Task Force 4: Pediatric Cardiology Fellowship Training in Electrophysiology[1]

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PII: S0735-1097(15)00810-4

DOI: 10.1016/j.jacc.2015.03.005

Reference: JAC 21055

To appear in: *Journal of the American College of Cardiology*

Please cite this article as: Dubin AM, Walsh EP, Franklin W, Kanter RJ, Saul JP, Shah MJ, Van Hare GF, Vincent, JA, Task Force 4: Pediatric Cardiology Fellowship Training in Electrophysiology[1], *Journal of the American College of Cardiology* (2015), doi: 10.1016/j.jacc.2015.03.005.

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Task Force 4: Pediatric Cardiology Fellowship Training in Electrophysiology[1]

Endorsed by the Pediatric and Congenital Electrophysiology Society

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1. Introduction

1.1. Document Development Process

The Society of Pediatric Cardiology Training Program Directors (SPCTPD) board assembled a steering committee which nominated 2 chairs, 1 SPCTPD steering committee member, and 5 additional experts from a wide range of program sizes, geographic regions, and subspecialty focus. Representatives from the American College of Cardiology (ACC), American Academy of Pediatrics (AAP), American Heart Association (AHA), and Pediatric and Congenital Electrophysiology Society (PACES) participated. The steering committee member was added to provide perspective to each task force as a "non-expert" in that field. Relationships with industry and other entities were not deemed relevant to the creation of a general cardiology training statement; however, employment and affiliation information for authors and peer reviewers are provided in Appendices 1 and 2, respectively, along with disclosure reporting categories. Comprehensive disclosure information for all authors, including relationships with industry and other entities, is available as an online supplement to this document (http://jaccjacc.acc.org/Clinical_Document/Ped_TS_TF4_Comprehensive_RWI_Supplement.pdf).

The writing committee developed the document, approved it for review by individuals selected by the participating organizations (see Appendix 2), and addressed their comments. The final document was approved by the SPCTPD, AAP, and AHA in February 2015 and approved by the ACC and endorsed by PACES in March 2015. This document is considered current until the SPCTPD revises or withdraws it.

[1] The American College of Cardiology requests that this document be cited as follows: Dubin AM, Walsh EP, Franklin W, Kanter RJ, Saul JP, Shah MJ, Van Hare GF, Vincent JA. Task force 4: pediatric cardiology fellowship training in electrophysiology. J Am Coll Cardiol. 2015;••:••••–••••.

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1.2. Background and Scope

Pediatric electrophysiology is a rapidly evolving field. New technology for implantable devices and ablations and advances in the genetic diagnosis of channelopathies challenge the pediatric electrophysiologist. The need for formal guidelines to train the pediatric cardiologist in electrophysiology is readily apparent, with a formal statement from the AHA, ACC and Heart Rhythm Society (HRS) published in 2005 (1). This initial set of guidelines was derived in part from training guidelines in adult clinical cardiac electrophysiology but recognizes the important difference between the pediatric and adult arrhythmia patient (2).

Pediatric patients differ in important ways from adult patients, as recognized by the separate training programs and board certifications for adult and pediatric cardiologists. The pediatric cardiologist should be able to manage the child with a structurally normal heart and supraventricular tachycardia (SVT) and the child with a perioperative arrhythmia following congenital heart disease (CHD) repair, as well as be knowledgeable about the fetus with an in utero arrhythmia and where and when to refer. The adult CHD patient offers further challenges. These new guidelines have been modified to reflect the changing practice of pediatric electrophysiology and stress the need for a working understanding of genetic channelopathies, as well as the importance of a deeper understanding of the indications for – and management of – the present generation of pacemakers, defibrillators, resynchronization devices, and implantable loop recorders.

Our revised training recommendations describe the program resources and environment that are required for training pediatric cardiology fellows, together with a competency-based system promulgated by the American College of Graduate Medical Education (ACGME), to implement specific goals and objectives for training pediatric cardiology fellows. This system categorizes competencies into 6 core competency domains: Medical Knowledge, Patient Care and Procedural Skills, Systems-Based Practice, Practice-Based Learning and Improvement, Professionalism, and Interpersonal and Communication Skills, along with identification of suggested evaluation tools for each domain. Core competencies unique to pediatric cardiac electrophysiology are listed in Section 3 (see the Training Guidelines for Pediatric Cardiology Fellowship Programs Introduction for additional competencies that apply to all Task Force reports).

