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REVIEW ARTICLE

Development of pediatric cardiac surgery in Indonesia—a thousand islands and a handful of centers

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Abstract
Providing good medical access for patients with congenital heart disease (CHD) is still a significant issue in most developing countries, including Indonesia. With approximately 50,000 newborns with CHD annually, the development of pediatric cardiac surgery in Indonesia needs to be intensified. After the establishment of the National Cardiovascular Center Harapan Kita in 1985, followed by other centers, the development of pediatric cardiac surgery in Indonesia has surpassed several milestones in treating CHD. However, some main problems, including lack of human, medical, and financial resources, lack of education centers, and uneven distribution of the centers, still need to be solved urgently with the cooperation of medical health providers, the government, and the stakeholders.

Keywords Pediatric cardiac surgery · Developing country · Indonesia

Background

Congenital heart disease (CHD) is a significant, rapidly emerging global problem in child health. Without the ability to substantially alter the prevalence of CHD, interventions and resources must be used to improve survival and quality of life. The diagnosis and treatment of pediatric and congenital cardiac disease have undergone remarkable progress for almost 80 years. In recent years, the focus of pediatric and cardiac surgery has changed from an effort to decrease postoperative mortality to now improving quality of life and decreasing morbidity, not only in the early period just after intervention, but also in the long-term outcome of the patients, with the increasing focus on the adults with congenital cardiac disease [1]. Unfortunately, this progress has been primarily limited to the developed world, and most developing countries still need to develop primary access to congenital cardiac care. Nevertheless, every year, approximately 90% of more than 1,000,000 children born with congenital cardiac disease across the world receive either suboptimal care or are totally denied care [2].

Indonesia is an excellent archipelago consisting of about 17,000 islands. In 2024, Indonesia is the fourth largest population in the world with almost 270 million people. With the current total birth rate (2.14), approximately 50,000 babies are born with CHD annually. However, the annual procedure of congenital heart intervention and surgery is far from the equal proportion; it was only 4896 procedures in 2022. This problem contributes to the high infant mortality rate (16.85 for every 1000 livebirths) in Indonesia [3]. Therefore, in this article, we outline the development of pediatric cardiac surgery in Indonesia and the contemporary state of difficulties in managing congenital cardiac illness in this nation. Through this, we will better explain our efforts to advance the cardiac surgery and pediatric cardiology fields in Indonesia.

Brief history of pediatric and congenital cardiac surgery in Indonesia

The first congenital cardiac surgery in Indonesia was ligation of patent ductus arteriosus by Prof. Soekarjo in 1948. Another pioneer was Dr. R.I. Soeria Santoso who performed a classical Blalock-Taussig shunt in a tetralogy of Fallot

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patient in 1957. He also performed a pulmonary valvotomy using the Brock procedure on a pulmonary stenosis patient. Subsequently, using the inflow occlusion technique with hypothermia, he managed to do atrial septal defect closure. In 1961, Dr. Eri Soedewo introduced the cardiopulmonary bypass machine for the first time, but it was dominantly used for animal experiments [4].

The Japanese government assisted Indonesian physicians in their efforts to develop heart surgery between 1968 and 1969. The first successful use of cardiopulmonary bypass in open heart surgery was in 1968 in Indonesia, when Prof. S. Sakakibara and his colleagues corrected an atrial septal defect in an 18-year-old patient. In 1976, Dr. Soerarso Hardjowasito became the first surgeon from Indonesia to successfully repair tetralogy [4]. The number of heart surgery treatments performed in Indonesia has consistently increased since the National Cardiovascular Center Harapan Kita (NCCHK) was established in 1985. With this, one of the most significant periods in Indonesian cardiac surgery history began. Mr. Roger Mee, originally from Melbourne, Australia, played a major role in founding the pediatric heart surgery unit of this hospital. Development of pediatric and congenital heart surgery department significantly improved after Dr. Jusuf Rachmat, finishing his fellowship in Royal Children Hospital, Melbourne, returned home. The total surgery cases of pediatric and CHD in this center from 1985 until 2022 has reached 21,687 cases, and 1200 pediatric cardiac surgery cases (800–900 pump cases) are performed annually.

