Certification in echocardiography of congenital heart disease: experience of the first 6 years of a European process

Luc Mertens1, Owen Miller2, Kevin Fox3, and John Simpson2*

1Division of Cardiology, The Hospital for Sick Children, University of Toronto, Toronto, ON, Canada; 2Department of Congenital Heart Disease, Evelina Children’s Hospital, London, UK; and 3Imperial College, London, UK

Received 30 March 2012; accepted after revision 28 May 2012; online publish-ahead-of-print 26 June 2012

Aims
Certification in congenital heart disease echocardiography presents unique challenges compared with certification of adult transthoracic and transoesophageal echocardiography. We report our experience in collaboratively developing an exam process that covers the size and age range of congenital heart patients, the varying professional backgrounds of echocardiography practitioners across the field and our approach to the challenge of introducing a pan-European certification endorsed by the major stakeholder groups; the European Association of Echocardiography (EAE), the Association for European Paediatric and Congenital Cardiology (AEPC) and the Grown Up Congenital Heart Working Group of the European Society of Cardiology (ESC).

Methods and results
Since its inception in 2006 the exam has been held seven times; 137 candidates from 27 countries have sat the exam, 107 candidates (78%) have passed the exam components and 60 candidates have successfully completed the logbook submission and have been certified in echocardiography of congenital heart disease echocardiography by the EAE. In addition to the certification process, a comprehensive curriculum, teaching programme, and teaching courses have been developed.

Conclusion
The institution of a European certification process for echocardiography of congenital heart disease has proved feasible.

Keywords
Echocardiography • Certification • Accreditation • Europe • Examination • Teaching • Training • Congenital heart disease

Introduction
Echocardiography is a key diagnostic technique for the diagnosis of congenital heart disease (CHD). Most congenital heart defects are diagnosed based on an echocardiogram and in the paediatric age range; the majority of children are referred for cardiac surgery based on echocardiographic imaging only. Furthermore, in the peri-operative and post-operative management of patients with CHD, echocardiography is the most important first line diagnostic imaging technique. Therefore, a high degree of diagnostic accuracy in echocardiographic imaging is a key for the clinical management of patients with CHD. Congenital echocardiography is different from imaging acquired heart disease because the normal connections of the heart cannot be assumed which means that different training and expertise is required. With respect to paediatric and neonatal echocardiography, training requirements have been defined by both European and North American professional organizations1–3 (Table 1). No specific training requirements have been published with respect to echocardiography of CHD in adults. The European paediatric guidelines distinguish three levels of expertise: basic, advanced, and expert.1 These levels range from basic training in the performance and interpretation of echocardiograms for simple congenital and acquired lesions, advanced level including more complex disease, transoesophageal echocardiography, and supervised foetal echocardiography through to the expert level which is intended for directors of paediatric echocardiography laboratories. In the North American guidelines core and advanced levels are recognized.2 The core
level specifies ‘the ability to perform and interpret transthoracic echocardiography in normal infants, children and adolescents, and in those with childhood heart disease, with consultation as needed’ and the advanced level requires ‘special expertise in performance and interpretation of transthoracic echocardiography in all forms of congenital and acquired paediatric heart disease, including the adult with CHD, enabling the practitioner to function independently.’ This includes transoesophageal (TOE) and foetal echocardiography. The requirements for these training processes including required echocardiographic study numbers and training period are summarized in Table 1 and are compared in detail elsewhere.2 The American National Board of Echocardiography organizes examinations for transthoracic and transoesophageal echocardiography but there is no specific paediatric or congenital certification.

Rationale for a certification process

Given that congenital echocardiography is highly user-dependent and requires specific training, the European professional organizations involved in the care of patients with CHD decided to specify and endorse a certification process for congenital echocardiography. The primary aim of the introduction of the certification process was to enhance education and development of the core skills required to perform congenital echocardiography. This process would guide trainees through a curriculum and allow trainees to test their knowledge and practical expertise against a common standard. Specifically, the initiative was not designed as a measure of fitness to practice which was left with national institutions. It was felt that the subdivision of congenital echocardiography by age was unhelpful and that a certification process should be suitable for those undertaking echocardiography of CHD in either children or adults. The certification initiative was designed to include any professional performing congenital echocardiography in Europe. Thus the process accommodates paediatric cardiologists, adult cardiologists, paediatricians, anaesthetists, and cardiac physiologists/echocardiographers.