1.3. Levels of Expertise – Core and Advanced

Core training must be available at all centers with a fellowship program in pediatric cardiology. The core curriculum described in Section 3 is intended to be sufficient for fellows who do not plan a

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formal career in electrophysiology. Core training is required for all trainees and is intended to ensure that fellows acquire the knowledge base and skills necessary to become a pediatric cardiologist referring his/her patient for more detailed and invasive rhythm investigation. Advanced training guidelines are designed for fellows who wish to embark on a career that will include invasive electrophysiology procedures. Advanced electrophysiology training should only take place at select centers with a procedural volume that can satisfy the minimum recommended procedural experience (see Section 4).

2. Program Resources and Environment

For training in pediatric electrophysiology, training should be obtained in a center where there is a pediatric cardiology training program accredited by the Accreditation Council for Graduate Medical Education (ACGME). Pediatric catheterization laboratory facilities should be available with the appropriate equipment to perform electrophysiology studies and catheter ablation. Such facilities should include the capability for 3-dimensional electroanatomic mapping, and be equipped for both radiofrequency ablation and catheter cryoablation. The program must also have facilities for the implantation of arrhythmia control devices (i.e., pacemakers, implantable cardioverter-defibrillators [ICDs]). In some settings, this will be the pediatric cardiac catheterization laboratory or electrophysiology laboratory, and in others, it may be the operating room. The center's clinical procedural volume must be sufficient to allow for exposure of each trainee to clinical cases in numbers that satisfy trainee procedure volume expectations. Some centers may have inadequate volume in every clinical area to ensure that trainees get adequate exposure in the allotted core training period, particularly when considering exposure to pacemaker and ICD implantation. In such cases it may be feasible for a trainee to gain this experience at a partner adult institution. At least 1 board-certified pediatric cardiologist with advanced electrophysiology skills should be identified as the director of the pediatric electrophysiology core training program, and at least 1 staff cardiologist and/or cardiac surgeon should be skilled in the implantation of pacemakers and ICDs.

Although third-tier board certification is not available through the American Board of Pediatrics for the subspecialty of pediatric electrophysiology, the International Board of Heart Rhythm Examiners (IBHRE) now offers certification examinations for competency in both pediatric cardiac electrophysiology and cardiac rhythm device therapy. For any center offering *advanced* fellowship training, at least 1 electrophysiology staff member should hold current certification in either (or both) of the IBHRE exams.

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3. Core Training: Goals and Methods

By the completion of the core training period, the trainee should achieve high-level competency in clinical aspects of noninvasive electrophysiology. Table 1 lists the core curricular competencies for pediatric electrophysiology, along with corresponding evaluation tools. Specifically, they should be able to independently evaluate, treat, and know when to refer young patients with syncope, palpitations, supraventricular arrhythmias, ventricular arrhythmias, atrioventricular conduction disturbances, and all forms of early postoperative arrhythmias. They will have developed skills in risk assessment for sudden death in young patients having heritable disorders and in those having worrisome but nonspecific symptoms or laboratory findings. They should understand the indications for and be competent in the interpretation of electrocardiograms (ECGs), ambulatory rhythm monitoring (Holter), and event monitoring. There should be adequate diversity in clinical material, such that patients having pre- and post-operative congenital heart disease are adequately represented.

Basic science knowledge in the core curriculum includes pharmacology, cellular and anatomic electrophysiology, molecular and clinical genetics, and rudimentary physics. This knowledge should be acquired in the context of clinical care, didactic lectures, bedside teaching, and independent reading. This knowledge will be applied to the use of pharmacologic agents to treat arrhythmias in the fetus, child, and adolescent and those having CHD, including specific understanding of electrophysiologic pharmacodynamics, pharmacokinetics, drug-drug interactions, drug-electrolyte interactions, and side-effects; expert knowledge of the anatomy of the conduction system in congenital heart disease; working knowledge of the genetics of channelopathies and cardiomyopathies, the indications to order genetic testing, general interpretation of the results of genetic testing for such conditions; and basic knowledge of the physics of pacing, cardioversion, defibrillation, and therapeutic ablation of arrhythmia substrates..

