

## Original Article

# Global perspective on training and staffing for paediatric cardiac critical care

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**Abstract** This manuscript provides a global perspective on physician and nursing education and training in paediatric cardiac critical care, including available resources and delivery of care models with representatives from several regions of the world including Africa, Israel, Asia, Australasia, Europe, South America, and the United States of America.

**Keywords:** Global; paediatrics; CHD; critical heart disease

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THE OPENING PLENARY SESSION FOR THE 12TH International Conference of the Pediatric Cardiac Intensive Care Society (PCICS) was on establishing and standardising education and training for physicians, advanced nurse practitioners, and nursing in paediatric cardiac critical care. Representatives from surgery, intensive care medicine, and nursing provided their perspectives on education and training in the United States of America. This manuscript provides a global perspective on physician and nursing education and training, available resources, and delivery of care models with

representatives from several regions of the world including Africa, Israel, Asia, Australasia, Europe, South America, and the United States of America.

## Africa

Overall healthcare resources in Africa are limited, but access to cardiac surgery is particularly limited. Resources are more accessible in North and South Africa. However, even in South Africa, only a small proportion of children requiring cardiac surgery have access to care. Cardiac surgery for most of the continent is conducted by visiting teams, although there are some areas with local expertise. Critical care for children is similarly limited across the continent. Although there are many ICU for children and there

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has been a gradual increase in the number of units with specifically trained paediatric intensivists – in Sub-Saharan Africa this includes units in Nigeria, Ghana, Kenya, Uganda, and South Africa – the availability of resources is limited.

Within South Africa there are several paediatric cardiac surgical services, of which the largest are the Maboneng Heart Institute (private sector) and the Red Cross War Memorial Children's Hospital (RCWMCH) (state sector). At these centres, cardiac care involves specialists in paediatric critical care. At other centres, perioperative care for paediatric cardiac disease is mostly under the supervision of cardiothoracic surgeons and anaesthesiologists.

Training programmes for paediatric critical care in South Africa exist in Cape Town, Durban, and Johannesburg. At these centres, trainees who have completed 4 years of training in specialities such as anaesthesia or paediatrics undergo a 2-year training programme at the end of which they are required to undergo the subspecialist examinations of the College of Paediatrics of South Africa. There have been increasing numbers of trainees from Africa – including Ghana, Uganda, and Kenya – who have completed this training and returned to practice in their respective countries. A number of physicians have completed paediatric critical care training at centres outside Africa, and have returned home to work in those disciplines. A number of trainees have also completed both paediatric cardiology and paediatric critical care training but, across the continent, there are very few doctors with any training in paediatric cardiac critical care.

Paediatric nursing critical care programmes are available in Cape Town at the RCWMCH, and trainees from countries such as Kenya, Malawi, Zambia, Namibia, and Ghana have completed training at that programme and returned to their respective countries.

### South America

There are few specialised, high-volume cardiac ICU in South America. There are many small-volume centres where care is provided in mixed paediatric care units and perioperative care is provided by surgeons, paediatric intensivists, or cardiologists. In specialised units, members of staff are primarily intensivists with knowledge and experience in cardiac disease. Most of the intensivists who are dedicated to cardiac critical care trained as fellows or residents in hospitals with dedicated cardiac units. In most Latin American countries, there are no standardised training programmes and there is no certification pathway for paediatric cardiac intensive care. There are 3-year fellowships in cardiovascular

disease and some institutions offer 1- or 2-year fellowships for paediatric intensivists, which include some experience in cardiac care. In Argentina, intensivists are certified by the University of Buenos Aires and the Argentine Pediatric Society.

Brazil is a country with continental dimensions facing diverse challenges throughout. It is estimated that every year there are 28,846 new cases of CHD and a need for 23,077 surgical procedures. The Brazilian National Health Surveillance Agency has established minimal requirements for an ICU. Paediatric cardiac ICU follow similar requirements and stipulate that a physician manager must be qualified in paediatric intensive care medicine for a PICU and either paediatric intensive care or neonatology for a neonatal ICU.