The congenital echocardiography certification initiative was integrated within the European Association of Echocardiography (EAE) certification processes, which already existed for adult transthoracic and transesophageal echocardiography.4,5 The Association for European Paediatric and Congenital Cardiology (AEPC) together with the working group for Adult Congenital (Grown Up Congenital Heart) Disease from the European Society of Cardiology decided to use the existing organizational structures and expertise within the EAE to deliver the European certification of congenital echocardiography.

Evolution of the certification approach

At the outset, it was decided that the certification process should be structured to assess both knowledge and skills in congenital echocardiography. Core echocardiographic modalities were included namely transthoracic echocardiography using established cross-sectional, M-mode, colour flow, and other Doppler techniques. It was decided that more subspecialized imaging such as TOE or foetal echocardiography and modalities such as tissue Doppler or three-dimensional echocardiography would not be included in the certification. Given the large number of different countries involved, it was felt that there should be an examination incorporating both video and written questions, which would supplement further information from log books of practice.

Certification oversight

Prior to the commencement of the certification process, a CHD certification committee was formed with the aim of producing
appropriate exam material and to consider the structure of the examination. This included representatives of the EAE, AEPC and Adult Congenital Heart Disease Working Group of the European Society of Cardiology (ESC). The model of the existing transthoracic and transoesophageal examinations was used as a reference. Some important issues emerged early in the process. A core question which had to be addressed was image orientation. In many congenital units, images are displayed ‘anatomically’ rather than in ‘adult’ orientation. As an example, this impacts on whether a four-chamber view is presented with the cardiac apex up or down. No consensus on using a single orientation could be reached on this point due to considerable institutional variation in Europe. Thus, a pragmatic decision was reached that images could be presented in either projection, and candidates should be familiar with either. However, it was agreed that assistance of candidates with respect to image projection should be universal so that for all such reporting questions an orientation key defining left/right and superior inferior relationships would be included adjacent to the moving image (Figure 1). A further question related to the type of examination material to be included. Within congenital echocardiography, paediatric echocardiographers may be more familiar with unrepaired lesions, whereas adult congenital echocardiographers may be more familiar with longer term complications following repair earlier in life. Agreement was reached that the examination should include a balance of cases from both children and adults including both unrepaired and repaired lesions. Feedback to the EAE, AEPC, and ESC was provided via the EAE Certification Committee and the EAE board, the AEPC Imaging working group and the ESC adult congenital working group, respectively.

**Process for certification**

Candidates wishing to pursue certification in echocardiography of CHD can register via the website of the EAE (http://www.escardio.org/communities/EAE/accreditation/CHD/). To register, the prospective candidate needs to secure the agreement of a local supervisor who is expected to be a practicing attending/consultant congenital cardiologist with an interest in echocardiography or an individual who has certification in echocardiography of CHD. The supervisory role includes oversight of the candidate’s progress and verification of the logbook submission and direct observation of practice echocardiographic assessment. Given that the certification process is relatively new, the fact that echocardiography is central to CHD practice and that practice (and especially training) is typically centred around tertiary institutions, it was felt that supervision according to the criteria outlined above was satisfactory without any further formal ‘selection’ procedure. In practice, supervisors are usually experienced cardiologists/echocardiographers who are fulfilling a supervisor role in other settings. A minimum of 250 echocardiograms must be logged over a maximum period of 2 years. The number of cases was agreed by consensus and was felt to be broadly consistent with previous recommendations. The candidate is expected to maintain the core details in an anonymized electronic format and to retain a paper version of the log book for future reference. The log of cases was submitted by post to the EAE in the first years but this has been superseded by electronic submission. This is supplemented by confirmation by the supervisor that the cases represent the candidate’s work. The website includes the examination syllabus, suggested reading material, and proposed balance of the types of cases which are to be included within the logged examinations. No more than one-third of logged cases should be normal studies. Until December 2010, a sample of 15 echocardiographic reports were selected by the EAE education department and submitted for grading by external reviewers according to written guidelines consistent with other adult TTE and TOE certification pathways. This process was, however, revised from December 2010 because it was felt that it was less appropriate for congenital echocardiography because of the degree of diversity of diagnosis.

