



Training and mentoring of the congenital heart surgeon for India

Suresh Gururaja Rao¹ · Simran Kundan¹

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Abstract

Congenital heart surgery is one of the most demanding subspecialties in surgery. To become a competent surgeon, a lot of investment of time, in-depth study, training under a committed mentor, acquisition of the necessary fine surgical skills, and development of a three-dimensional appreciation of corrections are needed to be cultivated. These make it not only a speciality of skills, but also a cerebral speciality. It is commonly felt amongst the residents training in cardiovascular and thoracic surgery that they perform far less operative work to make them even “somewhat” confident of doing procedures independently towards the end of their residency. If this young cardiac surgeon needs to subspecialize in congenital heart surgery, more exposure to newer concepts and a much higher level of skill-based training become mandatory for achieving competence. Taking all this into consideration, this article will dwell on some of the traits and abilities that are desired in the candidates choosing to train in congenital heart surgery (CHS), the requirements of the speciality, and some tips to the trainers/mentors to help in effective devolution of thoughts, principles, and skills. Salient points of the mentoring process have also been discussed. A modular plan for staged acquisition and transmission of surgical skills, as well as surgical management of common congenital cases, has been outlined. Finally, a note is added to sensitize the young congenital heart surgeon to learn to embrace the nuances of practicing this speciality in India. This could also apply to many other developing and low- and middle-income countries.

Keywords Training in congenital heart surgery · Mentor-mentee relationship

Pediatric cardiac surgery separates the men from the boys
... Christiaan Barnard

Introduction

Congenital heart surgery (CHS) is perhaps one of the most demanding specialities in medicine [1], and certainly ranks high amongst the surgical subspecialties in terms of duration of training. The making of a competent congenital heart surgeon goes beyond technical training. It entails a long-term investment of apprenticeship time, effort, and an in-depth understanding and study on the part of the mentee, working

shoulder to shoulder with a mentor. Close supervision and mentoring on part of the mentor is necessary to bring the young surgeon to a reasonably safe level of competency.

It is commonly felt amongst the cardiovascular and thoracic surgery (CVTS) trainees that not enough operative opportunities come their way during residency [2], thus leaving them with a feeling of inadequacy on completion of the prescribed period of training. This translates into more time spent in further apprenticeship, and a noticeable lack of confidence in doing even simple routine surgeries. CHS, which is much more demanding in technical skills, magnifies this feeling amongst the surgeons who choose this subspeciality [2].

“Good surgeons need skillful hands” as the adage goes is only partly true with regard to CHS. In this field, it is a combination of “skilled” hands connected with an equally sharp, knowledgeable, and a three-dimensionally tuned brain that needs to be developed. This makes congenital heart surgery a very “cerebral speciality”. The acquisition of the knowledge base, along with mastering and marriage of these traits, makes the apprenticeship longer than many other surgical subspecialities.

✉ Suresh Gururaja Rao
suresh.rao@kokilabenhospitals.com

¹ Division of Pediatric and Congenital Heart Surgery, Children’s Heart Centre, Kokilaben Dhirubhai Ambani Hospital & Research Centre, Four Bungalows, Andheri (W), Mumbai 400053, India

Background

“Operative” training in cardiovascular surgery in India is very varied amongst the teaching institutions. This echoes across the world [3]. With no specified standards or guidelines for practical training, it is left to each teacher and centre to “train” their residents in the acquisition of operative skills. The amount of “operative responsibility” delegated during residency is meagre at most in many Indian centres, with residents primarily playing the role of assistants in the operating rooms, doing bits and pieces of the procedures given to them to complete, other than routine sternotomies. In the very few institutions which do give opportunities, the operative training imparted is largely unsupervised. In such a non-conducive environment, trainees are left to themselves to acquire the skill sets needed to become a competent cardiac surgeon, leave alone a congenital heart surgeon.

