

Consensus Statement by the Congenital Cardiac Anesthesia Society: Milestones for the Pediatric Cardiac Anesthesia Fellowship

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Pediatric cardiac anesthesiology has evolved as a subspecialty of both pediatric and cardiac anesthesiology and is devoted to caring for individuals with congenital heart disease ranging in age from neonates to adults. Training in pediatric cardiac anesthesia is a second-year fellowship with variability in both training duration and content and is not accredited by the Accreditation Council on Graduate Medical Education. Consequently, in this article and based on the Accreditation Council on Graduate Medical Education Milestones Model, an expert panel of the Congenital Cardiac Anesthesia Society, a section of the Society of Pediatric Anesthesiology, defines 18 milestones as competency-based developmental outcomes for training in the pediatric cardiac anesthesia fellowship. (*Anesth Analg* 2018;126:198–207)

Pediatric cardiac anesthesiology has evolved as a subspecialty of both pediatric and cardiac anesthesiology and is devoted to caring for individuals with congenital heart disease (CHD) ranging in age from neonates to adults. Second-year fellowships are offered in pediatric cardiac anesthesia after completion of a pediatric anesthesia fellowship or an adult cardiothoracic anesthesia fellowship.¹ Currently, 17 programs offer 24 positions for subspecialty training in the United States. At present, there is no accreditation process by the Accreditation Council on Graduate Medical Education (ACGME) for pediatric cardiac anesthesia fellowships.² While the structure and educational content of pediatric cardiac anesthesia fellowships have been generally defined, there currently exists substantial variability in both the training duration and the clinical and didactic content of existing programs.³ Consequently, the leadership of the Congenital Cardiac Anesthesia Society, a section of the Society of Pediatric Anesthesiology, felt it necessary to better define competency-based developmental outcomes (eg, knowledge, skills, attitudes, and performance) for training in the subspecialty. An expert panel

was convened to utilize the ACGME Milestones Model as is currently applied to anesthesia residency programs, pediatric anesthesia fellowship programs, and adult cardiothoracic anesthesia programs to develop specific milestones for pediatric cardiac anesthesia fellowship training.^{4–6}

The purpose of the fellowship year of training is to train proficient consultants in anesthesia for congenital and pediatric acquired heart disease. The goal is that this training is achieved through clinical competency and education with progress measured through the developmental milestones defined below. During the 12-month fellowship, trainees are also expected to develop consultant-level knowledge of relevant areas such as perioperative cardiac intensive care and the management of children and adults with CHD having noncardiac surgery and other procedures.

EXPERIENCE/CLINICAL EXPOSURE

The primary purpose of the fellowship year program is to train anesthesiologists to be expert in the perioperative care of patients with both simple and complex forms of congenital and pediatric-acquired cardiac disease. At the completion of the program, fellows are expected to have both sufficient knowledge of congenital cardiac pathophysiology and the applicable surgical and catheter-based interventions and the technical expertise necessary to direct the perioperative management of neonates, infants, children, and adults with congenital and pediatric-acquired heart disease undergoing cardiac and noncardiac surgery. The fellowship graduate must be able to expertly deliver anesthetic care for cardiopulmonary bypass (CPB), deep hypothermic circulatory arrest and antegrade cerebral perfusion, hemodynamic and interventional cardiac catheterization procedures, intrathoracic procedures, other cardiac procedures such as electrophysiologic studies, radiofrequency ablation, transthoracic echocardiography (TTE), transesophageal echocardiography (TEE), magnetic resonance imaging, and computerized tomography and noncardiac procedures for patients with CHD.

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Accepted for publication August 14, 2017.

The authors declare no conflicts of interest.

Reprints will not be available from the authors.

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DOI: 10.1213/ANE.0000000000002482

DIDACTIC COMPONENT

A suggested comprehensive formal didactic program would include weekly lectures on pertinent topics in pediatric cardiology, cardiac surgery, and anesthesia (eg, CPB, coagulation, myocardial preservation, cerebral protection, specific congenital cardiac lesions in children and adults), a cardiac anesthesia journal club, and a mortality and morbidity conference where interesting and complicated cases are discussed. In addition, exposure to and participation in research projects should be encouraged. Trainees should be encouraged to attend multidisciplinary, combined cardiac surgery/cardiology/cardiac anesthesia/cardiac critical care conferences and meetings where complex cases are discussed. Daily informal 1-on-1 teaching is also an important component of the educational program. Fellows are expected to fully evaluate and discuss their cases preoperatively with the responsible staff member. Intraoperative teaching (case-based and on more general didactic topics) is also emphasized and is a daily part of the fellow's education.