The trainee should acquire basic knowledge regarding nonpharmacologic electrophysiology, heretofore defined as invasive electrophysiology. Table 2 delineates the recommended minimal procedural experience required to assess competency in pediatric cardiac electrophysiology for both core and advanced training. By the completion of core training, the individual should be capable of managing acute pacing strategies including the use of temporary transvenous pacing catheters, esophageal electrode catheters, and percutaneous surgical wires. This includes skills in arrhythmia interpretation of acute post-operative arrhythmias; management, and follow-up of temporary pacing systems; termination of SVT and/or VT with pacing maneuvers; and indications, techniques, and associated risks (including stroke) of elective and emergent direct current cardioversion. This also includes the ability to determine pacing and sensing thresholds. It is expected that the trainee will have contemporary knowledge of indications, risks,

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benefits, and limitations of electrophysiologic testing and catheter ablation of tachyarrhythmias. They will have general understanding of the diagnostic methods for discriminating arrhythmia types using intracardiac testing, the use of pharmacologic agents during testing, principles of substrate mapping, and fundamental risks and methodologies of catheter ablation. They will be capable of interpreting common and straightforward intracardiac electrograms, including electrical interval measurements. These skills will be accomplished by a combination of clinical exposure, conferences, didactic lectures, and supplemental reading.

All trainees should understand the indications for pacemaker and ICD placement, know the differences in pacing modes, be capable of performing basic pacemaker interrogation, be able to perform fundamental reprogramming and trouble-shooting, and recognize basic device and lead malfunction. This includes recognition of sensing abnormalities, failure to capture, and battery end-of-service characteristics. The trainee will be able to evaluate the radiographic studies and perform basic device evaluation in young patients presenting with symptoms that could be attributable to device malfunction.

Table 1. Core Curricular Competencies and Evaluation Tools for Pediatric Electrophysiology

Medical Knowledge:

- Know the cellular and whole organ electrophysiology.
- Know the anatomy and embryology of conduction tissues.
- Know the developmental changes in cardiac rates and rhythm with age.
- Know the basic mechanism of arrhythmias.
- Know the clinical presentation and mechanisms of supraventricular tachycardias.
- Know the clinical presentation and mechanisms of ventricular tachycardias.
- Know the clinical presentations and mechanisms of channelopathies and hereditary cardiomyopathies.
- Know the clinical presentations of and mechanisms of bradycardia and atrioventricular block.
- Know the clinical presentations and diagnoses of fetal arrhythmias.
- Know the presentations and mechanisms of palpitations, syncope, and sudden cardiac death in the young.
- Know the specifics for clearance for sports participation.
- Know the mechanisms and types of arrhythmias in CHD.
- Know pacing modes, basic pacemaker interrogation, pacemaker or ICD types, and basic trouble-shooting for pacemaker and implantable defibrillator therapy.
- Know the indications and risks for invasive electrophysiology studies.
- Know the basic principles of mapping and catheter ablation.
- Know the indications for arrhythmia surgery.
- Know the indications for utilizing antiarrhythmic drug therapy.

Evaluation Tools: direct observation, conference participation and presentation, procedure logs, in-training examination

Patient Care and Procedural Skills:

- Have the skills to utilize ECG, Holter monitoring, exercise testing, and event monitors as diagnostic tools.
- Have the skills to use pharmacologic agents, esophageal or intracardiac pacing, and direct current cardioversion in the acute stabilization of arrhythmias.
- Have the skills to interpret basic electrophysiology information obtained through electrophysiology studies and

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catheter ablation therapy.
- Have the skills to apply adult arrhythmia data to pediatric practice where relevant.

Evaluation Tools: direct observation, conference participation, procedure logs

ECG indicates electrocardiography; CHD, congenital heart disease; and ICD, implantable cardioverter-defibrillator.