Very few mentors take it upon themselves to personally oversee development of operative skills from the other side of the table by scrubbing up with the juniors. Many of our trainees, even those from reputed and busy centres, are fairly well versed in theory by the end of their magister chirurgiae (MCh) (CVTS) training, but are unable to independently manage simple and straightforward surgical procedures confidently. India does not have a regulatory body, or whole time programme directors to oversee and to ensure the minimum “surgical skill acquisition” by the residents from amongst the various surgical programmes. National board of examinations (NBE) and universities have loose recommendations for the same. Generally, there is a lax attitude shown towards log book maintenance, and this essential task document is not given adequate importance as a prerequisite to take the qualifying/credentialing examinations. A misplaced importance is given to the thesis, rather than research methodology and publication in the literature, leading to a surgeon well versed in theory, than in practical techniques and methods.

To this end, the Indian Association of Cardiovascular & Thoracic Surgeons (IACS) has commenced a 2-year post MCh Fellowship in CHS since 2016, hoping to make it a skill- and competency-based all-round fellowship training rather than one which focuses only on theoretical knowledge where the trainee only assists in operations like many others. It is still in a nascent stage and in the process of evolution. It will be a few years before we know whether it has made any difference to skill acquisition by the trainees in CHS.

The candidates coming up for training in congenital heart surgery in India are younger [4] as compared to their Western counterparts, and possess basic cardiac surgical skills varying from very poor to reasonable with very little or no exposure to complex congenital heart surgery, particularly in neonates and infants. Almost always, the first few months are spent in unlearning some of the previously learnt skills and thought processes to align themselves with the concepts and thought processes necessary to become a congenital heart surgeon.

Desirable personality traits in a prospective CHS trainee

1. Passion, empathy, interest, and motivation.
2. Focus and commitment to excellence.
3. Ability to put in very long hours.
4. Should have good health and fitness.
5. An open and a questioning mind.
6. Thoroughness and a desire for perfection.
7. Honest and critical introspection of actions and techniques at all times.

Desirable abilities

1. Leadership and good communication skills.
2. Demonstrate critical decision making abilities, especially in crises and emergencies.
3. Have an affable personality with ability to interact professionally and function as a part of a multidisciplinary medical team.
4. Ability to accept criticism and bounce back after a reverse.
5. Ability to analyse and think through a problem in challenging situations.
6. Writing skills as a bonus to establish and demonstrate clarity of thought.

Speciality requirements

1. Good depth of reading and up to date knowledge of congenital heart defects (CHD) in terms of morphology, basic paediatric cardiology, pathophysiology, cath calculations, and, and surgical techniques (theory and practical).
2. Good knowledge and a proactive participation in post-operative care of the congenital heart surgical patient.
3. A good working knowledge of electrocardiogram (ECG), echocardiography (preoperative, intraoperative, transesophageal, and three-dimensional (3D)), computerized tomography (CT) angiography, and magnetic resonance imaging (MRI).
4. An in-depth knowledge of paediatric perfusion, its utility in varied situations, different perfusion techniques, myocardial protection methods, and perfusion hardware.
5. Sound basic surgical skills.

Surgical training involves acquisition of various skills, tangible and intangible. Oftentimes, importance is placed only on operative skills which, though essential, form only a part of the required skill sets. What is certainly of paramount importance is sound operative skill backed by intense thought, observation, practice, and genuine introspection of errors. Transmission of skills is rooted in ancient Indian tradition as

illustrated by treatises of our *Guru–Shishya Parampara*. We believe training in CHS is no different, particularly as the *Shishya* needs to develop a high degree of discriminatory and “safe” operative skills to become a well-trained congenital heart surgeon.

The challenges that we are facing today in training are as follows

1. Putting a time limit to this training process.

This could vary for each trainee due to the factors listed below, which play a big role in the training process:

 - a. The mentee’s basic knowledge, basic skills, and their application.
 - b. The relationship between the mentor and the mentee, which has to be most close and cordial.
 - c. The mentor’s methods and commitment to training.
 - d. The mentor’s seniority to give more operative opportunities.
 - e. Staffing of the training centre and volume of surgeries performed.
2. Utopian expectations by the trainee that after the scheduled fixed period of training, he/she will be capable of independently performing any/all kinds of congenital heart surgery, including neonates and other complex subsets.
3. A false sense of comfort and confidence amongst the current generation of trainees that everything is available on “YouTube” and can be learnt and executed by seeing these videos. There is no substitute for conscientious hard work, and the time spent on YouTube does not, and will not, substitute time spent physically in the theatre witnessing an operation and interacting with the mentor.
4. For the mentors, spending enough time with the mentee to develop the latter’s skills in a graded modular fashion, and having the patience to take them through a surgery with critical and encouraging inputs/comments and suggestions for improvement, is mandatory. Mentors should be very skilled surgeons first, with great insight, depth of knowledge, and experience, and should enjoy a respected peer standing in their subspeciality. They should be able to inspire the mentee, and be competent enough to confidently take care of any inadvertent complications created by their junior colleague, or be mature enough to take over to bring no harm to the patient.
5. The maturity of the mentee to take criticism constructively, and implicitly attempt to pick up decision making and other needed attributes from the mentor.

There should be scathing criticism if a situation warrants it, but a healthy relationship should buffer these contingencies. It should finally be made into a “learning experience” for the

mentee, and the problems discussed in a less stressful and neutral situation, say, over a cup of coffee! This is sorely found wanting in many training centres across the country.

Current scenario and future potential

India is blessed with a plethora of cases coming up for primary surgery for another generation of surgeons. The numbers per centre are undergoing a redistribution now, given the increasing number of units doing congenital heart surgery, and opening up greater opportunities for trained surgeons. With a higher number of redo surgeries being done today than ever before, it is fortuitous that for the next generation of surgeons, there will be an ample mix of cases to hone their skills after their formal training. Though expectations and demands of patients, and the legal scenario are also undergoing a metamorphosis, it becomes more and more imperative that training should be imparted with least mortality and no compromise in the quality of outcomes.

Suggested training plan

A personally tested and validated plan of training is put forth below:

Foundations

1. Compulsory participation in the units multidisciplinary cath-meetings and case discussions to imbibe the surgical decision making process.
2. Get a good working knowledge of intraoperative, transoesophageal, and post-operative echocardiography, CT and cardiac MRI.
3. Good depth of reading, and keeping abreast with current literature.
4. Acquisition of knowledge of pre- and postoperative haemodynamics of CHD, post-operative management issues related to the lesion and their surgical correction, good knowledge of angiography and catheter data and their interpretation.
5. Come prepared for the posted case, armed with all the information listed above.
6. Discuss the surgical and perfusion plan and associated issues with the senior operating surgeon.
7. Present cases in the morbidity and mortality meetings to develop confidence in facing the critiques and interrogation by peers, and also develop writing skills to develop clarity and organization of thoughts.
8. Critical appraisal of literature.
9. Maintain an introspective surgical logbook, which transfers the operative procedure into thoughts and muscle

memory, and also aids in surgical memory of all the untoward situations and their solutions.

10. Knowing your limitations and asking for help
11. Take up a clinical or a surgical research project that leads to in-depth reading, ensuring clarity of concepts and thoughts on the subject. This will also secure the trainee an original publication!
12. Value additions to the training program could be rotating trainees to other units, and ensuring a trained young surgeon's placement after his apprenticeship to develop his/her skills further. Modern day wet labs, morphology specimen classes, case discussions, and learning on 3D printed models are useful additions to the learning process.

Operative training

In terms of operative training, our personal view is that the mentee should initially endeavour to be a clone of the mentor in terms of operative steps and technique in the training period, until he/she gains confidence and achieves independence.

Operative training should consist of a series of skill modules that the mentee should go through and demonstrate competency in each, before progressing to the next level. He/she should also strive to live up to the confidence imposed on him/her by the mentor and the team all along.

This assumes greater importance in neonates and infants than for older children. Most often, the minimum basic skills needed for the latter are easily cultivated as part of adult training.

A big component of operative training is also training of the mind. A mental process/checklist has to be inculcated from the initial years of training for opening the chest, going on and coming off bypass, haemostasis, and final closure. Clear and polite communication with anaesthesiologists, perfusionists, and nurses should also be cultivated for smooth conduct of the surgery, with zero or minimal errors due to miscommunication.

Competencies to be demonstrated in a modular fashion before reaching independence, particularly in neonatal and infant corrections, are as follows:

Module 1

- A “perfect sternotomy always” in the centre of the sternum, particularly at the manubriosternal angle.
- Delicate thymic dissection, respecting and safeguarding the phrenic nerves.
- Deliberated pericardial patch harvest and delicately hitching the pericardium, watching closely for haemodynamic disturbances.