SUGGESTED MILESTONES FOR THE PEDIATRIC CARDIAC ANESTHESIA FELLOWSHIP

The intent is that the presented milestones will define the educational goals of the trainees and will be used to

facilitate delivery of feedback with the goal of improving performance over time. Programs will utilize these milestones to formulate a structured curriculum framework that facilitates growth of well-defined, competency-based skills for individual fellows over 12 months of training.

Suggested Milestones

Currently, the pediatric anesthesia fellowship includes 14 milestones and the adult cardiothoracic anesthesia fellowship includes 15 milestones. These are summarized in Table 1. The suggested milestones for the pediatric cardiac anesthesia fellowship would include 18 milestones based on the ACGME six core competencies as listed in Table 2.

Each of the milestones for the pediatric cardiac anesthesia fellowship listed in Table 2 is assessed based on the ACGME definition of levels 1 (basic) through 5 (independent). The ACGME defines the levels as: "Level 1, the fellow demonstrates milestones expected of an incoming fellow; Level 2, the fellow is advancing and demonstrates additional milestones but is not yet performing at a mid-fellowship level; Level 3, the fellow continues to advance and demonstrate additional milestones, consistently including the majority of milestones targeted for fellowship; Level 4, the fellow has advanced such that he or she now demonstrates mastery of the milestones

Table 1. Milestones for the Pediatric Anesthesia and Adult Cardiothoracic Anesthesia Fellowships

Pediatric Anesthesia Fellowship (14)	Cardiothoracic Anesthesia Fellowship (15)
<ul style="list-style-type: none"> • Patient care = 3 • Medical knowledge = 2 • Systems-based practice = 3 • Practice-based learning and improvement = 2 • Professionalism = 3 • Interpersonal and communications skills = 1 	<ul style="list-style-type: none"> • Patient care = 2 • Medical knowledge = 4 • Systems-based practice = 3 • Practice-based learning and improvement = 2 • Professionalism = 3 • Interpersonal and communications skills = 1

Table 2. Core Competencies and Milestones for the Pediatric Cardiac Anesthesia Fellowship

Six Core Competencies and Milestones

Patient care (4) <ul style="list-style-type: none"> • Perioperative assessment, planning, and management • Technical/procedural skills • Understanding cardiovascular surgical procedures • Understanding cardiac catheter-based therapeutic procedures and electrophysiologic studies
Medical knowledge (4) <ul style="list-style-type: none"> • Congenital and acquired cardiovascular anatomy, physiology, and pathophysiology • Pharmacology • Cardiopulmonary bypass, extracorporeal circulation, and circulatory assist device principles • Understanding cardiac diagnostic procedures (eg, echocardiography, magnetic resonance imaging, cardiac catheterization, computerized tomography)
Systems-based practice (3) <ul style="list-style-type: none"> • Coordination of care • Incorporation of patient safety and quality improvement into clinical practice • Understanding of health care economics; cost awareness and cost-benefit analysis
Practice-based learning and improvement (2) <ul style="list-style-type: none"> • Self-directed learning and scholarly activity • Education of team members and other health care providers
Professionalism (3) <ul style="list-style-type: none"> • Commitment to institution, department, and colleagues • Receiving and giving feedback • Responsibility to maintain personal, emotional, physical, and mental health
Interpersonal and communications skills (2) <ul style="list-style-type: none"> • Communication with patients and families • Interprofessional communication and transitions of care

Patient Care—Perioperative Assessment, Planning, and Management

Level 1	Level 2	Level 3	Level 4	Level 5
Obtains medical and surgical history, performs physical examinations, and obtains informed consent.	Identifies disease processes and medical issues specific to the anesthetic care of patients with CHD.	Identifies disease processes and relevant medical or surgical issues; may need guidance in identifying unusual clinical problems and their implications on anesthetic care in patients with CHD.	With conditional independence, performs a complete assessment of complex or critically ill patients with CHD.	Independently performs comprehensive assessment for all patients with CHD.
Identifies clinical issues relevant to the preparation and transport of cardiac outpatients and inpatients from the cardiothoracic unit.	With direct supervision, optimizes preparation of CHD patients receiving anesthetic care. Able to discuss the risks, benefits, and alternatives. Safely manages to transport critically ill patient with direct supervision.	With indirect supervision, optimizes preparation of patients with CHD. Manages the transport and discussion with the multidisciplinary team with indirect supervision.	With conditional independence, optimizes preparation of complex or critically ill children and transport across all age groups.	Independently serves as a consultant to other members of the health care team regarding optimal preanesthetic preparation.

