

Recommendations of the Association for European Paediatric Cardiology

The ideal configuration of the modern theatre for paediatric cardiac catheterisation: Recommendations of the Association for European Paediatric Cardiology

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Compiled by a Working Party of the Association for European Paediatric Cardiology

General considerations

Congenital malformation of the heart can be diagnosed by non-invasive investigations such as cross-sectional and colour Doppler echocardiography, computerised tomographic scanning, and magnetic resonance imaging. Cardiac catheterisation and angiography is now required only for complex cases, and for the assessment of pulmonary arterial pressures and pulmonary vascular resistance prior to palliative or corrective surgery. A major component of the work undertaken in the cardiac catheterisation theatres is now devoted to interventional techniques for the treatment of the congenital cardiac malformations. Between one-third and three-quarters of the workload in the catheterisation theatre may now be interventional. The change of emphasis from diagnostic to interventional types of work means that the requirements for training to achieve the necessary expertise, and the standards of the cardiac catheterisation theatres, need to be re-evaluated.¹⁻⁴ It should be understood that the requirements of a cardiac catheterisation theatre are the same irrespective of whether the bulk of the work is consumed by diagnostic procedures, or also involves interventions.

Facilities

- Interventional techniques require more skilled manoeuvres than do diagnostic procedures, and a variety of different types of devices are used in the cardiovascular system. Some of these procedures, because of their complexity, may necessitate a joint approach between the interventionist and the paediatric cardiac surgeon, or involve the need for

surgical standby cover, and the availability on-site of paediatric cardiac intensive care.

- Other procedures may be sufficiently complex, or have an increased likelihood of complications requiring surgery, so that a cardiac catheterisation theatre may need to be converted to a sterile surgical theatre. There is, thus, a need for a theatre of adequate space allowing such work to be undertaken without hindrance.
- Some of the other procedures may carry a sufficiently low risk to allow these to be performed in catheterisation theatres without the need for surgical cover, although generally this is not recommended when investigating or treating children with congenital cardiac disease, as even some of the patients undergoing procedures considered to carry a low risk can suffer complications and require emergency surgical treatment.
- Cardiac catheterisation theatres should be located near the main cardiac surgical theatres so as to allow smooth transfer of patients should this be required. Where possible, the suites for magnetic resonance imaging should also be located nearby.

Cardiac catheterisation theatres

- In some institutions, the theatre for cardiac catheterisation may be dedicated exclusively to work in children, be shared with adult cardiologists in others, and, occasionally, may be shared with radiologists. Whether dedicated or shared, the theatre should be available for "round the clock" emergency work. Whilst this may be a necessity based on the workload of each unit, the cardiac catheterisation procedures, whether diagnostic or interventional, should only be performed by paediatric cardiologists skilled in these techniques. In the modern era, it is not acceptable for adult cardiologists, or

radiologists, still to perform the occasional diagnostic, and even interventional, procedures on patients with congenital cardiac malformations.

- Paediatric cardiac catheterisations, whether diagnostic or interventional, should be performed only in institutions and in theatres where there is support on-site for paediatric cardiac surgery, paediatric intensive care, and paediatric anaesthesiology.
- With these facilities, procedures may be performed on a day-case basis in selected cases, otherwise overnight stay is usually needed.
- A sterile environment comparable with that expected in the operating room must be maintained in the catheterisation theatre, with frequent changes of air at the rate of 15 to 22 room cycles per hour. The theatre should be sufficiently spacious to permit conversion into an emergency surgical theatre. Appropriate control of the room temperature is essential.
- Adequate provisions should be made to control the temperature of babies and infants by the use of Bair-hugger, or similar, equipment.

