Cardiology in the Young (2015), **25**, 1602–1607
doi:10.1017/S1047951115002139

Original Article

Commentary on the required skills for ambulatory cardiac care in the young: is training necessary?*

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Abstract Extensive supplemental training exists for many subspecialty disciplines within fellowship training for paediatric cardiology in the United States of America. These disciplines, or domains, such as echocardiography, cardiac intensive care, interventional cardiology, and electrophysiology, allow for initial exposure and training during the basic 3 years of fellowship, plus mandate a 4th year of advanced training; however, ambulatory cardiology has no in-depth or additional training beyond the basic clinical exposure during fellowship training. Ambulatory cardiology is not included in the recommended scheduling of the various domains of cardiology training. This document reviews the reasons to consider augmenting the depth and breadth of training in ambulatory paediatric cardiology.

Keywords: Outpatient; clinic; private practice; academic practice

Received: 6 September 2015; Accepted: 18 September 2015

In the United States of America, paediatric and congenital cardiologists who provide fetal, child, adolescent, and adult congenital cardiac care undergo 3 years of fellowship training in this discipline. During those 3 years, as in many other specialties, trainees acquire numerous clinical and procedural skills in order to care for their patients. They learn a specific collection of strategies and skills to manage the various medical situations affecting these patients. These domains include the ability to perform and to interpret echocardiograms and cardiac catheterisations; to interpret electrocardiograms, other electrophysiological monitors, and exercise stress tests; and to evaluate and manage patients appropriately in an intensive care setting, in a step-down inpatient setting or its equivalent, and in the outpatient clinic. These strategies derive from a combination of experience, opinion, and research collected by both the teachers of these trainees and the trainees themselves. At the conclusion of their training, they are expected to be proficient enough in multiple domains of paediatric and congenital cardiology and should be able to practice in almost any general paediatric cardiac practice. Yet, unlike the majority of components that create a competent paediatric cardiologist, training in the outpatient clinic is often the least structured part of the training programme.

For instance, fellowship trainees are taught how to treat the complex pathophysiology of a newborn with hypoplastic left heart syndrome, balancing the optimisation of systemic versus pulmonary blood flow, ensuring prostaglandin is infused, assessing for side-effects of treatment, etc. This treatment is a well-studied, long-practised, and often rehearsed melange of behaviours, medications, and knowledge. In contrast, this similar mixture is lacking in the outpatient setting. Simple acts, such as how soon and how frequently to see a post-operative patient in follow-up, are more a function of habit or opinion than data. The therapy of congestive heart failure in a patient with acyanotic heart disease is also a matter of fiat and experience with few extra data, besides the adult cardiology literature, to guide the practitioner. In fact, the choice of medications, the optimal dose, the amount of time to await a response, and the

*Presented at the Children's Hospital of Philadelphia Cardiology 2015: 18th Annual Update on Pediatric and Congenital Cardiovascular Disease: "Challenges and Dilemmas", Scottsdale, Arizona, United States of America, Wednesday February 11, 2015 – Sunday, February 15, 2015.

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signposts that indicate that it is time to abandon medical care and transition to surgical intervention depend much more on a "wait and see" attitude than a body of literature that has determined best practices. Most cardiologists, at some point in their early career, recognise this deficiency, particularly as they enter independent practice. It can take several years for doctors to settle into a personal style of patient management with which they are comfortable and to believe that they are caring for patients in an appropriate manner. Anecdotally, some new graduates may be advised by their teachers to "get an echo on many patients seen early in their practice" and that they "will get more comfortable with physical diagnosis skills, and cut back on needing those studies as time goes on". Much of outpatient practice is a combination of trying methods that have been observed, sifting through various opinions that have been heard, and experiencing trial-and-error successes and failures. Learning this assimilatory skill is the "practice" of medicine.