- Learn and practice gentle tissue handling and fine instrument use.
- Be acutely aware of happenings in the theatre, and cultivate a sense of “situational awareness” [5] anticipating impending problems by listening to the various tones of the monitor beeps indicating the heart rate and saturations when the chest is being opened or closed. Be prepared to act at short notice.

Module 2

- Purse strings: A great deal of thought should go into their positioning and placement. Issues with purse strings often impede the smooth flow of the operation, leading to irritation and in turn compromising the safety of the patient.
- Cannulation techniques have to be mastered as desired by the mentor, and be in accordance with the protocols of the respective unit for each and every case.
- Concentrate on “safe” cannulation and decannulation techniques. A routine has to be inculcated and followed always. Revise and seek advice if there is even a little bit of doubt. Never compromise in these steps.
- Placing intraoperative lines like left atrium (LA)/pulmonary artery (PA) lines, atrial and ventricular pacing wires.
- Going on and coming off bypass safely.

Module 3

- Learn tissue and instrument handling inside the small heart as in for simpler atrial septal defect (ASD) and ventricular septal defect (VSD) closures.
- Refine suturing techniques. Be very “fussy” in suturing with even placement of loops and knots, to the extent of being obsessive.
- Do every step of the procedure perfectly. Once a step is done, one should not have to go back and recheck it.
- Closure of all varieties of atriectomies and ventriculotomies securely.
- Transannular/right ventricular outflow tract (RVOT) patch suturing.
- Haemostasis, closure, and decision for a delayed sternal closure in consultation with the senior surgeon.

The mentee progresses to the next step/module only after the mentor is satisfied that the steps of the previous module have been performed to his satisfaction. The time taken to achieve this is variable, depending on the attitude, application, and innate surgical skills demonstrated by the mentee. A conscientious and keenly observant person with perfectionist and diligent qualities could progress faster than a person with a callous and overconfident attitude.

Once the abovementioned skills have been cultivated to the satisfaction of the mentor, the mentee could be taken through an ASD and VSD closure with the mentor scrubbed in, for the initial few cases, and then letting the mentee assume independence gradually with the case closely supervised by the mentor in a few more cases.

Module 4

- ASD closure

Module 5

- VSD closure
- Tetralogy of Fallot corrections
- Gradual progress to more complex surgeries in stages and submodules

Closing all varieties of ASDs and VSDs securely without residual shunts and conduction abnormalities should be treated as a milestone in the training of congenital heart surgery as this takes care of an important step in 50% or more of the corrective surgeries. This also adds to the confidence of the mentee greatly. It takes experience and a great deal of practice to assess the appropriate size of the VSD patch and plan the various approaches particularly in complex VSDs. This judgement will be gradually gained in time as the mentee performs more of such surgeries independently under watchful supervision.

In contemporary practice, we would recommend that every trainee/mentee develop the mindset to insist on confirming the security and completeness of the ASD, VSD closures, and adequacy of resection repair by post-operative transthoracic/transoesophageal echocardiography, done either by a cardiologist/trained cardiac anaesthesiologist or by self and assessed independently by a cardiologist/cardiac anaesthesiologist. Always, be open to go back to improve on the repair, if found wanting, or deemed necessary to ensure perfection and completeness. An unbiased third party evaluation is desirable to ensure the quality of correction, to the satisfaction of all stakeholders in the team, avoiding surgical bias. In the absence of this facility, or in addition, on table manometry/oximetry could be of great help clinically and academically. The mentee should take an objective view and develop a positive approach, if the situation warrants redoing, in the best interest of the patient, as this also adds a new perspective and teaches valuable lessons. Simultaneously, the mentor should also be gracious enough to allow the mentee to learn from such shortcomings. A debriefing afterwards will go a long way in internalizing the experience.

