PERSONAL PRACTICE

Neonatal/infant echocardiography by the non-cardiologist: a personal practice, past, present, and future

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An increasing number of neonologists and general paediatricians with an interest in neonatology are performing echocardiography on neonates and infants. There have been several articles, a book, and a CD-ROM on the subject by specialists outlining the pros and cons of a generalist developing the skill. However, there has been little or no comment in the paediatric literature by any neonatologists or general paediatricians. This article outlines my personal experience, highlighting possible pitfalls and problems encountered while developing the skill of echocardiography.

WHY SHOULD A NON-CARDIOLOGIST PERFORM ECHOCARDIOGRAPHY?

My personal view is that echocardiography when properly performed is a very useful ultrasonographic investigation. It can influence the management and outcome of the neonate so much, especially that of the extreme preterm, that I feel that this investigation should be available within 24 hours of requirement. Once weekly or even once fortnightly scanning sessions can no longer be justified. A few paediatricians still believe that if you cannot see, feel, or hear ductal signs, then there is no patent ductus arteriosus (PDA). This is despite a large paediatric literature showing that this is incorrect. It has even been suggested that the absence of a murmur in an infant with a PDA may in fact be “a more sinister sign” haemodynamically. It is not unusual for regular scanning to detect a haemodynamically significant PDA several days (usually about three) before any signs appear.

Weekly scanning and consequent delayed diagnosis of a PDA may prove costly in terms of morbidity: worse respiratory disease, increased incidence of intraventricular haemorrhage, an increased incidence of necrotising enterocolitis, problems of renal hypoperfusion, and circulatory problems. Infants who develop a late murmur with or without bounding pulses may in fact have a transient peripheral pulmonary branch stenosis after closure of the duct. This may occur in almost 50% of cases of PDA and blind treatment of infants as though they have a reopened duct may lead to mistakes. Babies may have their fluids restricted, be started on diuretics, or even be put on indomethacin for days before the weekly scan confirms the correct diagnosis. The cause of the bounding pulses in this instance may be high CO2 in an infant with compensated respiratory acidosis secondary to chronic lung disease. The duct does not in fact “wink” and, except rarely in very low birthweight infants, once it closes it does not normally reopen. In further support of regular scanning of infants with PDA, there is recent evidence from Su et al. that, if PDA flow patterns are followed serially by echocardiography, indomethacin treatment could be stopped before administration of the full course, thus reducing the risk of complications. Most importantly, there was no difference in their series of rate of closure or reopening between infants that received the full course and those that had an abbreviated course.

For the above reasons and others cited below, frequent echocardiography is likely to become the norm on neonatal intensive care units for optimal management, especially of very low birthweight infants. However, there are only about 60 paediatric cardiologists in the United Kingdom, and other people, preferably neonatologists or paediatricians who care for neonates, will have to learn the skills to provide this facility.

THE PAST

Mine was the most inauspicious start to the development of the skill of echocardiography; I would go as far as to suggest that scanning the obviously clinically abnormal heart should be avoided until one is quite familiar with the structure of the normal heart. One is then in a position to recognise abnormalities. It is important from the outset to be trained to look at all four classical views during each scan. In addition, a long axis view of the arch and descending aorta and a look at the abdominal aorta and inferior vena cava are essential. The practice of most paediatric cardiologists in echocardiographic diagnosis is to identify the position, relation, and connection of each vein and heart chamber to each other, from the inflow to the outflow of the heart following through to the great arteries, identifying abnormalities along the way. This process is known as “sequential chamber localisation” and is a logical technique to prevent defects from being missed through the use of short cuts. A machine with colour and pulsed Doppler is highly desirable, and a very good one costs less than £50,000.

I then started weekly attendance at one of the paediatric cardiology clinics at the local tertiary centre. I soon progressed to “taking a look” at infants with heart murmurs from postnatal wards and the neonatal intensive care unit, and also looking for PDA. If anything abnormal was found, such as a ventricular septal defect, atrial septal defect, or PDA, I would not pronounce a diagnosis, but tell the parents about my suspicions and then arrange for my colleagues at the local tertiary centre to review the case. This was usually within three days, but sometimes on the same day if I was particularly worried. Understandably, a normal scan in the presence of a significant murmur was most worrying. Such cases always prompted referral. Initially, I refused to perform postnatal screening scans for antenatally suspected cardiac lesions as I was worried about a family history of congenital heart disease.
It is of paramount importance that scanning should not be stopped when a lesion is found, because an associated lesion could be missed. This happened to me in the early days when the excitement of finding a ventricular septal defect in a pink newborn infant with a murmur stopped me from looking any further and so I missed the obvious overriding aorta and all the other features of a Fallot's tetralogy. I was most annoyed with myself when the paediatric cardiologist rang later that day to tell me the diagnosis, although he was very gracious and encouraging. The support, supervision, encouragement, and lack of pomposity of the local tertiary centre are absolute requirements for success for all aspiring echocardiographers.