At the same time, ambulatory cardiology patients are often the "bread and butter" of paediatric and congenital cardiology, such as patients with murmurs, chest pain, palpitations, dizziness, and syncope. The large majority of these patients is often normal and has no cardiac disease. Thus, it is interesting to note that, for some providers in academic paediatric cardiology practices, the outpatient clinic is often, either overtly or inadvertently, approached with a negative attitude by those practitioners who do not work in the clinic on a routine basis; one might hear the opinion "anyone can do clinic", the implication being that it is mundane and requires little extra training. Others feel that it is more of a burden required for revenue generation, and that it allows less time to do the things they would prefer, such as research or their own domain of sub-specialisation. For some, it becomes a repetitive onus or an unexciting experience; however, patients with congenital cardiac defects fare no better in the clinic. Despite the fact that many medical disciplines, including inpatient cardiology, have generated pathways of patient care in order to limit variability and to improve outcomes, the concept of utilisation of guidelines in the outpatient clinic is met with concerns of loss of autonomy and the intrusion of "cookbook medicine".

On the surface, the clinic exists as the place where patients undergo initial consultation for non-acute problems and for follow-up of chronic problems, and the outpatient clinician provides that necessary evaluation and follow-up. Sometimes, consultations are required for genetic diseases, and therefore the ambulatory cardiologist must be familiar with patient and family screening and the accompanying counselling associated with these heritable problems. Beyond the screening and counselling, the outpatient clinician educates patients and families on other important topics: how the patient can have as normal a life as possible; appropriate antibiotic prophylaxis, medication use, and exercise participation; and transition and transfer.

Yet, behind the obvious utility, there are less overt functions that the clinic, and the ambulatory cardiologist, fulfils. The outpatient clinicians act as the face of the cardiology group. They serve as the interface with referring providers as well as the caregiver with whom the patients and families bond. The roles of the clinic provider include being a practice builder, growing the referral base, as well as educating the providers in the community. Although not readily acknowledged, the role of gatekeeper is yet another task handled by the outpatient doctor – for example, although echocardiography is much less expensive compared with a surgical procedure, the revenue generated by the volume of studies performed in the outpatient setting rivals that of interventional procedures by the economy of scale. Determining the appropriate utilisation of this tool is an integral task performed daily. Furthermore, the clinician is the resource through which inpatient procedures such as surgery, interventional catheterisation, and electrophysiology are referred.

Although not specifically delineated in any training guidelines, the ability to conduct an ambulatory cardiology practice has extra requirements as well. An understanding of business management – including leadership, organisation, and administration – is key to the success of any medical practice, although this is not a requirement of training. Understanding how to leverage outreach and the building of a practice is a skill that has traditionally been accomplished informally, by observing the modelling of teachers in the absence of a formal approach; however, as the environment for training occurs at academic centres, learning how to prepare for a career in private practice cardiology is typically limited or absent. It is not enough that the academic training programmes teach the fellows about the organisation and performance of research. To be able to successfully improve the way outpatient medicine progresses, it is necessary to know how to study long-term outcomes, management protocols, reduction of variability, and process improvement. These often are not included in the curriculum of a cardiology fellowship.

Since the advent of cardiac surgery in the late 1930s, paediatric and congenital cardiology has progressed over the ensuing 70-plus years from palliative management to keep patients alive to performing increasingly complex interventions that attempt to normalise much of the anatomy and physiology of the patient. Improved peri-operative care and reduced mortality and morbidity have become the norm, such that there are now more adults than children

with congenital cardiac disease. Yet, it has only been recently recognised that there is more to the care of these patients than just performing surgical or catheter interventions. Longer-term outcomes, including neurodevelopmental abnormalities, are now being evaluated more regularly, as the more subtle, less visible, and time-dependent aspects of the complications of both their disease and the interventions emerge and are studied; however, these studies occur downstream after a period of time in which various outpatient cardiologists have managed these patients in his or her own way that is not standardised or validated. The same strides achieved in the other realms of care have not translated to care in the outpatient clinic.