Module 6

Gradually increasing operative responsibilities of the mentee with close supervision and approval of the mentor at every step, such as with RVOT resections in tetralogies, decisions with regard to the need of a transannular patch or otherwise, repair of partial atrioventricular septal defect (AVSD), Glenn shunt, completion Fontan, dissection of aorta for arch repairs, and reconstruction of the pulmonary part of arterial switch operation (ASO) could be the areas where the mentee could get pretty good experience to demonstrate his/her acquired fine surgical skills before going on to perform more complicated operations.

Module 7

Operating more cases with these freshly acquired skills will enable them to become self-confident and lead to gradual independence. Finally, the mentee could move over to complete independence to perform a whole operation “skin to skin” with the mentor covering in case of any need.

Module 8

Redo sternotomies could be challenging to surgeons of any level of seniority and experience. These surgeries are becoming more common with the passage of time. The future generation of surgeons are wont to face these more frequently in their practice. Their exposure and training in the principles for a safe redo opening and conduct are of paramount importance and the need of the hour.

We have found completion Fontans, with previous staging surgeries done in the same unit, a good case to start with reasonably safely. With increasing numbers and experience without major mishaps, the mentee could gain more confidence in performing redo-sternotomies.

However, sternotomies after multiple previous re-entries, transpositions, or other lesions with an anterior/dilated ascending aorta, hypertrophic and dilated right ventricles are cases that need lots of experience to plan and execute successfully. It may not be a good idea to let a trainee do these cases during initiation.

Towards the end of completion of the training period, the trainee needs to have developed sufficient skills for femoral and innominate artery exposure and cannulation in children and axillary exposure and cannulation in adults and older children for safe re-entry.

Module 9

Systemic to pulmonary shunts in infants and neonates are another group of cases that are not usually given to trainees unless they have gained a high level of competency and experience and/or are on the verge of being appointed as consultants. These require great skill and judgement with a zero

error margin, particularly in neonates. However, in these cases, the mentee could be allowed to expose and dissect out the arteries if delicate tissue handling skills have been demonstrated consistently, and he/she enjoys the confidence of the attending surgeon. The mentee could also be allowed sizing and bevelling of the graft as this demonstrates a 3D comprehension of the anatomy and a higher order of understanding required for these situations.

What should be the duration of training for a congenital heart surgeon?

Assuming the training is to be imparted in a high-volume dedicated congenital heart centre, doing two or more surgeries daily across all complexities in neonates, infants, toddlers, and adults with CHD, with two or more senior surgeons, it would appear to obey the 10,000-h rule. We agree with Backer [6] that if a resident or trainee operates 6 h a day, 5 days a week, then it would take 7 years to achieve the 10,000-h mark. In our opinion and experience, all things going in favour of the trainee, this is the period we feel it would take a young cardiac surgeon fresh out of training, to become a reasonably confident and proficient congenital heart surgeon, having learnt the art and science of this subspecialty with the least mortality and *heartbreaks*!

Economics

The congenital heart surgeon in India has to be aware of, and very sensitive to, the costs involved and its overruns, as the bulk of the surgeries are undertaken with fixed shoestring budgets. Every effort should be made to keep the costs and overheads to the minimum, without compromising safety of the patient. Planning the surgery well to the last detail, meticulous execution, good haemostasis requiring minimal use of blood products, robust adherence to protocols, checklists, and infectious disease practices, all contribute to keeping the costs under control. It would also help if the mentee aims to benchmark and work towards reducing the cardiopulmonary bypass and aortic cross clamp times, keeping those of the mentor as a yardstick. This would effectively translate into reduced morbidity and reduced stay in the intensive care unit (ICU), thereby reducing cost overheads. These practices have to be consciously cultivated during the training period and introspected often.

A congenital heart surgeon in India

Unlike in many developed countries, the congenital heart surgeon in India is faced with peculiar problems for which exposure is needed during the training period.