Several congenital heart surgery centers were developed in Indonesia, such as Cipto Mangunkusumo General Hospital, Soetomo General Hospital, Kariadi General Hospital, and Sardjito General Hospital. Most of the centers are enrolled by the government, and only limited private hospitals are dedicated to serving pediatric cardiac surgery programs. However, most of these hospitals are located in Java Island, one of the biggest five islands in Indonesia. Recent data showed that the annual number of pediatric cardiac surgeries has reached approximately 2000 surgeries.

Current problems of pediatric and congenital cardiac surgery in Indonesia

In Indonesia, there are around 5 million live births annually, and it is estimated that about 50,000 babies are born with CHD, with approximately 12,500 cases of critical CHD. It follows that, up to now, only approximately 9.7% (4896 procedures consisting of 2678 interventions and 2218 surgical procedures) of children with congenital heart defects have been properly treated in Indonesia. This rate of coverage for the medical treatment of patients with CHD is much lower compared to other countries in South-Eastern Asia. Due to the current state of surgical care for patients with CHD, Indonesia is still far away from international standards of care in this area.

The development of pediatric and congenital cardiac surgery in Indonesia has been late, slow, and erratic. There are several reasons related with this condition.

1. Lack of human and medical resources

Proper diagnosis and screening of critical is essential to improve the management of CHD. A recent study found that around 61% of cases were diagnosed with a late condition, which also contributes to a high mortality rate [5]. Unfortunately, the number of pediatric cardiologists in Indonesia is still far from enough to cover the number of populations. Out of 1708 cardiologists, there are only 100 pediatric cardiologists, and most of them are concentrated in Java Island.

Although we have 360 catheterization laboratories, cardiac surgery is performed at 19 hospitals only in Indonesia. In most centers, the number of pediatric cardiac surgical procedures is still small and mainly consists of adult cardiac cases. With the total of 2218 congenital and pediatric cardiac surgeries, more than half of them were done in NCCHK, followed by Cipto Mangunkusumo General Hospital (16% of total cases). In NCCHK, there are 6 pediatric cardiac surgeons facilitated with 3 operating theatres and 20 beds in the pediatric cardiac intensive care unit. Unfortunately, the waiting time for candidates for congenital heart surgery has reached more than 18 months in NCCHK. From 2015 to 2022, ventricular septal defect closure was the most dominant procedure, followed by tetralogy of Fallot repair.

In order to treat neonates and infants with heart problems, there are far too few cardiac surgeons, anesthetists, perfusionists, intensive care unit experts, and nurses with the necessary training. To properly treat all Indonesian children with congenital heart malformations, over 100 cardiac facilities would be required. Moreover, in 2023, there were 213 cardiothoracic and vascular surgeons in Indonesia and only 18 surgeons were dedicated to performing pediatric and congenital cardiac surgery (Fig. 1).

2. Lack of education center and long time for cardiothoracic surgeon training

To create a pediatric cardiac surgeon, it requires at least 14 years for a senior high-school graduate. It takes 7 years for a medical doctor degree, 5 years to become a board-certified cardiothoracic and vascular surgeon, and 2 more years to advanced pediatric cardiac surgery training. Moreover, the cardiothoracic surgeon training in Indonesia still uses the university-based system. Graduated medical doctors need to pay tuition fees during cardiothoracic and vascular surgery residency without any appropriate salary during residency.