It is interesting to note that the writing committee that created the training recommendations for fellowship in paediatric cardiology as part of the American College of Cardiology Foundation/American Heart Association/American College of Physicians Task Force on Clinical Competence in 2005[1] omitted outpatient clinic exposure and training from the various required experiences (Table 1). Although "general experience" was listed, the accompanying parenthetical clarification specifically refers to inpatient experience, which usually takes place in a step-down or general care unit; cardiac intensive care is denoted separately. The writing group painstakingly defined the minimum numbers of procedures needed to be performed and/or interpreted for both core as well as advanced training in cardiac catheterisation (Tables 2 and 3), electrophysiology (Table 4), and echocardiography (Table 5). On the other hand, there were no specific requirements for exposure to certain disease processes or numbers of patients cared for in the same document. A "core knowledge base" composed of various topics necessary for general cardiology education was listed (Table 6). These topics are variably addressed throughout the various trainee rotations, such as echocardiography, inpatient service, electrophysiology, etc. Most cardiology fellows typically have a half-day continuity clinic, in which they see patients specifically assigned to that clinic or patients empanelled to an attending provider. Some patients require follow-up for specific cardiac diagnoses, whereas many are referrals with new symptoms. The only guideline mentioned for the outpatient clinic in the training recommendations is that it should start "early in training," be at least bi-weekly, and allow for the need for continuity of care.[1]

Even if more time could be dedicated to training in ambulatory cardiology, the amount of available time needed for training a cardiology fellow is being reduced by numerous and mounting pressures. The American College of Graduate Medical Education has placed progressive restrictions on the number of hours of work that a trainee can have.[2,3] This has led to fewer continuous hours of work, as well as fewer overall allowed hours of work, combining to create a loss of training time. This coincides with an increase in the administrative paperwork required of the trainees, including routine faculty assessments and maintenance of both patient logs and procedure logs. Compounding this, the field of cardiology continues to expand its technologies and disciplines, including

Table 1. Core training recommendations.

Experience	Time commitment (in months)
General experience (inpatient)	3–6
Echocardiography/imaging	4–6
Cardiac catheterisation	3–4 (estimate*)
Electrophysiology	2–3
Cardiac intensive care	2–4
Adult congenital heart disease	0–2 (estimate*)
Research	12–18
Total	36

From Graham and Beekman[1]
*Task Force identified experience-based recommendation. See individual section for numbers

Table 2. Core training.*

	Recommended minimum case numbers
Total cardiac catheterisations	100
Interventional procedures	20
Type of intervention	
Balloon septostomy**	5
Other	Not specified

From Graham and Beekman[1]
*Recommended minimum case numbers
**Fluoroscopic or echocardiographic guidance

Table 3. Advanced training.*

	Time commitment (in months)	
Total cardiac catheterisations	200	
Interventional procedures	100	
Type of intervention		
Balloon septostomy**		
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	10	
Occlusion		

From Graham and Beekman[1]
*Recommended minimum case numbers
**Fluoroscopic or echocardiographic guidance

https://doi.org/10.1017/S1047951115002139 Published online by Cambridge University Press

Table 4. Core and advanced training: recommended minimum experiences

Level of training	Core paediatric cardiology training	Advanced paediatric EI* training
Training time	2–3 months equivalent	12 months or more after general PC training*
ECG interpretation	500**	1500
Ambulatory ECG interpretation	50	200
Exercise ECG	10	40
Tilt table tests	2	10
Transoesophageal EPS/temporary post-operative epieardial wire study	5	10
Intracardiac EPS	10	75***
Intracardiac EPS at 12 years of age or less		40
Intracardiac EPS in repaired congenital heart disease		10
Catheter ablation	5	40
Catheter ablation at 12 years of age of age or less		20
Catheter ablation in repaired congential heart disease		10
DC cardioversion	4	10
Pacemaker + ICD		
Evaluations/follow-up	20	50
Intra-operative evaluation pacemakers and devices		35 (20 new, 10 revisions, 5 ICDs)
Track 2: implant pacemaker and complex devices		50 (15 in ages 12 years or less)

DC = direct current; ECG = electrocardiogram; EPS = electrophysiological study; ICD = implantable cardioverter defibrillator
From Graham and Beekman[1]
*4 to 6 months of this training could be obtained during a regular 3-year pediatric cardiology training program if it did not interfere with other required training
**ECG reading may be performed throughout three-year fellowship
***The diagnostic portion of an ablation procedure may be used to satisfy this requirement

Table 5. Echocardiogiaphy training: recommended minimum procedure numbers.