Equipment

A modern and ideal cardiac catheterisation laboratory for treatment of patients with congenital cardiac malformations should:

- Have an imaging system of quality capable of producing high-resolution images.
- Have a system for acquisition of biplane angiographic images. Some institutions continue to work in children with cardiac disease using systems that may be biplane non-digital, single plane digital, and even single plane non-digital. It has been acknowledged that, in interventional work, either a single plane digital system based on flat-plate technology, or a biplane digital system, should be the minimal requirement. Anything less than this should not be considered acceptable for safe practice. A single plane digital system would also be acceptable to adult cardiologists and radiologists in those theatres in which the work is likely to be shared by those working in these sub-specialties.
- Possess comprehensive facilities for monitoring, including continuous electrocardiographic monitoring using at least three leads simultaneously, non-invasive and invasive monitoring of blood pressure, pulse oximetry, capnometry, and temperature regulation and control. Measurement of at least two blood pressures simultaneously should be possible in the theatre.
- Have facilities for measuring and recording pressures and oximetry. These should be conveniently

placed in the catheterisation theatre such that the operator is able to evaluate the results without placing the personnel at an increased risk of exposure to radiation. Extra monitors displaying fluoroscopic images must be available for other staff, such as radiographers and cardiac technicians, permitting them to view the activity from a control room.

- Possess a system capable of acquiring complex angled views during diagnostic angiography and interventions.
- Have "cine-less" angiographic systems.
- Apply standard rules relating to the measurement of dosage of radiation, and ensure maximum protection against radiation for the patients and the staff.
- Measure and record fluoroscopy times and the total radiation dose.
- Whenever possible, use techniques to reduce the dose of radiation.
- Whenever possible, provide a system for on-line instantaneous replay of angiograms, together with software capable of performing measurements of the diameter of vessels, and "road-mapping" for interventions.
- Contain facilities for the archiving of studies, ideally by means of an efficient method of storage of data using compact or optical discs.
- Possess a system linked to the hospital network for storing images, so that facilities for replay and review are available in locations such as the cardiac surgical theatres.
- Ensure regular servicing and up-grading, or replacement, of the equipment so as to maintain high quality imaging.
- Provide facilities for telemedicine. In the future, paediatric cardiologists will make increasing use of this technology for education, and for performance of complex procedures with feedback from an expert at another centre. Thus, each cardiac catheterisation theatre should have such the capability for external linking, providing flexibility for the future.

Inventory

- All the available catheterisation theatre equipment should be specific for children of all ages. Attempts to use equipment designed for adults, modified for use in children, should be strongly discouraged.
- The introducer sheaths, guidewires, catheters, balloon catheters, devices, stents, and coils must be available for use in children with congenital cardiac malformations. A large inventory of equipment specific to paediatric cardiology is needed. A variety of stock of emergency equipment and

devices, such as retrieval snares or baskets, should be available in the theatre.

- A pressure injector is essential for angiography.
- Any items deemed for single use only by the manufacturer should not be resterilised.
- Echocardiographic and trans-oesophageal probes should be available in the cardiac catheterisation theatre for emergency use, and as an aid for use in techniques involving closure using devices.
- Equipment and facilities for emergency resuscitation should be sited within the catheterisation theatre, and be regularly serviced and checked for correct function.

Personnel

- The staff working in the cardiac catheterisation theatre should be specifically trained and experienced in techniques used in paediatric cardiology, and in the care of infants and children. These include all doctors, whether paediatric cardiologists or anaesthetists, nurses, cardiac technicians, radiographers, and operating room assistants.
- There should be a designated director, or lead interventionist, in each theatre undertaking cardiac catheterisation in children, who should be a paediatric cardiologist responsible for leading and directing the procedures undertaken. Such a person should be able to oversee other paediatric cardiologic staff working in the catheterisation theatre,

should keep up to date with the latest technology and diagnostic and interventional techniques, and should be capable of introducing these in the practice of the unit.

- Regular review of performance by audit, and comparison with data available internationally, should be part of the duties of the director or lead interventionist.
- Catheterisation of adults with congenital cardiac malformations should be performed by a person trained in the investigation of congenital cardiac disease in all age groups.

References

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