There is a shortage of trained nurses, particularly paediatric nurses, in Latin America. In Argentina, nurses can obtain a university degree. The curriculum is focused on adult care with little emphasis on paediatric care. The training process for cardiac nurses starts in the paediatric ward and eventually extends into the ICU. Those nurses with a particular interest and knowledge in cardiac critical care are selected to work in the cardiac ICU. The nursing profession in Brazil is divided into different categories: nursing assistants, nursing technicians, and registered nurses. Nursing technicians and registered nurses work together to provide adequate patient care to critically ill patients in the ICU setting and usually have little to no previous experience in paediatric cardiac critical care. As there are no specific mandatory professional training hours required after conclusion of a nursing degree or medical degree, improving the quality of care is challenging. Newly hired nursing professionals must receive training to work in the ICU and participate in a continuing education programme.

### Asia

The majority of children in Asia are born in low- and middle-income countries such as China, India, Indonesia, and Vietnam, as a result of population size and relatively high birth rates. CHD has emerged as a significant health problem among newborns and infants in these regions that are now witnessing rapid human and economic development, necessitating the establishment of many new paediatric cardiac programmes. In the face of significant shortcomings in material and human resources in these regions, there are significant challenges in delivering comprehensive paediatric cardiac care, particularly in newborn and infant cardiac surgery. The greatest shortfall of trained personnel is in paediatric cardiac critical care, with both physician and nursing personnel in short supply. There are very few organised models for the

delivery of paediatric cardiac critical care, with cardiac surgeons, anaesthesiologists, and paediatric cardiologists often jointly delivering cardiac critical care. Structured training programmes in paediatric cardiac critical care are practically non-existent.

In Japan, centralisation of healthcare is not well developed and there are a large number of hospitals per capita. As of 2016, there were 8471 hospitals, almost double the number in United States of America, including 81 medical universities/colleges and 34 children's hospitals. The total number of cases annually approaches 10,000. However, the number of cases per institution is small because paediatric cardiovascular surgery is performed at more than 100 centres.

Traditionally, postoperative care has been provided by cardiovascular surgeons, cardiologists, or anaesthesiologists. Paediatric critical care medicine has only emerged in Japan over the past 10 years. Before this, most paediatric patients were managed in an adult ICU or general paediatric ward. However, there have been an increasing number of paediatric ICU. There are currently 28 paediatric ICU, with 12 in university hospitals and 16 in children's hospitals. Large hybrid paediatric critical care units – combining cardiac and general critical care – are increasing in number as well. Elsewhere in Asia, several countries have well-developed paediatric intensive care services. For example, Singapore has two paediatric critical care units that are large hybrid units and rely on paediatric intensivists to handle general and cardiac critical care.

In Asia, nursing shortages are compounded by large-scale migration of trained staff to high-income nations. Most paediatric cardiac programmes now recognise the urgent need to build capacity in paediatric cardiac critical care by developing well-organised, robust, and sustainable in-house training programmes for physicians and nursing staff. Overseas training in high-income nations is becoming increasingly difficult and often does not prepare prospective trainees to manage the limited resources present in low- and middle-income nations. In Japan, there is a special education and certification system for intensive care nursing. However, there is no specific certification for paediatric cardiac intensive care. Approval to practice paediatric cardiac intensive care nursing is based on institutional policy and the individual's experience.

### Australia and New Zealand

Australia and New Zealand have populations of 24.4 and 4.8 million, respectively –approximately 20% under 15 years of age. Both have long shared histories of centralisation of paediatric cardiac surgery and

paediatric intensive care, intensivist-led ICU, and prescribed intensive care training requirements. There are three cardiac surgery programmes in Australia and one in New Zealand that can perform the full scope of procedures. There are two additional programmes in Australia that perform a limited scope of lower-risk procedures. All programmes are associated with tertiary level paediatric ICU. Certification of training and of individual ICU is through the College of Intensive Care Medicine (CICM). The model of cardiac critical care delivery is a separate cardiac ICU alongside a general ICU in two programmes, and mixed general and cardiac ICU in the other four. All tertiary units are associated with post-graduate courses in paediatric intensive care, and the CICM standard is that at least 50% (ideally 75%) of nurses have a post-graduate intensive care qualification.