Comment: Indirect supervision means while consulting with the staff anesthesiologist. Conditional independence is based on a case-by-case assessment by the staff.

Example: A 3-year-old patient presents to the preoperative clinic for evaluation before his Fontan procedure. The nurse practitioner in the clinic calls the fellow to evaluate the patient. The fellow is able to do a comprehensive preoperative evaluation on his own including a thorough medical and surgical history and physical examination. The fellow also determines that the patient was seen at an outside hospital 2 days ago and was diagnosed with upper respiratory infection (URI) and sent home. In discussion with the staff anesthesiologist, the fellow is capable of articulating the risks and benefits of proceeding with a nonemergent surgical procedure in a child with a recent URI and is able to articulate the perioperative implications of a URI in a Fontan patient.

Patient Care—Technical/Procedural Skills

Level 1	Level 2	Level 3	Level 4	Level 5
Recognizes unique characteristics of pediatric cardiac anatomy, airway management in patients with CHD, vascular access (arterial and venous).	Under direct supervision, performs pediatric airway management and places arterial and central venous lines across the age spectrum from neonates to adults with CHD.	Under direct supervision, identifies the need for advanced pediatric airway management and identifies possible complications with airway management and vascular access in patients with CHD.	With conditional independence, identifies and corrects problems and complications associated with airway management, vascular access of complex cardiac patients, and potentially associated complications.	Independently identifies and corrects problems and complications of advanced airway management and vascular access.
Demonstrates knowledge of the basic principles of ultrasound and Doppler technology.	With direct supervision, uses the ultrasound for vascular access. Displays basic skills related to TEE. This includes insertion of the TEE probe, identification of basic structures, and evaluation of ventricular function. Recognizes the complications related to the TEE insertion. Displays basic skills related to TTE and acquisition of the images.	With indirect supervision, uses ultrasound for vascular access. With direct supervision, is able to acquire images for simple congenital lesions and uses TEE for emergency cardiac evaluation. With direct supervision, uses TTE for point-of-care evaluation and diagnosis.	Independently, uses ultrasound for vascular access. With indirect supervision, is able to acquire images for simple congenital lesions and uses TEE for emergency cardiac evaluation. With indirect supervision, uses TTE for point-of-care evaluation and diagnosis.	Independently and proficiently uses the ultrasound for vascular access and TEE/TTE for diagnostic evaluation and management of the patient.
Recognizes the possible need for regional anesthesia and lung isolation techniques when applicable in patients with CHD.	Able to request and discuss the regional anesthetic and lung isolation techniques needed in patients with CHD.	Recognizes the complications related to a regional anesthetic. Manages lung isolation techniques with direct supervision (eg, double lumen endotracheal tube, bronchial blocker) in patients with CHD.	Manages lung isolation techniques with indirect supervision in patients with CHD.	Independently supervises and provides consultation to other members of the health care team for advanced airway management and difficult vascular access as well as management of complications in patients with CHD.

Example: A 13-year-old patient has undergone placement of a transvenous pacemaker. At the conclusion of the procedure, ventilation of the patient became difficult, high inspiratory pressure is necessary, and the chest rise is noted to be asymmetrical. Using lung ultrasound, the fellow demonstrates the ability to differentiate main stem bronchus intubation from the presence of a pneumothorax.

Patient Care—Understanding Cardiovascular Surgical Procedures

Level 1	Level 2	Level 3	Level 4	Level 5
Describes the interaction between the surgical procedures and the underlying clinical conditions and medical history. Describes the patient, anesthetic, or surgical risk factors unique to the patient with CHD. Recognizes presence of early postoperative cardiopulmonary and hematologic complications.	Formulates intra- and postoperative plans for patients with CHD undergoing simple procedures that include consideration of underlying clinical conditions, medical history, patient, anesthetic, and surgical risk factors unique to the patient with CHD. Identifies and manages early postoperative cardiopulmonary and hematologic complications, with direct supervision.	Formulates intra- and postoperative plans for patients with CHD undergoing increasingly complex procedures that include consideration of medical, anesthetic, and surgical risk factors and that take into consideration factors unique to this patient population. Identifies and manages early postoperative cardiopulmonary and hematologic complications, with indirect supervision.	With conditional independence, formulates and tailors intra- and postoperative care plans that include consideration of perioperative medical, anesthetic, and surgical factors unique to patients with CHD undergoing complex procedures. Identifies and manages early postoperative cardiopulmonary and hematologic complications, with conditional independence.	Independently formulates intra- and postoperative care plans that include consideration of medical, anesthetic, and surgical risk factors for complex patients and procedures. Identifies and manages early postoperative cardiopulmonary and hematologic complications independently.