Core training	
TTE perform and interpret (<1 year of age)	150 (50)
TTE review	150
Advanced training*	
TTE perform and interpret (<1 year of age)	200 (50)
TTE review	200
TEE perform and interpret	50
Fetal echocardiogram	50

TTE = transthoracic echocardiogram
From Graham and Beekman[1]
*Numbers are in addition to those obtained during core training

the need to be facile with interpreting magnetic resonance and computed tomography images, new advances in cardiac intensive care, pulmonary hypertension, and care of the adult with congenital heart disease – all concepts that did not exist, or were in limited use, as little as 20 years ago. These factors combine to require the training directors to become creative in time allocation for training.

Eventually, once trainees complete their education, how do we know how well they do in the clinic and in their practice? Certainly, this valuable information, if fed back to the training programmes, would help in improving the educational process. We do know that disciplines such as echocardiography and catheterisation have minimum requirements for procedure volume and for accreditation; however, other than direct observation during training, we typically do not know how our fellows subsequently perform. There are two notable exceptions to this, however: research and publications and academic achievement, although this may not occur in private practice. It is tempting to want to use the passing of board examinations and maintenance of certification requirements as a proxy for the demonstration of success, but these have not been demonstrated to correlate with quality performance in the outpatient clinic. A recent study[4] did show that there was higher utilisation of echocardiography in the outpatient clinic for the diagnosis of innocent murmurs during the first 10 years after completion of training (54%) compared with later in the career (39%). This is concerning, as several previous studies have demonstrated that paediatric cardiologists were the highest skilled medical practitioners in the clinical discernment of innocent murmurs using just the history and physical examination.[5–7] In addition, although the physical examination is not perfect, it is difficult to assess the quality of these skills when relatively inexpensive technologies such as handheld echocardiography can quickly lead to, or rule out, a diagnosis in the absence of the need for physical examination. The pushback on this, however, will likely come as the climate of reimbursement for medical care limits what are considered to be unnecessary expenditures. This means that the practitioner will likely have to justify increased utilisation of testing compared with peers. It is interesting to note that both fellows as well as attending providers in adult cardiology have already demonstrated a decrease in the quality of their physical examination skills.[8,9]

https://doi.org/10.1017/S1047951115002139 Published online by Cambridge University Press

Table 6. Core knowledge base.

Anatomy and physiology of congenital heart defects (e.g., tetralogy of Fallot, hypoplastic left heart syndrome, ventricular septal defect)
Cardiac, autonomic and non-cardiac causes of syncope and near-syncope
Cardiac MRI/CT
Cardiac sequelae of chronic hepatic disease
Cardiac sequelae of chronic renal disease
Cardiac sequelae of HIV/AIDS
Cardiac sequelae of obstructive sleep apnoea
Cardiac sequelae of oncologic therapy
Cardiomyopathy, heart failure, and transplantation in children
Cardiopulmonary bypass
Cardiovascular pharmacology
Cardiovascular physiology and anatomy
Cardiovascular sequelae and follow-up of Marfan, William, DiGeorge, Turner, and Noonan syndromes
Cardiovascular sequelae of pregnancy and the impact of congenital heart disease
Cardiovascular sequelae of rheumatologic disease
Cardiovascular sports medicine
Care of the single ventricle patient
Cellular electrophysiology (e.g., action potentials and ion channels)
Chest pain
Clinical electrophysiology (e.g., mechanisms of arrhythmias, pacemakers, ablative therapy)
Coagulation and anticoagulation
Diagnosis and management of arrhythmias
Diagnosis and management of elevated pulmonary vascular resistance
Diagnosis and management of intravascular/intracardiac thrombosis
Diagnosis and management of left-to-right shunt lesions
Diagnosis and management of patent ductus arteriosus in premature infants
Diagnosis and management of right-to-left shunt lesions
Diagnosis and management of valvular heart disease, including artificial heart valves
Diagnostic evaluation of heart murmurs
Differential diagnosis and management of cardiac tumours
Differential diagnosis and management of pericardial effusion and pericardial tamponade
Embryonic, fetal, and postnatal cardiovascular development
Endocarditis
Exercise testing
Fetal/neonatal/perinatal cardiovascular physiology
Genetics of cardiovascular diseases of childhood
Hyperlipidaemia
Hypertension
Kawasaki disease
Medical ethics
Normal cardiovascular anatomy and physiology, including exercise physiology
Obesity
Pericarditis and pericardial effusions
Physics of echocardiography and Doppler analysis
Physiology and natural history of congenital heart disease
Population health
Preventive cardiology, including prevention of adult acquired heart disease
Quality assurance and process improvement methodology
Rationale, expectations, and methods of screening for congenital heart disease in neonates with trisomy of chromosome 21, 18, or 13
Rationale, expectations, and methods of screening for congenital heart disease infants of diabetic pregnancies
Rationale, expectations, and methods of screening for congenital heart disease in the presence of neonatal emergencies such as gastroschisis, omphalocele, congenital diaphragmatic hernia, or cardiorespiratory failure, leading to extracorporeal membrane oxygenation
Rheumatic fever
Risk factors in childhood and adolescence
Segmental cardiac analysis
Statistics and study design

