

Task Force 3: Training Guidelines for Pediatric Cardiac Catheterization and Interventional Cardiology

Endorsed by the Society for Cardiovascular Angiography and Interventions

Robert H. Beekman III, MD, FACC, FAAP, *Chair*, William E. Hellenbrand, MD, FACC, Thomas R. Lloyd, MD, FACC, James E. Lock, MD, FACC, FAAP, Charles E. Mullins, MD, FACC, FAHA, FAAP, Jonathan J. Rome, MD, FACC, David F. Teitel, MD

INTRODUCTION

The purpose of this document is to recommend minimum training experiences in cardiac catheterization for clinical fellows in pediatric cardiology training programs. Training guidelines in cardiac catheterization are well-established in adult cardiovascular medicine (1,2), and they have been considered recently in pediatric cardiology as well (3,4).

Pediatric cardiac catheterization is a unique specialty encompassing a wide range of diagnostic and therapeutic techniques applied to a diverse group of congenital and acquired cardiovascular disorders. A physician who performs a pediatric cardiac catheterization must possess the technical skills and clinical judgment to safely and accurately perform a thorough diagnostic cardiac catheterization and angiographic study. Furthermore, an interventional pediatric cardiologist must also assess the indications for a catheter intervention, including the risks of performing or not performing the procedure (i.e., requires knowledge of the natural history of the defect), and must skillfully perform the appropriate catheter intervention. It is appropriate, therefore, to delineate minimal training requirements in cardiac catheterization for pediatric cardiology trainees.

There are no studies relating training experiences to subsequent clinical skill in pediatric cardiac catheterization. Therefore, the recommendations in Task Force 3 represent the opinions of the authors. To help guide this process, all Accreditation Council for Graduate Medical Education (ACGME)-accredited pediatric cardiology training programs were surveyed in 2001 to inquire about current practices and opinions regarding fellow training in pediatric cardiac catheterization and intervention. Thirty-two programs responded. The responses represented the opinions of fellowship directors ($n = 21$), catheterization laboratory directors ($n = 15$), and division directors ($n = 13$) (in some programs one individual holds more than one position). This document draws on this Training Program Survey to help define training guidelines in this specialty.

FACILITIES AND ENVIRONMENT

Training in cardiac catheterization should occur within a pediatric cardiology fellowship program that is accredited by the ACGME. The cardiac catheterization laboratory should serve a hospital with inpatient and outpatient facilities, neonatal and pediatric intensive care units, and an active

pediatric cardiac surgical program. The pediatric cardiac catheterization laboratory should be under the supervision of a full-time pediatric cardiologist, whose primary responsibility is supervision of the laboratory. The laboratory must perform a sufficient number of cardiac catheterizations and interventional procedures to provide each trainee with an acceptable experience.

The cardiac catheterization program must have a regular teaching conference in which diagnostic data (hemodynamic and angiographic) and therapeutic outcomes are formally discussed. In addition, each program that provides *advanced* interventional training must have a regular morbidity and mortality conference in which all adverse outcomes of catheter interventions are systematically reviewed. Participants in this conference should include cardiology faculty, clinical fellows, and preferably pediatric cardiothoracic surgeons and cardiac anesthesiologists. Active participation in these conferences by all clinical cardiology fellows, particularly those at *advanced* levels, is essential to clinical training that emphasizes quality outcomes.

LEVELS OF EXPERTISE

In this report we discuss *core* training for all fellows, and *advanced* training for fellows desiring special expertise in cardiac catheterization and interventional cardiology. The *core* training is recommended for all clinical fellows during their core clinical experience. It is intended to be sufficient for fellows who do not plan a career in interventional pediatric cardiology, but who may be required to perform simple diagnostic studies and to interpret catheterization and angiographic data in their clinical practices. (Cardiologists who provide "diagnostic only" catheterization services must coordinate the care closely with interventional cardiologists and surgeons at referral centers to minimize the need for repeat catheterization procedures.) The *advanced* training provides expertise in both diagnostic and interventional catheterization procedures, and it is intended to qualify a fellow to embark upon a career in cardiac catheterization and intervention.

Core Training: Goals and Methods

Core training in cardiac catheterization refers to the training experiences recommended for all clinical cardiology fellows, regardless of specific career goals. In the Training Program Survey, there was unanimous support for core training in

cardiac catheterization for all clinical fellows. The goal of such core training is to introduce fellows to the field of cardiac catheterization and the risks and benefits of catheter-based procedures, to teach basic diagnostic catheterization skills, and to provide a basic knowledge of hemodynamics, angiography, and radiation safety. A core curriculum in pediatric cardiac catheterization should include the topics and experiences outlined in **Table 1**.