Example: A 5-year-old patient has just undergone a complex re-do cardiac surgical procedure and has separated from CPB. Despite protocol-driven transfusion of coagulation factors, there continues to be significant blood loss that precludes leaving the operating room. The fellow is able to articulate a logical approach to diagnosis (activated clotting time, laboratory tests, thromboelastography/rotational elastometry) and treatment (blood product replacement, factor replacement including prothrombin complex concentrates and recombinant factor VII) of the bleeding. The fellow is able to engage the surgical team in a constructive conversation about treatment options.

Patient Care—Understanding Catheter-Based Cardiac Therapeutic Procedures and Electrophysiologic Studies

Level 1	Level 2	Level 3	Level 4	Level 5
Adapts to new settings for delivery of pediatric patient care (eg, cardiac catheterization, therapeutic interventional procedures, and electrophysiologic studies). Demonstrates knowledge of the nomenclature and the different types of pacemakers (eg, epicardial, transvenous) and implantable cardioverter defibrillators (ICDs).	With direct supervision, conducts routine intra- and postoperative care, including management of commonly encountered physiologic alterations associated with the anesthetic care of cardiac patients in the catheterization and electrophysiology laboratories. Demonstrates knowledge of the different programming options of pacemakers and ICDs and the need to reprogram the device into an appropriate alternative mode when needed (eg, surgical procedure). Predicts the anesthetic implications of cardiothoracic therapeutic procedures.	Conducts intraoperative and postoperative care with indirect supervision but may require direct supervision for more complex procedures and patients in the catheterization and electrophysiology laboratories. With direct supervision, the fellow is able to program a temporary pacemaker into the appropriate mode after a cardiac surgical procedure. Analyzes and applies understanding of the impact of sensitivity and output. Predicts the anesthetic implications of cardiothoracic therapeutic procedures and assesses risks and benefits of different techniques with direct supervision.	With conditional independence, conducts complex intra- and postoperative care; may supervise others in the management of complex clinical problems in the catheterization and electrophysiology laboratories. With indirect supervision, able to program a temporary pacemaker into the appropriate mode after a cardiac surgical procedure. Analyzes and applies understanding of the impact of sensitivity, output, A-V interval and postventricular atrial refractory period. Predicts the anesthetic implications of complex and less common cardiothoracic therapeutic procedures with indirect supervision. Assesses risks and benefits of different techniques in collaboration with the interventional team.	Performs complex intra- and postoperative care independently in the catheterization and electrophysiology laboratories. Able to assess the operational characteristics of in situ pacemakers and ICDs in the perioperative setting. Can provide input as an expert consultant in the operation of temporary pacemakers. Recognized to have an advanced understanding of complex cardiothoracic therapeutic studies and their impact on procedural planning and conduct and patients' outcome.

Example: A 4-year-old patient with newly diagnosed pulmonary hypertension is to undergo cardiac catheterization to delineate the etiology and to potentially perform vasodilator testing. The fellow is capable of articulating the potential causes of pulmonary hypertension and how the physiologic subset (pre or post capillary pulmonary hypertension) influences management. The fellow is capable of articulating an organized approach to the management of a pulmonary hypertensive crisis based on the physiologic subset up to and including the indications and use of extracorporeal membrane oxygenation (ECMO).

Medical Knowledge—Congenital and Acquired Cardiovascular Anatomy, Physiology, and Pathophysiology