There is a feeling of surprise when one actually starts to correctly diagnose various congenital heart problems. It is at this stage, however, that one's limitations should be recognised. It is essential that a cardiologist assesses the infant at the earliest possible opportunity.

During this period, access to good reading material is highly desirable, and there are several books and an interactive CD-ROM on the market.\textsuperscript{14,15} Polishing up on theoretical knowledge is highly recommended.

\section*{THE PRESENT}

After about 18 months of scanning, to my amazement, the tertiary centre pronounced that they considered me competent enough to "go solo". This paradoxically made me scan even more thoroughly and carefully because I was terrified of missing something and therefore still maintained a very low threshold for referral. The tertiary centre to their credit put up with my insecurity without complaint until I started to share my clinical opinion should always be sought.\textsuperscript{17} cardiologists have missed TAPVD. The important point here is that the patient was transferred urgently because my diagnosis did not make complete sense. If in any doubt, an urgent cardiological opinion should always be sought.

Assessment of hypotensive neonates by echocardiography is going to become a major part of their management because most are in fact not hypovolaemic\textsuperscript{22–25} but instead have problems related to myocardial contractility or ducal patency. Most do not therefore need infusion of volume expanders, which are in fact potentially dangerous.\textsuperscript{22–25} but treatment with inotropes or therapeutic ductal closure.\textsuperscript{22–25} Reliable assessment of ventricular function is a skill that, although a little more difficult to master, is achievable with proper instruction at a more advanced echocardiography course for neonatologists.

<table>
<thead>
<tr>
<th>Type of lesion</th>
<th>Comments</th>
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<tbody>
<tr>
<td>VSD (ventricular septal defect)</td>
<td>Small ones may be missed if one scans too soon after delivery. Interrogation with colour and pulsed Doppler essential. Subcostal four chamber view is best. Some may be just large patent foramen ovale. Measurements of size and T- artifactisation\textsuperscript{14} will help to differentiate.</td>
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<tr>
<td>ASD (atrial septal defect)</td>
<td>As above</td>
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<tr>
<td>AVSD (atrioventricular septal defect)</td>
<td>Look for the normal offsetting of the inlet valves; the tricuspid valve is usually set more apically than the mitral valve.</td>
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<tr>
<td>Fallot's tetralogy</td>
<td>One of these cases was missed in the earlier days and was transferred as a large VSD.</td>
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<tr>
<td>TGA (transposition of the great arteries)</td>
<td>Four limb oxygen saturations and blood pressures essential</td>
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<tr>
<td>Pulmonary atresia with intact ventricular septum</td>
<td>Colour and pulsed Doppler are useful. The former to detect and the latter to confirm.</td>
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<tr>
<td>Interrupted aortic arch</td>
<td>Usually postductal closure and often misdiagnosed as a &quot;winking duct&quot;.\textsuperscript{6} This is a physiological phenomenon.</td>
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<tr>
<td>Coarctation of the aorta</td>
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<tr>
<td>Mild to moderate pulmonary stenosis</td>
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<tr>
<td>Peripulmonary stenosis with Noonan's syndrome</td>
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<td>Supra-aortic stenosis with William's syndrome</td>
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<td>TAPVD (total anomalous pulmonary venous drainage)</td>
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<td>Transient peripheral pulmonary stenosis</td>
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<td>Atrial flutter</td>
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\section*{Atrial Flutter}

Reliable assessment of ventricular function is a skill that, although a little more difficult to master, is achievable with proper instruction at a more advanced echocardiography course for non-cardiologists.
All specialist paediatric registrars (SPRs) on our unit are encouraged to attend an echocardiography course and are then given further hands on experience during the neonatal part of their tenure at our hospital. Most learn to recognise a PDA, although the decision to treat with indomethacin is made by a more senior paediatrician. Some SPRs have left with quite an impressive portfolio of cardiac lesions on video.

Echocardiography has become such a vital part of our armamentarium in the management of the extreme preterm infant that it has become difficult to imagine how we ever managed without it. Table 1 shows examples of cardiac abnormalities diagnosed on our unit by echocardiography.

THE FUTURE

The future lies in telemedicine with establishment of links between peripheral hospitals and tertiary centres.1 This will not only enhance training in and maintaining the skill of echocardiography, but will also improve management by allowing ready consultation. It will also mean fewer unnecessary transfers to tertiary centres for assessment of congenital heart disease. This will have several benefits: ease of clinical management of the infant;23 financial savings; the unquantifiable parameter of convenience for the family. The person actually performing the scan need not be very experienced, as the study of pictures transmitted using this innovative and relatively cheap facility can result in a high degree of accuracy of diagnosis. We are in the process of installing it on our unit funded by a charitable trust.

It is my belief that echocardiography is going to become an essential tool for the management of the sick neonate and that neonatologists should be encouraged to learn the skill. My story should give encouragement to all those who want to develop the skill but are, like me at the beginning, a little apprehensive.

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