Essentials for a CHIP Program

A comprehensive CHIP program requires a true heart team approach, specialized operator skills and training, and institutional support and resources.

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Despite advances in prevention and optimal medical therapy, coronary artery disease (CAD) remains the leading cause of morbidity and mortality in the United States and throughout the world. Coronary artery revascularization in high-risk patients, such as those with acute coronary syndrome or stable ischemic heart disease with high-risk anatomy, is supported in current practice guidelines and appropriate use documents. Historically, patients with complex CAD and significant comorbidities have had inadequate treatment options. Those who were deemed high risk or inoperable for coronary artery bypass grafting (CABG) were often relegated to medical therapy despite severe multivessel CAD. Similarly, this high-risk subset has often not been offered percutaneous coronary intervention (PCI) due to technical limitations or a perceived lack of benefit.

However, this high-risk subset of patients often has the most to gain from revascularization despite the inherent associated risks, leading to what has been termed a risk-treatment paradox. Historically, when PCI was offered, it was often performed in an incomplete manner. High-grade, low-complexity lesions were “cherry-picked,” whereas more complex anatomy was left behind. Refined patient selection and advances in interventional techniques have made it possible to safely offer complete revascularization to patients in whom the procedure was previously impossible or inadvisable. This population has increasingly been given the moniker complex higher-risk (and indicated) patients (CHIP) and has received growing interest within the field of interventional cardiology.

CHIP risk assessment contains three clinical components: (1) coronary anatomy (location and complexity), (2) comorbid conditions, and (3) concomitant cardiac disease (structural/valvular disease, left ventricular [LV] dysfunction, decompensated heart failure) (Figure 1). The number of those in the high-risk CHIP population is large and only expected to increase. Although PCI volumes are expected to decrease by approximately 10% in the coming years, the percentage of those

Figure 1. CHIP risk assessment factors.
in the CHIP subset is expected to increase. The overall prevalence of CAD is projected to grow 47% over the next 25 years, given an aging population, and the simultaneous growth of other chronic conditions and comorbidities will likely lead to expansion of the high-risk PCI patient population. As a result of the growing “multimorbid” patient population, the case mix for PCI volumes is projected to shift.

Given these realities, treatment of the CHIP population has been of increasing importance in contemporary practice. However, effective treatment of these patients is anything but a proverbial “chip shot.” A comprehensive CHIP program requires a true heart team approach, specialized operator skills and training, and institutional support and resources. Given the high-risk nature and attendant comorbid conditions, anything short of such a comprehensive program will yield inadequate or suboptimal results.

COMPREHENSIVE HEART TEAM APPROACH

The treatment of patients with multivessel or complex coronary anatomy in the setting of low ejection fraction or other significant comorbid conditions involves considerable expertise spanning multiple specialties and sub-specialties. A collaborative team-based model is required to leverage specialized expertise, decision-making, and result in improved outcomes. An excellent contemporary example of the heart team approach is that developed for transcatheter aortic valve replacement (TAVR). The TAVR heart team approach has established a new paradigm of collaborative and noncontentious management of patients with complex disease and comorbidities among cardiovascular specialists from multiple disciplines. The complexities of the CHIP population often lead to relative clinical equipoise in terms of revascularization strategies, requiring nuanced decision-making. These situations call upon the collective experience and clinical acumen of an entire team of experts and affords improved outcomes.

A truly effective CHIP team begins with appropriate patient selection. The team should identify patients with CAD and ongoing symptoms despite optimal medical therapy who may potentially derive benefit from revascularization (PCI or CABG). Once identified, a holistic view of the patient should be considered, including the extent of CAD, ejection fraction, viability, hemodynamic status, and comorbid conditions. Goals of care, medical optimization, and timing are generally established by a primary care physician, general cardiologist, and/or heart failure cardiologist. Optimal revascularization modality and strategy are then determined primarily by a CHIP interventionalist and cardiothoracic surgeon. These patients often have concomitant valvular heart disease or arrhythmia, which are evaluated by a structural interventionalist and electrophysiologist, respectively.

Once a comprehensive treatment plan has been formulated, effective and expert execution rely not only on cardiovascular physicians but also on a cadre of talented staff. Caring for those in the CHIP population will inevitably involve unforeseen issues and complications requiring a dedicated and invested team. It is advisable to have designated cath lab scrub personnel who are familiar, knowledgeable, and interested in complex and high-risk interventions. All members of the clinical care team, including cath lab nurses, intensive care unit nurses, house staff, and physician assistants, are indispensable and require special training. These patients need to be closely monitored and often require an understanding of advanced hemodynamics and troubleshooting of support devices such as the Impella device (Abiomed, Inc.).

OPERATOR SKILLS AND TRAINING

Any CHIP program, at its heart, requires a physician champion, which is usually an experienced and skilled interventional cardiologist. The technical requirements and familiarity with an extensive toolbox of skills required for both success and safety far exceed those required to perform contemporary conventional PCI. In the most complex and challenging anatomy, success rates have improved among operators trained in specialized techniques but have remained significantly lower among everyday interventionalists. In most instances, a given hospital or health system will need to designate dedicated CHIP operator(s) to ensure adequate procedural volume of complex cases. For these complex patients, practice makes for better outcomes, and operator volume is associated with decreased major adverse cardiac events. As such, adequate volume thresholds need to be maintained to ensure best practices. Treating the CHIP population is a team sport but requires specialized players.