Level 1	Level 2	Level 3	Level 4	Level 5
Demonstrates current body of knowledge of: -Cardiac embryology, anatomy, and morphology. -Congenital and acquired cardiac lesions. -Associated syndromes, congenital anomalies, and comorbidities -Coagulation abnormalities and therapy.	Articulates current body of knowledge of: -Cardiac embryology, anatomy, and morphology. -Congenital and acquired cardiac lesions. -Associated syndromes, congenital anomalies, and comorbidities -Coagulation abnormalities and therapy.	Expands the current body of knowledge of: -Cardiac embryology, anatomy, and morphology. -Congenital and acquired cardiac lesions. -Associated syndromes, congenital anomalies, and comorbidities. -Coagulation abnormalities and therapy.	Synthesizes the current body of knowledge of: -Cardiac embryology, anatomy, and morphology. -Congenital and acquired cardiac lesions. -Associated syndromes, congenital anomalies, and comorbidities. -Coagulation abnormalities and therapy.	Recognized as an expert with advanced knowledge of: -Cardiac embryology, anatomy, and morphology. -Congenital and acquired cardiac lesions. -Associated syndromes, congenital anomalies, and comorbidities -Coagulation abnormalities and therapy.
-Normal and abnormal physical and psychological development. Integrates knowledge of pathophysiology of common cardiopulmonary diseases into management of routine intrathoracic procedures (eg, uncomplicated ASD, VSD).	-Normal and abnormal physical and psychological development. Integrates knowledge of pathophysiology of cardiopulmonary diseases into management of complex intrathoracic procedures (eg, CAVC, TOF, TGA).	-Normal and abnormal physical and psychological development. With indirect supervision, integrates advanced knowledge of pathophysiology of cardiopulmonary diseases into management of complex intrathoracic procedures (eg, heterotaxy) into comprehensive management of complex intrathoracic physiology lesions).	-Normal and abnormal physical and psychological development. Independently integrates advanced knowledge of pathophysiology of complex and less common cardiopulmonary disease (eg, heterotaxy) into comprehensive management of complex intrathoracic procedures.	Recognized as an expert in the pathophysiology of complex and less common cardiopulmonary disease and the management of complex intrathoracic procedures and is able to provide input when consulted.

Comments: Cardiac disease includes congenital heart disease, cardiomyopathy, heart failure, cardiac tamponade, ischemic heart disease, acquired cardiac lesions (eg, myocarditis, rheumatic heart disease, acute rheumatic fever, endocarditis, Kawasaki disease, valvular disease) in the pediatric patient.

Example: A term neonate in the cardiac intensive care unit (ICU) with the postnatal diagnosis of hypoplastic left heart syndrome is scheduled for a stage 1/Sano repair. The fellow evaluates the patient, recognizes the possibility of other associated syndromes, and articulates the key priorities for bypass and postbypass management (eg, prostaglandin E₁ dependence, inspired oxygen concentration, arterial partial pressure of carbon dioxide target, balance of pulmonary and systemic vascular resistance). The fellow is also able to articulate the physiologic differences between a Sano and modified Blalock-Taussig shunt and their impact on coronary, cerebral, and splanchnic perfusion.

Abbreviations: ASD, atrial septal defect; CAVC, common atrioventricular septal defect; TGA, transposition of the great arteries; TOF, tetralogy of Fallot; VSD, ventricular septal defect.

Medical Knowledge—Pharmacology

Level 1	Level 2	Level 3	Level 4	Level 5
Describes basic pharmacologic principles of anesthetic, vasoactive, inotropic, and pulmonary drugs as applied to management of patients with CHD.	Applies basic pharmacologic principles of anesthetic, vasoactive, inotropic, and pulmonary drugs to management of patients with CHD.	Expands the understanding of pharmacokinetics and pharmacodynamics of anesthetic, vasoactive, inotropic, and pulmonary drugs to management of patients with CHD.	Synthesizes and applies the current understanding of pharmacokinetics and pharmacodynamics of anesthetic, vasoactive, inotropic, and pulmonary drugs to management of patients with CHD.	Recognized (through scholarship or education) as an expert resource in advanced understanding of pharmacokinetics and pharmacodynamics of anesthetic, vasoactive, inotropic, and pulmonary drugs to management of patients with CHD.

Example: The fellow possesses sufficient knowledge of age-related changes in the pharmacokinetics and pharmacodynamics of anesthetic agents, sedative/hypnotic drugs, and opioids (including context-sensitive half-time) to design an anesthetic plan that addresses the patient's hemodynamic vulnerabilities and is appropriate for the expected postoperative recovery trajectory, including timing of extubation of the patient.

Medical Knowledge—CPB, Extracorporeal Circulation, and Circulatory Assist Device Principles

Level 1	Level 2	Level 3	Level 4	Level 5
Describes the basic principles of CPB and extracorporeal support devices.	Analyzes and applies the principles of CPB and extracorporeal support devices to patients with CHD with direct supervision.	Analyzes and applies the principles of CPB and extracorporeal support devices to patients with CHD with indirect supervision.	Synthesizes and justifies the application of the principles of CPB and extracorporeal support devices to patients with CHD with conditional independence.	Recognized as an expert resource in management of CPB and extracorporeal support devices.

Comment: Extracorporeal support devices include extracorporeal membrane oxygenation and ventricular assist devices.