**Figure 1** Example of reporting question with orientation key and description.

Subcostal view, angled anteriorly

Superior

Right

Left

Inferior

L. Mertens et al.
and because of the different echocardiography reporting formats which are in use, which made comparisons difficult. Since 2010, reports are no longer evaluated but the candidates still need to submit a logbook including 250 cases. Instead of reviewing individual reports, a different system has been put in place called ‘direct observation of procedural skills’ (DOPS). This practical assessment involves the candidate performing complete echocardiographic studies under the supervision of an attending congenital cardiologist or certified echocardiographer at their own centre. DOPS can be performed under supervision of a single cardiologist although we encourage the use of multiple attending congenital cardiologists/certified echocardiographers to gain assessment from a wide range of individuals. Thus cardiologists and echocardiographers other than the overall supervisor are used in the process, although the responsibility for collation of all of the DOPS results and logbook rests between the candidates and their supervisor. This format was judged to be feasible because congenital heart expertise is frequently concentrated within specific centres and the pool of potential candidates was likely to be smaller than for adult TTE and TOE examinations. DOPS assessment scores the candidate through a wide number of facets of the study including set-up of the ultrasound system, image acquisition quality and completeness, interpretation of findings and documentation of a coherent report. The assessing cardiologist or echocardiographer is required to sign the DOPS report which are then collated by the candidate and signed off by the supervisor. A total of 10 satisfactory DOPS are required for certification. These DOPS forms together with the log of 250 cases and a letter of confirmation from the candidate’s supervisor are submitted electronically. Each submission is reviewed by a member of the CHD certification committee. On request the original anonymized video recordings of the DOPS cases may be requested by the CHD accreditation committee for review. The certification process is summarized in Table 2 in the form of a flowchart.

### Structure of the formal examination

The CHD echocardiography examination has been held annually at the Euroecho conference with a similar format to the adult TTE and TOE examinations. Such emulation of the structure of the existing examinations was deliberate because reports of the progress and implementation of those examination processes were available for reference. The examination is conducted in English and has two components: 50 questions related to echocardiographic videos or still images and 100 multiple choice questions relating to all aspects of congenital echocardiography as well as generic echocardiographic questions relating to ultrasound.

<table>
<thead>
<tr>
<th>Table 2</th>
<th>Flowchart of certification in echocardiography of congenital heart disease</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Candidate initiates certification process</strong></td>
<td></td>
</tr>
<tr>
<td>Registers on EAE website</td>
<td>Identifies supervisor prepared to oversee logbook cases and DOPS</td>
</tr>
<tr>
<td><strong>Candidate initiates log of congenital echocardiography cases</strong></td>
<td></td>
</tr>
<tr>
<td>Has up to 2 years to accumulate 250 anonymised transthoracic cases</td>
<td>Commences DOPS assessments</td>
</tr>
<tr>
<td><strong>Registration for Congenital Echocardiography Examination</strong></td>
<td></td>
</tr>
<tr>
<td>Syllabus and reading list available online</td>
<td>Examination held at Euroecho conference</td>
</tr>
<tr>
<td><strong>Passes Congenital Echocardiography Certification Examination</strong></td>
<td></td>
</tr>
<tr>
<td>Pass both theory and reporting sections of examination</td>
<td></td>
</tr>
<tr>
<td><strong>Submission of additional documentation</strong></td>
<td></td>
</tr>
<tr>
<td>Online Submission of 250 logbook cases</td>
<td>Submit Supervisor Confirmation</td>
</tr>
<tr>
<td><strong>Confirmation of Certification in Congenital Echocardiography</strong></td>
<td></td>
</tr>
<tr>
<td>Maintain ongoing log of cases / experience / learning for 5 yearly recertification</td>
<td></td>
</tr>
</tbody>
</table>
physics or standard echocardiographic calculations and formulas. For each question there are five possible answers of which only one is correct. Negative marking, that is removing points for an incorrect answer, is not used therefore candidates are encouraged to answer all questions. For the purposes of consistency and to facilitate comparison between different examinations a bank of suitable questions has been established with the aim of retaining 80% of questions and changing the remaining 20% between the different examinations. The policy of changing ~20% of questions between examinations was the same as that used for the adult examinations.