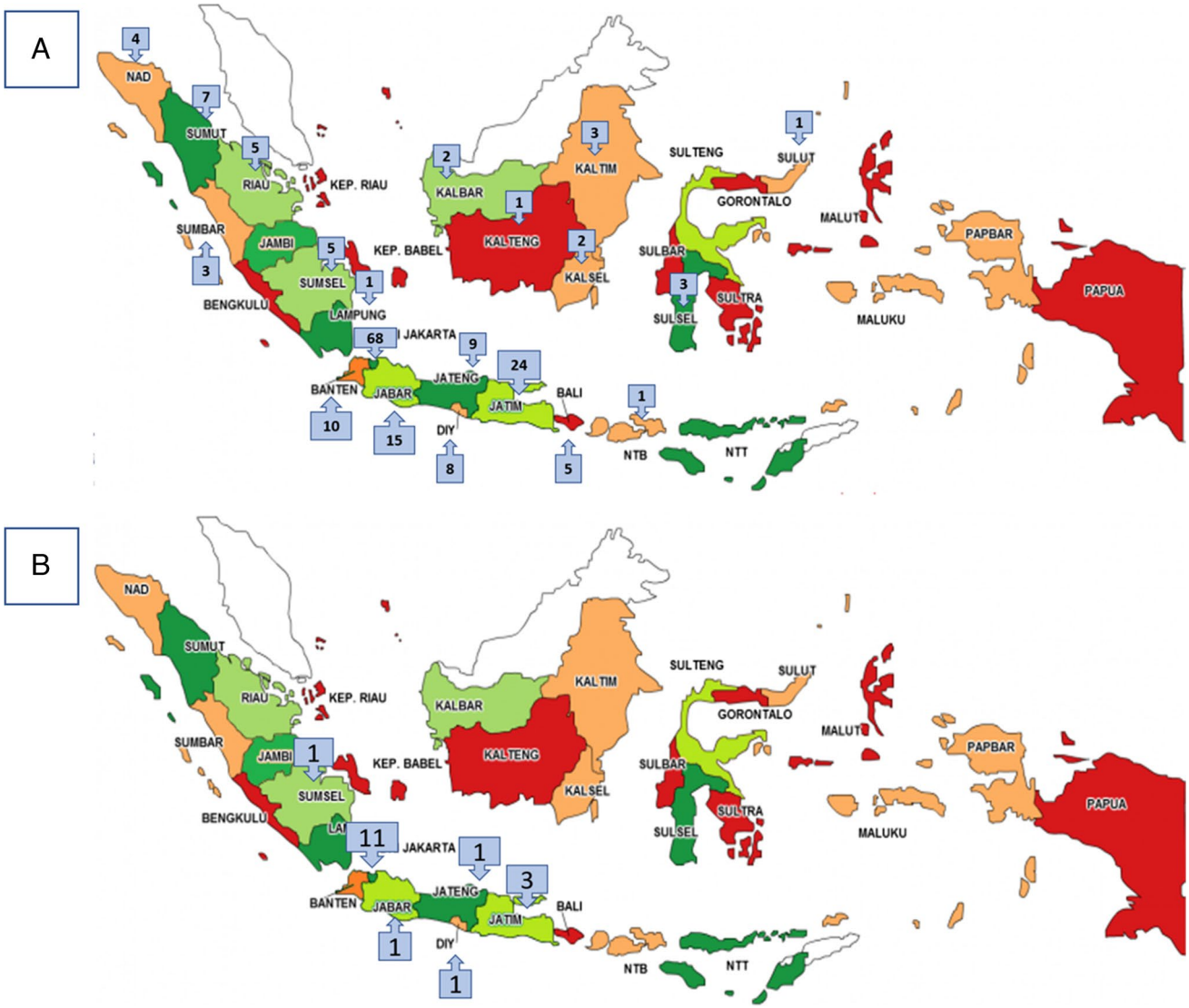

Fig. 1 Distribution of 213 cardiothoracic and vascular surgeons (**A**) and 18 pediatric cardiac surgeon consultants (**B**) in Indonesia

Despite the high demand for good performance due to the low margin of safety during residency, these problems also contribute to the low interest of the young generation of doctors. Until late 2022, we only had two universities that could train residents to become cardiothoracic and vascular surgeons. By this year, four additional universities started to accept trainees for the cardiothoracic and vascular surgery residency programs. As a major pediatric cardiac center in Indonesia, NCCHK has conducted training programs for general cardiovascular surgeons and fellowship for pediatric cardiac surgeons and pediatric cardiologists. Some cardiac surgeons from Indonesia finished their fellowship abroad at well-known cardiac centers such as Royal Children Hospital (Australia), Escort Heart Institute and Research Center (India), Hospital for Sick Children (Canada), Konkuk Medical Center (South Korea), and National Taiwan University Hospital (Taiwan). Transfer of knowledge from these surgeon experiences contributed to the development of pediatric cardiac surgery in Indonesia.