Example: A 1-year-old boy with cardiomyopathy on ECMO support is scheduled to come to the catheterization laboratory for hemodynamic evaluation, coronary angiography, and endomyocardial biopsy. After transfer to the bed, the ECMO circuit alarms and flow is reduced in half. The ECMO specialist reports a large pre- and postmembrane pressure difference. The fellow is familiar enough with the different components of the ECMO circuit and their potential mode of failure (eg, Servo pressure, postmembrane pressure, flow monitor, bubble detector), to work with the ECMO team to manage the patient and resolve the problem.

Medical Knowledge—Understanding Cardiac Diagnostic Procedures (eg, Echocardiography, Magnetic Resonance, Catheterization, Computerized Tomography)

Level 1	Level 2	Level 3	Level 4	Level 5
Interprets data from cardiothoracic diagnostic imaging such as echocardiography, magnetic resonance imaging, and catheterization to guide routine clinical decision-making and anesthetic management, with direct supervision.	Interprets and integrates data from cardiothoracic diagnostic imaging such as echocardiography, magnetic resonance imaging, and catheterization to guide routine clinical decision-making and anesthetic management, with indirect supervision.	Integrates data from cardiothoracic diagnostic imaging (pre- and intraoperatively) such as echocardiography, magnetic resonance imaging, and catheterization to guide advanced clinical decision-making and anesthetic management, with indirect supervision.	Recognizes the need for specific cardiothoracic diagnostic imaging (pre- and intraoperatively) such as echocardiography, magnetic resonance imaging, and catheterization to guide advanced clinical decision-making and anesthetic management and integrates the collected data with conditional independence.	Recognized as an expert in requesting the required diagnostic procedures (pre- and intraoperatively) for assessment and implications in decision-making for surgical or catheter-based interventional procedures.

Example: A neonate with pulmonary atresia with intact ventricular septum is to undergo a cardiac catheterization for hemodynamic evaluation and potential intervention for right ventricular outflow tract obstruction. The fellow is able to anticipate how catheter manipulations to obtain the necessary hemodynamic and angiographic data might adversely affect the hemodynamics. The fellow recognizes that if the patient has right ventricle-dependent coronary circulation, radiofrequency perforation of the right ventricular outflow tract and right ventricle decompression is contraindicated.

System-Based Practice—Coordination of Care

Level 1	Level 2	Level 3	Level 4	Level 5
Collaborates as a member of the care team with direct supervision. The care team would include the preoperative and intraoperative staff, blood bank and laboratory staff, perfusionists, medical, surgical, and critical care teams, and the anesthesia care providers.	Collaborates as a member of the care team with indirect supervision during routine cases. Requires direct supervision to effectively collaborate during complex clinical situations (eg, emergencies).	With indirect supervision, manages the care team during complex clinical situations such as emergencies.	With conditional independence, can lead the care team during complex clinical situations.	Easily and effectively can coordinate care in simple and complex cases independently.

Example: A newborn with infradiaphragmatic, obstructed total anomalous pulmonary venous return is admitted to the ICU. A multidisciplinary team including the surgeon, cardiac interventionalist, intensivist, and anesthesiologist discuss the urgency of the procedure and the different treatment options including intervention in the catheterization laboratory, surgical repair, or medical stabilization including ECMO before any intervention. The fellow is able to discuss all options and coordinates the care of the patient with the multiple teams involved.

System-Based Practice—Incorporation of Patient Safety and Quality Improvement Into Clinical Practice

Level 1	Level 2	Level 3	Level 4	Level 5
Introduced to the principles of patient safety and the importance of quality improvement (QI) initiatives.	Recognizes the causes of clinical errors (wrong medicine, blood transfusion) and medical device hazards. Explains the importance of reporting near misses as part of the clinical care system.	Identifies areas of improvement in patient safety and quality. Participates in activities that help analyze and review near misses or sentinel events (mortality and morbidity, patient safety and improvement committee).	Participates in patient safety and QI initiatives and/or activities. Utilizes evidence-based data or institutional data to define opportunities to improve patient care.	Leads a QI or patient safety initiative.

Example: With the assistance of a faculty member, the fellow presents an update on departmental efforts to reduce wastage of ordered but not transfused cryoprecipitate in children undergoing cardiac surgery on CPB.