The core training should involve each clinical fellow in a minimum of 100 cardiac catheterizations, at least 20 of which include an interventional component (**Table 2**). These experiences should familiarize the fellow to the indications for cardiac catheterization and intervention, femoral vessel access techniques, basic catheter manipulations, hemodynamic measurements and calculations, and angiographic interpretations. Participation by the fellow as either the primary operator or the primary assistant is satisfactory involvement. A log book should be maintained by the fellow to document the experience and outcomes of catheterization.

Advanced Training: Goals and Methods

Advanced training in cardiac catheterization refers to the training recommended for pediatric cardiology fellows who intend to pursue a career in pediatric cardiac catheterization and interventional cardiology. Therefore, the advanced training goal is to prepare the trainee to independently perform diagnostic and therapeutic catheter procedures with excellent outcomes. Prerequisite to these advanced training experiences is the successful completion of core training. Advanced training should involve each fellow in a minimum of 200 catheterization procedures, at least 100 of which are interventional. The minimum recommended numbers of procedures are specified in **Table 3** (and are in addition to those obtained during the core training). The procedure types and numbers in **Table 3** are recommended guidelines, not mandates, as it is understood that some qualified programs may not perform every procedure. Participation by the fellow as either the primary operator or the primary assistant is satisfactory involvement.

A minimum number of procedures is necessary, but this is not sufficient to prepare a trainee for a career in cardiac catheterization and intervention. Also important to a successful career, and perhaps more crucial, are technical facility and good clinical judgment. During advanced training the trainee must acquire sophisticated skills in complex

Table 1. Recommended Body of Knowledge Covered During Core Training

- Indications for and risks of cardiac catheterization and angiography
- Indications for and risks of therapeutic catheter procedures
- Interpretation of pressure waveforms
- Interpretation of O₂ saturation data
- Fick principle and shunt calculations
- Vascular resistance calculations
- Cardiac angiography: basic techniques/angles/interpretation
- Radiation safety

Table 2. Core Training—Recommended Minimum Case Numbers*

Total cardiac catheterizations	100
Interventional procedures	20
Type of intervention	
Balloon septostomy†	5
Other	Not specified

*Numbers represent the median response from the Training Program Survey. †Fluoroscopic or echocardiographic guidance.

catheter manipulations, wire and sheath exchanges, device implantation techniques, and retrievals. Furthermore, good clinical judgment regarding the indications for and against intervention require a thorough knowledge of the natural history of congenital cardiac defects (5,6), and of the medical, catheter, and surgical options available for treatment. It is the responsibility of the training program director to assure that each advanced trainee graduates with the technical skills, clinical judgment, and cognitive knowledge to pursue an independent career in pediatric cardiac catheterization.

A log book is to be maintained by the advanced fellow to document the nature and outcome of each diagnostic and interventional procedure he or she participated in throughout training. The fellow should also participate actively in regular cardiac catheterization teaching and morbidity conferences where outcomes and complications of interventional procedures are thoroughly discussed (see the previous text). Finally, it is strongly recommended that the advanced fellow participate in at least one clinical research project related to cardiac catheterization and/or interventional cardiology.

Advanced training in pediatric cardiac catheterization requires a dedicated 12-month experience, at a minimum. Some fellowship programs may be able to offer the recommended advanced training experiences during a 3- or 3.5-year training program. Nevertheless, even in those programs additional training provides the fellow an opportunity to enhance technical skills and clinical judgment in this very complex specialty. The authors of this document believe that the highest-quality training is obtained during a

Table 3. Advanced Training—Recommended Minimum Case Numbers*

Total cardiac catheterizations	200
Interventional procedures	100
Type of intervention	
Balloon septostomy†	5
Transseptal puncture	10
Pulmonary valve dilation	10 (5 newborns)
Aortic valve dilation	10 (5 newborns)
Pulmonary artery dilation	10
Pulmonary artery stent	10
Coarctation dilation	10
Coarctation stent	5
Collateral occlusion	10
Ductus arteriosus occlusion	10
Atrial septal defect occlusion	10

*Numbers represent the median response from the Training Program Survey. †Fluoroscopic or echocardiographic guidance.

