care that is most appropriate for the patient’s condition. Moreover, the recommendations made by the Heart Team can only be as good as the information available to the multidisciplinary team at the meeting. As a result, each patient presented at the meeting must have a completed institutional data collection sheet and a team member involved in the patient’s care to be present during the meeting.

Another significant challenge to implement the Heart Team approach in the United States is the current reimbursement system. In our present fee-for-service payment model, a physician is paid a fee for each service rendered to the patient. Under this model multidisciplinary team discussions are not reimbursed. However, in a healthcare provider organization, 1 goal is to incorporate cost and quality measures such as implementation of a Heart Team into current and future reimbursement models to help ensure that these measures lead to quality improvements and cost reductions. Many large academic medical centers, such as the University of Pittsburgh Medical Center, operate under an integrated delivery and finance system model. An integrated delivery and finance system is a coordinated, organized, and collaborative network that links various healthcare providers to provide a vertical continuum of services to a particular patient population or community.

The Heart Team is an individualistic approach that considers the patient as a whole, avoiding the focus of treating coronary disease alone. The Heart Team takes into account the patient’s views and preferences when considering the best plan of care that is most appropriate for the patient’s condition. Moreover, the recommendations made by the Heart Team can only be as good as the information available to the multidisciplinary team at the meeting. As a result, each patient presented at the meeting must have a completed institutional data collection sheet and a team member involved in the patient’s care to be present during the meeting.

Another significant challenge to implement the Heart Team approach in the United States is the current reimbursement system. In our present fee-for-service payment model, a physician is paid a fee for each service rendered to the patient. Under this model multidisciplinary team discussions are not reimbursed. However, in a healthcare provider organization, 1 goal is to incorporate cost and quality measures such as implementation of a Heart Team into current and future reimbursement models to help ensure that these measures lead to quality improvements and cost reductions. Many large academic medical centers, such as the University of Pittsburgh Medical Center, operate under an integrated delivery and finance system model. An integrated delivery and finance system is a coordinated, organized, and collaborative network that links various healthcare providers to provide a vertical continuum of services to a particular patient population or community.
Table 3. Benefits of the Heart Team

Facilitate collaborative consultation between multiple medical disciplines with expertise in cardiovascular diseases

Encourage active involvement of various physicians with patient and family members to inform the patient treatment plan

Permit a patient-centered care taking into consideration the patient’s needs

Evaluate research trial eligibility and enhance patient enrollment in protocols

Enhance educational opportunities for all team members

Patient-specific informed consent

An integrated delivery and finance system is accountable for the clinical outcomes and health status of the population or community served and has a system in place to manage and improve them.15 We have found that under an integrated delivery and finance system healthcare model, a structured Heart Team is feasible and effective in formulating revascularization strategies for individual patients in a timely manner. Although not yet reimbursed, we are exploring novel methods to incentivize the use of multidisciplinary Heart Team more efficiently while maintaining or improving quality. There may be several feasible mechanisms of reimbursement, and our institution is exploring opportunities to associate with our health plan to begin pilot projects in this regard. Further analyses are being explored at the University of Pittsburgh Medical Center to evaluate the effect of the Heart Team on patient outcomes.

Finally, assessment of outcomes of the Heart Team is necessary. We have established a robust database to monitor and track compliance with recommendations made by the Heart Team and to track patient outcomes. We have shown that frequent Heart Team meetings are feasible in a large, busy academic institution, and research is ongoing to assess outcomes measures in these patients. Efforts should be made to find ways to introduce a Heart Team approach in adherence to professional guidelines, but more importantly to make sure the care delivered is appropriate and translates into improved patient-centered outcomes.

Currently, outcome data are being collected on patients discussed by the Heart Team to assess any potential improvement that may be offered using this method. All the patient data and outcomes are being collected under an institutional review board–approved database. In the evolving era of healthcare where physicians are being increasingly scrutinized on the appropriateness of care delivered and more focus is being placed on reducing variability of care, our initial experiences with the Heart Team is a step forward in laying the foundation to address these complex issues.

Disclosures

None.

References


Key Words: coronary artery bypass • coronary artery disease • decision making • morbidity • mortality • percutaneous coronary intervention • risk assessment
Practical Implementation of the Coronary Revascularization Heart Team
Carlos E. Sanchez, Vinay Badhwar, Anthony Dota, John Schindler, Danny Chu, Anson J. Conrad Smith, Joon S. Lee, Sameer Khandhar, Catalin Toma, Oscar C. Marroquin, Mark Schmidhofer, Jay Bhama, Lawrence Wei, Sun Scolieri, Stephen Esper, Ashley Lee and Suresh R. Mulukutla

Circ Cardiovasc Qual Outcomes. published online September 10, 2013;
Circulation: Cardiovascular Quality and Outcomes is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
Copyright © 2013 American Heart Association, Inc. All rights reserved.
Print ISSN: 1941-7705. Online ISSN: 1941-7713

The online version of this article, along with updated information and services, is located on the World Wide Web at:
http://circoutcomes.ahajournals.org/content/early/2013/09/10/CIRCOUTCOMES.113.000269.citation

Permissions: Requests for permissions to reproduce figures, tables, or portions of articles originally published in Circulation: Cardiovascular Quality and Outcomes can be obtained via RightsLink, a service of the Copyright Clearance Center, not the Editorial Office. Once the online version of the published article for which permission is being requested is located, click Request Permissions in the middle column of the Web page under Services. Further information about this process is available in the Permissions and Rights Question and Answer document.

Reprints: Information about reprints can be found online at:
http://www.lww.com/reprints

Subscriptions: Information about subscribing to Circulation: Cardiovascular Quality and Outcomes is online at:
http://circoutcomes.ahajournals.org/subscriptions/