System-Based Practice—Understanding of Health Care Economics: Cost Awareness and Cost-Benefit Analysis

Level 1	Level 2	Level 3	Level 4	Level 5
Needs prompting to consider cost in the daily clinical care.	Discusses the concept of cost in health care and the implications in selecting devices, medications, and specific procedures.	Incorporates cost in the perioperative planning.	Identifies opportunities to decrease cost such as improving efficiency, waste, and choice of medications and devices used.	Participates in cost-analysis projects. Determines the most cost-effective perioperative plan for the scheduled procedure.

Example: The fellow recognizes that preparing infusions and drawing up medications that are unlikely to be utilized during a particular case is not cost-effective. The fellow prepares only those infusions and medications likely to be utilized and identifies the location and availability of the agents less likely to be utilized so that they can be obtained expeditiously if needed.

Practice-Based Learning and Improvement: Self-Directed Learning and Scholarly Activity

Level 1	Level 2	Level 3	Level 4	Level 5
Reviews the literature related to a specific patient-related topic	Participates by presenting at the mortality and morbidity conferences. Presents a journal club discussion based on recent articles and links the topic to the daily clinical practice.	Participates in an academic project such as clinical research project and writing a chapter or review article related to CHD. Presents an abstract at a regional or national meeting.	Incorporates evidence-based medicine in the discussion and clinical practice. Participates in the development of guidelines or policies.	Participates in designing and conducting clinical trials. Participates in reviewing studies/case reports for journal editorial boards. Participates in professional societies or institutional committees that promote scholarly activity.

Example: The fellow is involved with the care of 16-year-old patient with heparin-induced thrombocytopenia and active anti-platelet factor 4 antibodies scheduled for a heart transplant. The patient is successfully managed with bivalirudin during CPB. The fellow recognizes that no formal departmental practice guideline exists for use of bivalirudin for CPB anticoagulation. The fellow participates in development of departmental practice guidelines for use of bivalirudin.

Practice-Based Learning and Improvement: Education of Team Members and Other Health Care Providers

Level 1	Level 2	Level 3	Level 4	Level 5
Identifies the value of disseminating knowledge and clearly communicates the plan of care and its rationale to the members of the health care team.	Able to explain the clinical decision-making and its rationale to the members of the health care team with indirect supervision. Presents at departmental educational conferences.	Seeks opportunities to provide education to the members of the health care team, cofellows, trainees, and students in the clinical setting and in presentations.	Actively educates the team members regarding the clinical practice and patient care. Coordinates a conference, a case discussion, or a journal club.	Develops educational material for patients and families. Role model for teaching and mentoring. Develops educational curriculum or workshop.

Example: The fellow prepares and presents a departmental case conference on the management of a 2-year-old patient with Williams-Beuren syndrome scheduled for inguinal hernia repair. The fellow is able to present the case, review the pathophysiology of Williams-Beuren syndrome, review the current literature on the topic, and summarize the cardiac and noncardiac anesthetic considerations for the patient.

Professionalism—Commitment to Institution, Department, and Colleagues

Level 1	Level 2	Level 3	Level 4	Level 5
Complies with the duty hours. Completes all evaluations and learning modules required by the department and the institution.	Acts as a team member. Participates in activities that enhance the team approach (such as simulations).	Serves as a role model to other trainees on the team. Demonstrates effective communication skills with trainees and staff.	Seeks to participate in departmental or institutional committees. Valuable resource for other trainees that are rotating through the pediatric cardiac service. Supports colleagues when adverse outcomes occur or when they need assistance.	Active role in committees at the departmental, institutional, or national levels.

Example: The fellow ensures that the trainees (residents, first-year fellows) on the cardiac anesthesia rotation are well oriented to team organization and operational logistics. In addition, the fellow makes himself/herself available to the cofellows to discuss their experience during the rotation (eg, challenging case, difficulty placing an arterial line, a mortality). The fellow is able to refer his/her colleagues to departmental and institutional resources if additional support is needed.

Professionalism—Receiving and Giving Feedback

Level 1	Level 2	Level 3	Level 4	Level 5
Accepts feedback given from faculty members and colleagues.	Incorporates the feedback received from faculty into clinical practice.	Actively seeks feedback from faculty and members of the health care team.	Seeks feedback regularly. Self-reflects and set goals for improvement based on the feedback received. Able to provide feedback to the members of the team and to faculty. Maintains effective two-way feedback by giving and receiving feedback.	Shows lifelong learning. Seeks feedback daily and able to provide feedback to the students and trainees and to members of the health care team.

Example: After a challenging induction with difficult line placement, the fellow reaches out to the staff and solicits feedback regarding the management of hemodynamic instability during induction and on his/her technical performance during line placement. In addition, the fellow provides feedback to the staff regarding their teaching skills.