The examination results are forwarded to the chair of the CHD certification committee who also has a liaison role with the relevant working groups of the AEPC and the ESC. To pass the examination, the candidate must pass both the reporting and the theory parts of the examination. Typically, the pass mark is ~65% for each section, which is consistent with the other certification examinations. For candidates who pass one section but who are ‘borderline’ (within 2%) on the second section, their examination paper is reviewed individually before a final pass/fail decision is reached. Such borderline candidates must achieve the group mean score or above for the second paper to gain an overall pass. The pass mark was set after review of questions between several members of the congenital certification committee.

Once a candidate has successfully passed both sections of the examination and passed review of their submitted DOPS and or logbook they then receive certification from the EAE.

Audit of certification pathway
After each CHD examination, all questions have been sent for external statistical analysis that has included the proportion of candidates answering the question correctly and the discriminatory value of the question. Questions which are poorly discriminatory are reviewed closely. The questions themselves undergo external review with respect to ‘plain English’ so that every effort is made to present clear questions, particularly because not all candidates will be native English speakers.

Recertification
The recertification process for CHD has been designed to follow closely the certification pathways used by both adult TTE. Recertification is done on a five yearly basis and is achieved by documentation of continuing professional development and continued exposure to echocardiography of CHD in practice. The current criteria give the option of either 250 studies per year and 40 h of continuing learning, or 100 studies per year and 50 h of continuing learning. These requirements are identical to the adult transthoracic certification. There is no requirement to re-sit the congenital examination process.

Experience of certification examination to date
To date, a total of 137 candidates from 27 countries have registered for the certification process and have sat the certification examination. The number of candidates taking the examination each year is shown in Figure 2. This demonstrates a trend towards increased numbers of candidates year on year. The country of origin of candidates to date is shown in Figure 3. The number of candidates per country was a median of two candidates (range 1–47). The largest contributing country was the UK (47 candidates) but there was a wide geographic spread which extended beyond Europe (Figure 3).

The median percentage score for the video reporting section was 72% (range 32–90%) and the median percentage score for the theory section was 74% (range 26–93%). Of the total number of candidates 107 passed the examination and 30 failed giving a pass rate of 78%. This pass rate is strikingly similar to the rate observed for the adult certification examinations.5 Of the total candidates, 100 were cardiologists or paediatric physicians, 4 were anaesthetists, and 33 were sonographers. Although we do not have complete data on stage of training, 43 candidates (31%) were <36 years of age when sitting the exam, suggesting a significant proportion are either still in training or at a relatively early stage in their career. Feedback from candidates has been sought with respect to the perceived difficulty of both the reporting and theory sections of the examination. Based on a 1–5 scale of increasing difficulty the mean (range) rating of the difficulty of the reporting section was 4.2 (3–5) and theory section 3.9 (3–5). The examination process has evolved and responded to feedback where possible.

There was a significant correlation between the examination scores of the theory and reporting sections \((r = 0.56, P < 0.0001)\) (Figure 4). The distribution of scores in both the theory and video reporting sections is shown in Figures 5 and 6. Of the 107 candidates who have passed the written examination, 83 achieved this >1 year ago and of these 60 have completed the certification process with submission of the logbook and or DOPS and have been issued with EAE certification.

Discussion
The experience of the certification process in congenital echocardiography demonstrates that it is possible to organize and deliver a certification process in this field. For the delivery of such an initiative, the cooperation of the relevant professional bodies is essential and we have been fortunate that the working relationships between the Association for European Paediatric and Congenital Cardiology, European Society of Cardiology and the EAE were
sufficiently good for the process to be developed and endorsed. In addition, uniformity in the examination format and administrative processes across adult transthoracic, transoesophageal, and congenital heart certification meant that organizational aspects of the examination process were streamlined.