Table 2. Recommended Minimal Procedural Experience to Assess Competency in Pediatric Cardiac Electrophysiology

Procedure	"Core" Suggested No. of Procedures	"Advanced" Suggested No. of Procedures
Noninvasive		
ECG interpretation	500	1500
Holter/Event/Rhythm strips	50	400
Exercise testing rhythm	10	20
Post-operative epicardial wire/esophageal study	5	20
D/C cardioversion	4	10
Simple Electrophysiology Studies/Ablation		
Diagnostic study	10	10
Ablation for AP and AVNRT	5	50
Complex Ablation		
Small/young patients	-	5
3D mapping in CHD	-	10
Intraoperative Electrophysiology		
Assist epicardial pacemaker	-	5
Assist epicardial ICD	-	3
Intraoperative ablation	-	3
Simple Devices		
Test and program pacemaker/ICD	20	100
TV pacemaker implant/revision	-	20
TV ICD implant/revision	-	15
Complex Devices		
Implant pacemaker/ICD in young/CHD	-	10
Resynchronization pacing	-	5
Lead Extraction	-	5

3D indicates 3-dimensional; AP, accessory pathways; AVNRT, atrioventricular nodal reentrant tachycardia; CHD, congenital heart disease; ICD, implantable cardioverter-defibrillator; No., number; and TV, transvenous.

4. Advanced Training: Goals and Methods

Advanced training guidelines for pediatric electrophysiology were recently reviewed and updated by the Pediatric and Congenital Electrophysiology Society (PACES) and the HRS (3). That publication should be referred to for a comprehensive training syllabus and detailed description of procedural instruction. Included here is a brief synopsis of advanced pediatric electrophysiology training.

The goal of advanced electrophysiology training is to equip new practitioners with the knowledge and technical skills necessary to manage all manner of rhythm disorders in the fetus, infant, child, and adolescent, as well as in adults with CHD. This must involve extensive instruction in invasive procedures, including intracardiac electrophysiologic studies, catheter ablation, and implantable devices. The new

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guidelines for advanced training (3) recognize that learning curves for complex technical skills do not reach a plateau at the moment of graduation from formal instruction but will continue to rise throughout a trainee's early career. Additional mentoring may be required to achieve full competency in certain demanding procedures such as lead extraction and ablation in the setting of complex anatomy.

Trainees entering an advanced fellowship in pediatric electrophysiology must have successfully completed a core fellowship and be eligible for certification by the Cardiology Subboard of the American Board of Pediatrics (or its equivalent). Attaining advanced skills requires 12 months or more of focused training at an accredited high-volume academic center. The program must include instruction in all important bench science and clinical science that underlies the field, with particular emphasis on CHD, developmental influences on rhythm status, and hereditary arrhythmias. This information should be conveyed through a combination of bedside teaching, directed readings, and an organized series of didactic lectures. See Table 2 for a brief summary of the minimal procedural experience required to assess competency for advanced trainees.

5. Evaluation and Documentation of Competence

All training programs should include written goals and objectives for each cardiac electrophysiology rotation with performance goals set according to the fellow's level of training. These will serve as the basis for formative feedback. A copy of these goals and objectives should be supplied and explained to the trainee at the onset of fellowship training and reviewed at the beginning of each rotation. Evaluation of fellows should be performed midway through, and at the completion of, each rotation; evaluations should be directed towards whether the fellow met those pre-specified aims. The fellow evaluation should be performed by the cardiac electrophysiology lab director and/or senior cardiac electrophysiology physician chosen as director of electrophysiology training. The fellow evaluation should assess the fellow's performance in each of the 6 areas of core competencies, as appropriate for the level of training, and should be based on direct observation of the fellow. Evaluation of competency in preparation, performance, and interpretation of the results of a procedure should be given more consideration than a focus on the number of procedures performed. Evaluation of competency should be done in person with the trainee and documented in their fellowship record. If the trainee is not progressing as expected, remedial actions should be arranged and documented in accordance with institutional procedures. All fellows should maintain a log (preferably electronic) of all procedures performed.