1. Finding funding for the surgery is an inseparable part of practicing this speciality in India and perhaps so in many other low and middle income (LMI) countries. The mentee has to be sensitized to this issue, and plan the surgery and stages accordingly. At times, this may be at variance from what is published in literature, taking into account the local realities. The problem will exacerbate if there is a complication/retake for bleeding or a residual lesion, leading to overstay in the ICU or needing mechanical support. Hence, the need for deftness in performing the surgery carefully and methodically. Taking swift decisions if a problem is encountered rather than pursuing a wait and watch approach also helps in keeping costs in check.
2. As most congenital heart programmes are supported by the hospital or external agencies, the young consultant congenital heart surgeon should learn to build and nurture cordial relationships with hospital administrators, hospital promoters, office bearers of non-governmental organizations (NGO's), and other agencies supporting the child's surgery.
3. Every major investigation like CT, MRI, or even cardiac catheterization has to be carefully considered and planned with paediatric cardiologists, as these add to the financial burden for the family and the philanthropist supporting the child.
4. Non-essential disposables, conduits, and haemostatic agents have to be used judiciously.
5. It is imperative that the congenital heart surgeon in India is familiar with all aspects of post-operative care of neonates and infants as dedicated talent in this area is scarce in our country.
6. As the ultimate post-operative responsibility rests with the surgeon, it is in his/her interest to forge cordial professional relationships with the paediatric cardiologists, paediatric intensivists, anaesthesiologists, perfusionists, nurses, and other members of the team taking care of the child, and create an environment conducive for them to deliver their best and the most optimal care after surgery.
7. Needs to take active interest in training nurses, and perfusionists, especially when setting up a new unit.
8. Learn to be forthright with the parents while counselling for surgery, without pretence or exaggeration of the good and ill effects of the corrective surgery, backed by evidence and the unit's experience. It is prudent to assume that any amount of presurgical counselling of the risks of operation will cut no ice with a stressed family if an undesirable outcome occurs. Hence, it is advisable to have an open channel of communication and frequently provide the family information and counselling about the progress of the child after surgery during good and bad times.
9. Contribute to literature, particularly suited to our population of patients, which is often different from that of our Western counterparts in many ways, and their experiences

may not always be possible to be extrapolated to our setting. These may include, but not limited to, very low birth weight and nutritionally compromised infants, late referrals, non-optimal pre-operative management at the referring centre with super added sepsis, and complications during transport to a higher centre, all of which are unique to the practice in India.

Conclusion

Training in congenital heart surgery is akin to a complex jigsaw puzzle. During the period of apprenticeship, the mentee keeps learning and constructing bits and pieces of the jigsaw that gradually over the years fall into place to form the complete picture. It is at this time that the junior surgeon is ready to assume the mantle of an independent congenital heart surgeon with a fair measure of confidence and competence.

The two statements that succinctly capture the nuances of acquiring technical expertise and excellence in CHS are as follows:

Achievement of perfection is the acquisition of mastery of seemingly insignificant details-.....Anonymous
and

We are what we repeatedly do. Excellence then, is not an act but a habit-Aristotle

Abbreviations CHS, congenital heart surgery; CVTS, cardiovascular and thoracic surgery; MCh, Magister Chirurgiae; CHD, congenital heart defects; NBE, National Board of Examinations; ECG, electrocardiogram; CT, computerized tomography; MRI, magnetic resonance imaging; LA, left atrium; PA, pulmonary artery; ASD, atrial septal defect; VSD, ventricular septal defect; RVOT, right ventricular outflow tract; AVSD,

atrioventricular septal defect; ASO, arterial switch operation; ICU, intensive care unit; NGO, non-governmental organizations; LMI, low and middle income; 3D, three-dimensional

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References

1. Fraser CD. Becoming a congenital heart surgeon in the current era: realistic expectations. *J Thorac Cardiovasc Surg.* 2016;151:1496–7.
2. Kogon BE. The training of congenital heart surgeons. *J Thorac Cardiovasc Surg.* 2006;132:1280–4.
3. Mery CM, Kane LC. The ACGME fellowship in congenital cardiac surgery: The Graduates perspective. *Semin Thorac Cardiovasc Surg Pediatr Card Surg Annu.* 2017;20:70–6.
4. Morales DLS, Khan MS, Turek JW, et al. Report of the 2015 Society of Thoracic Surgeons congenital heart surgery practice survey. *Ann Thorac Surg.* 2017;103:622–8.
5. Sarkar H. Being aware!-situational awareness and its importance in safety and quality assurance in Neurosurgery. *Neurol India.* 2020;68:1166–9.
6. Backer CL. There's no fun like work. *J Thorac Cardiovasc Surg.* 2017;154:1339.

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