Specific technical skills and training are multitudinous and best highlighted in a CHIP course (Table 1). At the most basic level, a CHIP operator should be proficient in chronic total occlusion PCI (antegrade wire escalation, antegrade dissection and reentry, and retrograde techniques), left main bifurcations (single- and two-stent strategies), treatment of underexpanded stents (laser/atherectomy), and calcific disease requiring atherectomy (rotational and/or orbital). In addition,
knowledge and experience with complication management are essential. Specifics include emergency pericardiocentesis, prompt treatment of coronary perforations (covered stents, coils, embolization), and retrieval of dislodged stents/foreign bodies/snare techniques.

Hemodynamic support has become an indispensable part of many CHIP procedures. Proficiency with percutaneously implanted LV support devices is essential. The Impella family of circulatory support systems has been widely adopted by CHIP interventionalists for protected PCI procedures. Use of the Impella device has been shown to decrease procedural drops in arterial pressure, reduce major adverse cardiovascular and cerebrovascular events, and result in fewer hospital days and readmissions as compared with traditional intra-aortic balloon pump–supported procedures.\(^8\) Protected PCI with the Impella device has made the complete revascularization of challenging anatomy much more accessible and safe. Use of Impella and other support devices places the additional demand that CHIP interventionists be familiar with transradial access (when dual femoral access is already required) and large-vessel access/closure management. Given the prevalence of concomitant peripheral artery disease in these patients, alternative access considerations (eg, axillary, transcaval) have become increasingly important.

The experience and clinical judgment required to perform these procedures is beyond that obtained in a traditional single-year interventional cardiology fellowship. Some institutions now offer a dedicated CHIP fellowship for additional training beyond conventional interventional training. Technical considerations aside, hard-earned clinical judgment is a cornerstone of the CHIP operator. Assessment of hemodynamics at the time of intervention and patient optimization prior to intervention are key. Perhaps the most difficult—and often hardest lesson learned—is when to say no. The basis for proceeding with a high-risk intervention cannot be solely made by reviewing an angiogram. What is technically feasible often outpaces the holistic reality of the clinical picture. Some CHIP operators advocate meeting a patient prior to reviewing an angiogram to help make a more informed decision regarding the advisability of undertaking a complex intervention.

In summary, a comprehensive CHIP program requires either an individual or a cadre of dedicated and highly skilled interventionalists who possess a multitude of procedural and cognitive abilities. In addition to these proficiencies, a CHIP operator needs to be able to face adversity. Even the most talented CHIP operators fail on a regular basis given the challenging anatomy. Perhaps even more difficult is the ability to “bounce back” from difficult complications. These complications are inherent to and inseparable from CHIP practice and cannot be completely avoided regardless of the skill, dedication, and caution exhibited by any operator.

**INSTITUTIONAL COMMITMENT**

A successful CHIP program also requires gaining institutional buy-in. An administrative champion can...
prove vitally important in program development and negotiating potential pitfalls. A CHIP program requires the investment of time, space, and capital. Time and space are important in the sense that CHIP procedures take time and cannot be performed in a room with eight scheduled procedures in a given day. CHIP procedures also require specialized wires, catheters, balloons/stents, and support devices, such as Impella. This equipment is often expensive and largely not interchangeable with “knock-off” versions. The appropriate equipment can be the difference between success and failure in any given procedure. For example, if a support catheter “stalls” secondary to fatigue after negotiating a tortuous collateral pathway, the CHIP operator should swap it for a fresh support catheter to allow for successful completion of the intervention despite the additive cost. Having a supportive administrator in the “C-suite” with a 10,000-foot view of the program can make a difference in this regard. The focus should not be on the cost for individual cases or on adherence to institutional buying agreements but rather on a robust program and long-term gain. Although the CHIP operator must be cognizant of cost, once a complex intervention is undertaken, such considerations should be secondary.

Once a CHIP program and the key players have been established (administrative and clinical), a commitment to tracking outcomes, quality metrics, and identification of opportunities for improvement should regularly be undertaken. However, it is important that there is an institutional understanding that quality metrics (mortality, bleeding, periprocedural enzyme elevations, length of stay) will likely differ between CHIP procedures and conventional percutaneous revascularization procedures. Metrics should be representative of the quality of the procedure itself rather than reflecting the level of illness of the patient. This is particularly relevant for CHIP cases, and a broader discussion needs to be held regarding the criteria upon which quality is based, as many contemporary reporting metrics are inadequate.

Finally, administrative assistance in building awareness within a health system and in referral centers is also critical for developing a CHIP program. This can easily be accomplished by highlighting successful treatments and patient testimonials. Ultimately, a commitment to a successful CHIP program will prove valuable to an institution not only in terms of better patient care but also a “halo effect,” resulting in more referrals, procedures, and ancillary testing. It results in a win-win-win for patients, physicians, and administrators.

SUMMARY
Developing a CHIP program meets an increasingly important need for a growing population of patients. A CHIP program is exactly that—a program. A lone-wolf approach of uncoordinated operators attempting high-complexity and high-risk procedures will not benefit the field or the patients involved. The complexity and nuanced decision-making required to treat these patients calls for responsible and well-thought-out program development. Any CHIP program should have designated operators with specialized procedural and cognitive capabilities. These operators should work within a true program with treatment algorithms/outlines, quality metrics, and ongoing outcome assessment.

Most importantly, a CHIP program is a true team sport that involves a wide range of cardiovascular specialists, clinical support staff, and administrative personnel. A well-conceived and well-run CHIP program ultimately transforms the historical risk-treatment paradox into a “high risk, higher reward” paradigm that richly benefits a traditionally underserved patient population. The rewards for taking on the challenge of treating those in the CHIP population are well worth the effort.


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Disclosures: None.