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APPENDIX 1. AUTHOR RELATIONSHIPS WITH INDUSTRY AND OTHER ENTITIES (RELEVANT)—TASK FORCE 4: PEDIATRIC CARDIOLOGY FELLOWSHIP TRAINING IN ELECTROPHYSIOLOGY

Committee Member	Employment	Consultant	Speaker's Bureau	Ownership/ Partnership/ Principal	Personal Research	Institutional/ Organizational or Other Financial Benefit	Expert Witness
Anne M. Dubin *(Co-Chair)*	Stanford University—Professor, Pediatrics; Lucile Packard Children's Hospital, Stanford—Director, Pediatric Arrhythmia Service	None	None	None	None	None	None
Edward P. Walsh *(Co-Chair)*	Harvard Medical School—Professor of Pediatrics; Boston Children's Hospital—Chief, Cardiac Electrophysiology Division	None	None	None	None	None	None
Wayne Franklin	SafeCG—President/CEO	None	None	None	None	None	None
Ronald J. Kanter	Miami Children's Hospital—Director, Electrophysiology; Duke University—Professor Emeritus	None	None	None	None	None	None
J. Philip Saul	Ohio State University—Professor and Chair, Department of Pediatrics; Associate Dean, Pediatric and Transitional Health; Nationwide Children's Hospital	None	None	None	None	None	None
Maully J. Shah	University of Pennsylvania Perelman School of Medicine—Associate Professor, Pediatrics; The Children's Hospital of Philadelphia—Director, Cardiac Electrophysiology	None	None	None	None	None	None
George Van Hare	Washington University School of Medicine—Louis Larrick Ward Professor of Pediatrics; Saint Louis Children's Hospital—Director of Pediatric Cardiology	None	None	None	None	None	None
Julie A. Vincent	Columbia University, College of Physicians and Surgeons—Division Chief, Pediatric Cardiology; Welton M Gersony Associate Professor of Pediatric Cardiology; Associate Professor of Pediatrics at CUMC; New York-Presbyterian Hospital—Director, Pediatric Interventional	None	None	None	None	None	None

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Committee Member	Employment	Consultant	Speaker's Bureau	Ownership/ Partnership/ Principal	Personal Research	Institutional/ Organizational or Other Financial Benefit	Expert Witness
	Cardiology						

For the purpose of developing a general cardiology training statement, the ACC determined that no relationships with industry or other entities were relevant. This table reflects author's employment and reporting categories. To ensure complete transparency, authors' comprehensive healthcare-related disclosure information—including RWI not pertinent to this document—is available in an online data supplement (http://jaccjacc.acc.org/Clinical_Document/Ped_TS_TF4_Comprehensive_RWI_Supplement.pdf). Please refer to http://www.acc.org/guidelines/about-guidelines-and-clinical-documents/relationships-with-industry-policy for definitions of disclosure categories, relevance, or additional information about the ACC Disclosure Policy for Writing Committees.

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APPENDIX 2. PEER REVIEWER RELATIONSHIPS WITH INDUSTRY AND OTHER ENTITIES (RELEVANT)—TASK FORCE 4: PEDIATRIC CARDIOLOGY FELLOWSHIP TRAINING IN ELECTROPHYSIOLOGY

Name	Employment	Representation	Consultant	Speaker's Bureau	Ownership/ Partnership/ Principal	Personal Research	Institutional/ Organizational or Other Financial Benefit	Expert Witness
Dianne Atkins	University of Iowa—Division of Pediatric Cardiology	AHA	None	None	None	None	None	None
Lee Beerman	Children's Hospital of Pittsburgh—Associate Professor, Pediatrics, Cardiology Division	AHA	None	None	None	None	None	None
Regina Lantin-Hermoso	Texas Children's Hospital	ACC ACPC Council	None	None	None	None	None	None
Carole Warnes	Mayo Clinic—Professor, Medicine	ACC BOT	None	None	None	None	None	None
Eric Williams	Indiana University School of Medicine—Professor (Cardiology) and Associate Dean; Indiana University Health, Cardiology Service Line Leader	ACC CMC Lead Reviewer	None	None	None	None	None	None

For the purpose of developing a general cardiology training statement, the ACC determined that no relationships with industry or other entities were relevant. This table reflects peer reviewers' employment, representation in the review process, as well as reporting categories. Names are listed in alphabetical order within each category of review. Please refer to http://www.acc.org/guidelines/about-guidelines-and-clinical-documents/relationships-with-industry-policy for definitions of disclosure categories, relevance, or additional information about the ACC Disclosure Policy for Writing Committees.

ACC indicates American College of Cardiology; ACPC, Adult Congenital and Pediatric Cardiology; AHA, American Heart Association; BOT, Board of Trustees; and CMC, Competency Management Committee.

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