3. Uneven distribution of CHD centers and referral access problem

Indonesia is the world's biggest archipelago, spanning 5100 km from west to east. The majority of comprehensive hospital facilities are concentrated in major urban regions, whereas many rural communities continue to face serious staffing and equipment shortages. Moreover, even at urban institutions, the costly, but essential, diagnostic tools for CHD, such as echocardiography, are sometimes unavailable. As a result, the most critically ill neonates or infants are more likely to die before an accurate diagnosis can

be made. Fortunately, a multidisciplinary community of healthcare providers in Indonesia, named the Indonesian Society of Pediatric Cardiology (PERKANI, established in 1997), has played a significant role in educating primary doctors in rural areas and in making a good networking for the referral process.

Most of the surgery and intervention procedures for CHD were done in Java Island and only 6.6% of these procedures were done outside this island. Because of the prominent geographical difficulties, it takes a lot of time and money to travel to Java Island. As an example, it costs about 350 United States dollars (USD) (7–10 h flight with 2–3 transit) for each person to travel from Irian Jaya (most East island) to Java Island. Some patients might need to take several hours of transportation across the sea to reach the airport. Upgrading hospital facilities for CHD management and improving patient transportation for patients requiring pediatric cardiac surgery are critically needed due to significant geographic challenges. Therefore, the first and most important step in enhancing the care of critically ill cardiac neonates and infants is the implementation of an effective referral system.

4. Lack of financial resources

Since 2004, the government of Indonesia has made a serious effort to develop health insurance for all civilians. The Indonesian Health Care and Social Security Agency claimed that 252.17 million people, or 90.79% of the total population, are covered by the National Health Insurance-Indonesian Health Card as of March 2023. In Indonesia, all hospitals are classified into four types (types A to D) based on the facilities and medical services, and the insurance financial coverage for every disease differs based on the type of hospital. Based on this policy, a sound referral system and distribution of hospitals in every region of Indonesia were mandatory. Moreover, this insurance's financial coverage was insufficient to run the pediatric cardiac surgery program properly, even in the type A and B hospitals. Only several simple pediatric cardiac surgeries, such as atrial and ventricular septal defect closure without severe pulmonary hypertension and ligation of patent ductus arteriosus, can be fully funded by National Health Insurance. Due to the inadequate insurance coverage of pediatric cardiac surgery services, the salary for the healthcare professional is far from satisfactory, and it provokes low interest of specialist medical doctors to consent to this field. Therefore, there are only limited hospitals that can provide this service.

Beside the national insurance, a small number of nonprofit communities/organizations are present to support children to have proper management of the cardiac diseases. However, collaboration between these two funding systems was prohibited due to the national insurance policy.

Opportunities

Despite these problems, pediatric cardiac surgery in Indonesia has surpassed several milestones in order to reduce morbidity and mortality. The annual number of pediatric cardiac surgical procedures in Indonesia increased by the year. We managed to reduce the mortality rate to 7% of all pediatric cardiac surgeries. Although this number is comparably higher than other countries, we managed to overcome the late presenting condition of the patient with the limited expensive resource such as the usage of extracorporeal membrane support and homograft. To date, no transplantation procedure has been done.

The proctorship program of cardiac surgery services managed by the Ministry of Health has been started in 15 provinces to accelerate the distribution of cardiac surgery centers in Indonesia. Besides, the establishment of cardiac surgery facilities outside Java Island is being carried out intensively. This consent to the cardiac problem, especially CHD, gives new hope to the "neglected" patients who could not get access to proper medical services. A dedicated program for CHD screening in rural area should also be concerned to reduce the mortality due to CHD. Collaboration of the National Health Insurance with nonprofit organizations or private funding/insurance might be the answer to achieve adequate financial support.

Future direction

In terms of sustainable development of pediatric cardiac surgery, the optimal strategy should involve training and education of the whole team. The number of teams that consist of surgeons, cardiologists, anesthesiologists, intensivists, perfusionists, nurses, and other professionals involved in CHD management must be increased. Overseas training of this team in well-developed CHD centers will infinitely enrich their centers upon their return. Also, improving care for pediatric and congenital cardiac disease patients will require the systematic mobilization of healthcare professionals in a spirit of cooperation and teamwork.

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Declarations

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