Professionalism—Responsibility to Maintain Personal, Emotional, Physical, and Mental Health

Level 1	Level 2	Level 3	Level 4	Level 5
Basic understanding of the professional responsibilities: rested, prepared, and professional attire to work.	Able to balance the personal and work-related responsibilities. Recognizes the resources available to assist in time management and wellness during the training.	Recognizes the impact of wellness on outcomes of patient care. Directs his colleagues and residents and encourages them to comply and report any breach in duty hours or effect on their well-being.	Seeks an active role in wellness programs and initiatives in the department.	Serves as a support to the trainees on the service. Assists them with their time management. Participates in institutional committees and workshops related to well-being.

Example: The fellow recognizes the importance of physical and emotional health. The fellow participates in wellness programs such as engaging in activities or workshops and attending a wellness talk.

Interpersonal and Communication Skills: Communication With Patients and Families

Level 1	Level 2	Level 3	Level 4	Level 5
Effectively communicates with the patient and the family/legal guardian about the perioperative planning. Recognizes the importance of a respectful and culturally sensitive communication. Identifies when family conflict or a special social situation exists and is able to ask for help/assistance.	Identifies the need for resources (interpreters, patient representation, ethics consultation) in certain situations (eg, family conflict).	Under direct supervision, effectively communicates with the families and uses the required resources such as interpreters when appropriate. Effectively communicates with patients and families with different cultural background. Understands the availability of Social Work, Risk Management and Bioethics community and their availability to help in special situations such as medical errors or death.	With conditional independence, effectively communicates with the families and uses the required resources such as interpreters when appropriate. With indirect supervision, can declare complications/medical errors to the family.	Consistently communicates with the families and is able to easily connect with patients with diverse socioeconomic and cultural background. With conditional dependence, can declare to the family complications/medical errors. Coaches others in improving communications skills.

Example: During the postoperative visit to a non-English-speaking family, the fellow recognizes a language barrier. The fellow utilizes an interpreter to summarize the child's anesthetic course, to reassure the parents, and to answer their questions.

Interpersonal and Communication Skills—Interprofessional Communication and Transitions of Care				
Level 1	Level 2	Level 3	Level 4	Level 5
Requires direct supervision for effective transitions of care and hands-off (eg, transport from the operating room and sign-out to the ICU or transfer of care to another team).	With indirect supervision, manages transitions of care and hands-off (eg, transport from the operating room and sign-out to the ICU or transfer of care to another team).	With direct supervision, coordinates transitions of care for all clinical situations and hands-off (eg, transport from the operating room and sign-out to the ICU or transfer of care to another team).	With conditional independence, coordinates transitions of care for all clinical situations and hands-off (eg, transport from the operating room and sign-out to the ICU or transfer of care to another team).	Serves as a role model and teacher in demonstrating effective methods for coordination of care during transitions and hands-off (eg, transport from the operating room and sign-out to the ICU or transfer of care to another team).

Comment: Transport has been described as a separate milestone since approximately 40% of the patients with CHD are transported directly from an ICU bed to the operating room or cardiac catheterization laboratory. Furthermore, virtually all surgical patients and a high percentage of cardiac catheterization patients are transported back to an ICU bed after completion of their procedure.

Example: After replacement of a right ventricular to pulmonary artery conduit, a 12-year-old patient with tetralogy of Fallot is to be admitted to the ICU. The fellow is able to maintain hemodynamic stability and an appropriate level of sedation/analgesia during transport. The sign-out delivered by the fellow to the ICU team is concise and systematic, and it includes details of all preoperative and intraoperative events relevant to postoperative management and patient recovery. The fellow is able to assist the ICU team in smoothly transitioning the patient from intraoperative to postoperative care.

targeted for fellowship; this level is designed as the graduation target. Level 5, the fellow has advanced beyond performance targets set for fellowship and is demonstrating ‘aspirational’ goals which might describe the performance of someone who has been in practice for several years.”

Milestones for the pediatric cardiac anesthesia fellowship with examples illustrating level 4 competency are described.

CONCLUSIONS

This article written by an expert panel of the Congenital Cardiac Anesthesia Society/Society of Pediatric Anesthesiology presents a template for pediatric cardiac anesthesia training programs in the United States with the intent of defining educational and performance-based criteria for graduation. It will provide programs the opportunity to develop a curriculum with competency-based milestones. International programs may also consider this template and modify it to fit their own requirements. ■■

DISCLOSURES

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