Current intensivist training is a minimum of 6 years after internship, with a core of 3 years in intensive care and 12 months each in both anaesthesiology and paediatric medicine. Trainees with a qualification in either anaesthesia or paediatrics seeking dual certification require four additional years – 3 years in intensive care and 12 months in the alternate discipline. Training and staffing challenges include the following: first, the duration of training time, especially for those wishing to have dual certification, which has led to a reduction in the number of specialists with both anaesthesia and intensive care training; second, lack of cardiology-specific training that requires additional time in either a cardiac ICU or cardiology fellowship to overcome; and finally, whether to have separate or combined cardiac and general paediatric intensive care, balancing the benefits of specialised cardiac knowledge and experience against volume/outcome relationships.

Primary training for nursing is a 3-year university degree. The cardiac critical care units take a limited number of new graduate nurses. However, most nurses move to critical care units after gaining experience in other areas. Education modules covering general and cardiac intensive care nursing are provided within all units. Most centres offer a professional development and recognition programme that aligns with competencies and standards as set out by their governing bodies. Post-graduate qualifications in paediatric and cardiac intensive care, ranging from 1-year diplomas through to Masters and doctorates, are available in all the centres providing cardiac critical care.

### Continental Europe

Europe is a complex group of countries where guidelines for training in paediatric cardiac intensive

care are not homogeneous. Lately, CHD has emerged as a significant health problem among infants and newborns in those European countries that are facing rapid human and economic changes, and has resulted in the establishment of many new paediatric heart programmes. The growth in therapies and technology available for CHD has led to a concomitant need for a collaborative care team of surgeons, primary care providers, paediatric intensivists, cardiologists, anaesthesiologists, and neonatologists in countries where the CHD programmes were already established. Postoperative patients were initially cared for in paediatric ICU or in a modified post-anaesthesia care unit where the primary caretakers were often paediatric cardiac surgeons or adult cardiac anaesthesiologists. Care of these patients has now shifted to more dedicated paediatric cardiac intensive care programmes that are managed primarily by paediatric anesthesiologists and paediatricians with paediatric critical care training. Training in anaesthesia and paediatrics consists of 5 years. Paediatric anaesthesia fellowship training is typically 1 year in order to develop specialised expertise in all aspects of paediatric anaesthesia. This is usually followed by 1 year of fellowship training in paediatric cardiac anaesthesia, which is devoted exclusively to the delivery of care to paediatric and adult patients with CHD undergoing both cardiac and non-cardiac surgery, interventional procedures, and imaging studies, in the operating room and in the cardiac catheterisation laboratory.

Paediatric intensivists in most European countries are required to complete at least another 1 year of training in paediatric cardiac intensive care before becoming paediatric cardiac intensivists. Moreover, few European centres offer exclusive positions in paediatric cardiac intensive care, with most preferring clinicians to be able to provide anaesthesia and cardiac intensive care.

Structured nursing training programmes in paediatric cardiac critical care are scattered in most European countries. Most paediatric cardiac intensive care nurses in Europe now have a bachelor's degree in nursing science and a Masters degree in paediatrics or intensive care nursing. Most paediatric cardiac ICU have an orientation programme that usually includes some didactic content, simulation exercises, and a period of preceptorship.

### United Kingdom

In the United Kingdom, following graduation from medical school, doctors apply for a place in a 2-year foundation programme, which are followed by speciality and general practice training programmes. These programmes lead to a Certificate of Completion of Training and entry into the Specialist or

General Practice Register of the General Medical Council. A doctor intending to practice paediatric cardiac critical care will step into their paediatric training after their foundation programme. The first 3 years of the specialist training programme will be spent gaining experience in general paediatrics, neonatal and community medicine, and some specialist placements such as intensive care medicine. The following 2 years are spent working at a district general hospital in a registrar position managing clinics and general wards. During years 6–8, the physician enters specialty training such as cardiology, intensive care, and anaesthesia. At the conclusion of cardiac critical care training, additional experience is gained in higher specialist programmes such as extracorporeal membrane oxygenation. This experience leads to an intensivist post in cardiac intensive care.