From Graham and Beekman[1]

In summary, formal training in ambulatory paediatric cardiac care is suboptimal. It is variably defined, inconsistent among programmes, and often incomplete for practical need. Even as recently as 2015, these concerns are largely ignored. The aforementioned writing group that designed the original training guidelines[1] has recently revised and released the guidelines for training for paediatric cardiology.[10]

https://doi.org/10.1017/S1047951115002139 Published online by Cambridge University Press

This revision includes the use of domains of competency. These domains such as Medical Knowledge, Systems-Based Practice, Professionalism, and Interpersonal and Communication Skills are then applied and subdivided across several disease processes within multiple aspects of paediatric cardiology; one of those sections deals with "General Cardiology". The diseases within this section germane to ambulatory care include chest pain, syncope, Kawasaki disease, dyslipidaemias, cardiomyopathies, genetic syndromes, and left-to-right shunts; however, these are merely some of the types of patients encountered in the outpatient clinic. The remaining disease processes listed include the cyanotic newborn and right and left heart obstructive lesions, which are initially more the domain of the inpatient setting. The recommendations for the continuity clinic were supported by saying that the clinic should occur throughout the training period of the fellow. Nevertheless, threshold numbers of certain types of patients needed for exposure remain undefined. Ensuring that trainees are exposed to specific complex patients, such as those with pulmonary hypertension, cardiac transplantation, rhythm disorders, pacemakers, and adults with congenital heart disease, was addressed; of note, managing these types of complex patients requires 4th-year training for more advanced management skills.

Therefore, even with its latest iteration, training for paediatric cardiology continues to leave the practice of ambulatory cardiology as a nebulous event. Although there is considerable strengthening of the guidelines with criteria for training in the other domains of paediatric cardiology, the clinic is mostly forgotten. To remedy this will require division chiefs in academic cardiology programmes to recognise this deficiency and work towards improvement. Furthermore, consideration should be given to the creation of a 4th-year elective in ambulatory cardiology, similar to other 4th-year electives. This would require comparable guidelines for advanced training as well. Besides incorporating the evaluation of patients in the outpatient clinic, these guidelines would likely need to be multi-disciplinary in nature. It could include the need to ensure the performance and interpretation of threshold numbers of echocardiograms, exercise stress testing, and ambulatory electrocardiography – that is, Holter and transtelephonic monitors. It also could require training in administration, business management, and process improvement, such as utilisation of clinical pathways or outcomes studies, necessary skills for the modern practice. Finally, to complement this training, research in outpatient topics would be required. This could be developed as a comprehensive approach for success, no different from any of the other domains within training in paediatric cardiology. Yet, this can only be achieved when ambulatory cardiology is given the equal recognition and standing of the other domains within cardiac care. There is no doubt that more training is necessary in the required skills for ambulatory cardiology. It will be up to today's leaders to have enough vision to want to create better practitioners for tomorrow.

Acknowledgements

The author thanks Marie Gleason, MD, for her expert editing skills, teaching, counsel, and friendship.

Financial Support

This commentary received no specific grant from any funding agency, commercial, or not-for-profit sectors.

Conflicts of Interest

None.

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