With respect to the number of candidates who sit the examination there is a trend towards numbers increasing each year. However, the geographic spread is far from even with some countries notably the UK and Greece having more candidates than other European countries of similar size. It is also apparent that a significant minority of candidates come from non-European countries, particularly Saudi Arabia. Part of the explanation for this pattern may relate to the lack of availability of national certification programmes in echocardiography. In the UK, for example, certification in ‘paediatric’ echocardiography was withdrawn 6 years ago by the British Society of Echocardiography due to the relatively small number of candidates. Moving to a European model has the advantage of ensuring that there is a critical mass of candidates, even in this subspecialized area.

In many European countries, relatively few candidates have undertaken the certification process. From informal discussions, some congenital cardiologists feel that echocardiography is so ingrained into core training that a separate certification process is unnecessary. Although this may have some validity for those who certify as congenital cardiologists (whether paediatric or adult), it is not the case for other groups such as echocardiographers or more general paediatricians/neonatologists whose practice requires demonstrable expertise in cardiology.

A broad theme which came across in comments from candidates was that the timing allocated to each reporting exam question was viewed by some to be suboptimal in terms of the time available to read questions and view videos. In response to this feedback, from 2011 onwards the examination has been computer based with each candidate having their own networked laptop.
The professional associations involved in the organization of the accreditation examination endorsed a European course on congenital echocardiography that covers the most important aspects of congenital echocardiography. This annual 4-day course has been organized successfully each year for the last 6 years. Additionally, each annual EuroEcho meeting includes a 1-day congenital echocardiography teaching course that is more focused on introducing non-congenital cardiologists into the field and during recent years a congenital track has been organized in the EuroEcho programme. To provide the necessary teaching material, European and North American echocardiographers contributed to a new textbook on congenital echocardiography which provided a comprehensive and up-to-date introduction to the field. We hope that all this will lead to improvement in quality of care and improvement of diagnostic skills in those professionals taking care of the challenging and growing population of children and adults with CHD. We hope that increased mobility of physicians and technicians in Europe will lead to the development of better structured training programmes with formal teaching and training that go beyond learning in practice.

Future perspectives

The ultimate goal of the accreditation process was to stimulate training and standardize the standards of congenital echocardiography in Europe. This cannot be achieved by organizing an accreditation process only. Additional initiatives were taken to further provide teaching material and opportunities to different professionals involved in the field. The professional associations involved in the organization of the accreditation examination endorsed a European course on congenital echocardiography that covers the most important aspects of congenital echocardiography. This annual 4-day course has been organized successfully each year for the last 6 years. Additionally, each annual EuroEcho meeting includes a 1-day congenital echocardiography teaching course that is more focused on introducing non-congenital cardiologists into the field and during recent years a congenital track has been organized in the EuroEcho programme. To provide the necessary teaching material, European and North American echocardiographers contributed to a new textbook on congenital echocardiography which provided a comprehensive and up-to-date introduction to the field.6 We hope that all this will lead to improvement in quality of care and improvement of diagnostic skills in those professionals taking care of the challenging and growing population of children and adults with CHD. We hope that increased mobility of physicians and technicians in Europe will lead to the development of better structured training programmes with formal teaching and training that go beyond learning in practice.

Acknowledgements

We acknowledge the invaluable assistance of colleagues from the European Heart House, in particular Julie Poirey without whom the examination process would not be possible. We also acknowledge all local assessors, supervisors, and graders across Europe who have contributed time and expertise to assessing DOPS, supervising candidates and reviewing and grading logbooks. We would like to thank representatives of all of the professional bodies including the AEPC, EAE, and ESC at all levels whose support and co-operation was essential to launch this initiative.

Funding

J.S. acknowledges financial support from the Department of Health via the National Institute for Health Research Comprehensive Biomedical Research Centre award to Guys and St Thomas’ Hospital NHS Foundation Trust in partnership with King’s College London and King’s College Hospital NHS Foundation Trust.

Conflict of interest: none declared.

References