All student nurses in the United Kingdom receive a National Health Service (NHS)-funded bursary for their undergraduate nurse training. The current system of free education for nurses means the number of places is limited by what the NHS can afford, which has led to shortages. The United Kingdom trained ~20,000 nurses last year and it is hoped that this number will increase by 10,000. Paediatric cardiac critical care nursing requires a 4-year undergraduate degree – or Masters – in paediatric nursing, 1 year experience in non-critical care, and 1–2 years of critical care experience. Until recently, nurses were not allowed to practice in cardiac ICU immediately following graduation. However, because of staffing pressures and recruitment issues, some cardiac centres in the United Kingdom are offering bespoke new-graduate programmes, 6–12 months, to allow new-graduates, paediatric only, entry into paediatric cardiac ICU.

### Israel

Although located in the Middle East, Israel has traditionally been part of European scientific organisations, and most paediatric cardiac intensivists in Israel have trained in North America. There are four paediatric cardiac surgery programmes in Israel, which include two high-volume centres with over 350 cases annually and dedicated paediatric cardiac ICU. The first paediatric cardiac ICU was established in December, 1994 as a four-bed facility at Schneider Children's Medical Center of Israel, which has expanded over the years to its current capacity of 14 beds. The second dedicated paediatric cardiac ICU was established in 2009 at the Edmond J. Safra International Congenital Heart Center at Safra Children's Hospital. Paediatric cardiac intensivists are trained in paediatrics, with further sub-speciality training in paediatric intensive care. Although there



is no formal training programme for paediatric cardiac intensive care in Israel, the two high-volume centres have specialists with dual training in both cardiology and paediatric intensive care.

Nursing qualification requirements comprise a 4-year baccalaureate programme, leading to a Bachelor of Arts degree in Nursing that is awarded by the university-affiliated nursing school, along with a certificate of registered nurse under the auspices of the Israeli Ministry of Health. Usually after 1 year of structured local training in an ICU, nurses attend an advanced practice nursing programme in intensive care for adults, children, and neonates. There is no specific programme for paediatric cardiac intensive care nursing.

### United States of America

In the United States of America, physicians in paediatric cardiac critical care are predominantly trained in critical care medicine, cardiology, or both. However, there are some intensivists who have primary training in anaesthesia. Following completion of a 3-year general paediatric training programme, trainees then pursue a 3-year training programme in either Critical Care Medicine or Cardiology, or a 5-year combined training programme for dual board certification in the latter two specialities. Over the past several years, it has become increasingly competitive so that those graduates seeking to work in paediatric cardiac intensive care have received training in both cardiology and critical care medicine or have completed a so-called “4th year in Cardiac Critical Care.” In any case, there is no standardised assessment of physician competency in cardiac critical care, nor is there a standardised programme curriculum.

Over the past few years, there has been increasing interest in creating a sub-board within the American Board of Pediatrics for Paediatric Cardiac Critical Care in order to establish physician standards. If this were to occur, programme standards would be established through the Accreditation Council for Graduate Medical Education. Education and training establishes and maintains physician competency, but it also plays a vital role in the evolution and maturation of an emerging field. These initiatives are

necessary in order to drive the evolution and maturation of the field of Pediatric Cardiac Critical Care.

The majority of bedside nurses have received a Bachelor's Degree in Nursing, and may have experienced some paediatric cardiac critical care during their training. Additionally, nurse practitioners play a pivotal role in many coverage models. Nurse practitioners are advanced practice nurses who have received a Bachelor's degree in Nursing initially, and have graduated from a paediatric nurse practitioner programme that usually focuses on acute care, with either a Master's or doctoral degree. Certification is required and occurs with the passing of the paediatric acute care nurse practitioner examination, which is administered by the Pediatric Nursing Certification Board. Onboarding provides additional, albeit variable, training, including organisation-specific knowledge.

### Conclusions

There is great diversity across the globe in the care of children with critical cardiac disease including physician and nursing training and qualifications, resources, and care delivery models. It is widely believed that focused care – care providers trained in cardiac critical care delivering care in a dedicated unit – improves outcomes. To varying degrees, efforts have been directed globally at providing the most focused delivery of care that is possible. There are ongoing efforts to establish standards for training physicians, nurses, and advanced practice nurses in paediatric cardiac intensive care.

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### Conflicts of Interest

None.