ORIGINAL ARTICLE

Heart murmurs recorded by a sensor based electronic stethoscope and e-mailed for remote assessment

L B Dahl, P Hasvold, E Arild, T Hasvold

Arch Dis Child 2002;**87**:297–301

See end of article for authors' affiliations

Correspondence to: Dr L B Dahl, Department of Paediatrics, University Hospital, 9038 Tromsø, Norway; lauritz.dahl@rito.no

Accepted 19 March 2002

Background: Heart murmurs are common in children, and they are often referred to a specialist for examination. A clinically innocent murmur does not need further investigation. The referral area of the University Hospital is large and sparsely populated. A new service for remote auscultation (telemedicine) of heart murmurs in children was established where heart sounds and short texts were sent as an attachment to e-mails.
Aim: To assess the clinical quality of this method.
Methods: Heart sounds from 47 patients with no murmur (n = 7), with innocent murmurs (n = 20), or with pathological murmurs (n = 20) were recorded using a sensor based stethoscope and e-mailed to a remote computer. The sounds were repeated, giving 100 cases that were randomly distributed on a compact disc. Four cardiologists assessed and categorised the cases as having "no murmur", "innocent murmur", or "pathological murmur", recorded the assessment time per case, their degree of certainty, and whether they recommended referral.
Results: On average, 2.1 minutes were spent on each case. The mean sensitivity and specificity were 89.7% and 98.2% respectively, and the inter-observer and intra-observer variabilities were low (kappa 0.81 and 0.87), respectively. A total of 93.4% of cases with a pathological murmur and 12.6% of cases with an innocent murmur were recommended for referral.
Conclusion: Telemedical referral of patients with heart murmurs for remote assessment by a cardiologist is safe and saves time. Skilled auscultation is adequate to detect patients with innocent murmurs.

Heart murmurs are common in children, and may be heard through infancy to adolescence. Most are innocent—that is, not associated with anatomical or physiological abnormalities. It has been estimated that up to 80% of schoolchildren may have heart murmurs under certain circumstances, but less than 1% have confirmed organic heart disease, the majority being diagnosed during infancy.[1–3]

Evaluation of a heart murmur represents one of the most common reasons for referral to a paediatric cardiologist.[4] Studies have shown that following clinical examination by a paediatric cardiologist, the diagnosis of a murmur as innocent or pathological, is correct with a specificity of 95% and a sensitivity of 96%.[5 6] Further procedures, such as chest radiography, electrocardiography, and echocardiography, are thus unlikely to alter a clinical diagnosis of an innocent murmur made by a paediatric cardiologist, based on auscultation.[7] Parents and referring physicians often expect a number of investigations to alleviate their concern, or to confirm or refute their suspicions.[4 8 9] In some circumstances there may even be a financial incentive for the cardiologist to perform echocardiography. Expensive investigations are therefore sometimes performed without any evident medical reason.[10 11]

The University Hospital in Tromsø is a teaching hospital in north Norway. The coverage area of the hospital is sparsely populated with vast distances and a severe climate. Most of the doctors recruited to the small rural communities are young and inexperienced in assessing heart murmurs in children. During the period between January 1999 and December 2000, 103 children with heart murmurs were referred to the outpatient clinic at the University Hospital, and the waiting time averaged 60 days. It was found that 99 (96%) of these children had an innocent murmur, in most cases diagnosed by clinical examination only. We therefore suggested that utilising telemedicine by referring the children's heart sounds as sound files in an e-mail attachment, instead of referring the children, had the potential to eliminate waiting time, travel, and reduce cost associated with the assessment of cardiac murmurs in children in our area. Before introducing this method as a routine, we wanted to evaluate its clinical quality. Our hypothesis was that this could be safely performed both technically and clinically. To explore whether a heart murmur could be assessed accurately, we conducted simulated telemedicine consultations. The results of this evaluation are described.

SUBJECTS AND METHODS

A mix of normal heart sounds (from subjects with no murmur or an innocent murmur) and sounds from patients with cardiac lesions (with pathological murmurs) were recorded at the University Hospital of Tromsø. Up to five sounds from different locations in each patient were recorded separately by a sensor based electronic stethoscope (theStethoscope, Meditron AS, Norway).[12] The sounds were recorded using a sampling frequency of 22.1 K samples per second, mono, 16 bit dynamic resolution, and sent as a case by e-mail to a remote computer (PC) to be collected in a database and stored in separate files as a *.wav file (wave file). Information about the age of the patient and symptoms and other clinical signs were collected in a text file and e-mailed with the sound files. From this collection of sent and stored sounds, seven different cases without any murmur (mean age 4 years, range 2 months to 10 years) and 40 cases with a murmur—20 with physiological murmurs (mean age 5 years, range 1–13 years) and 20 with pathological murmurs (mean age 4 years, range 1 month to 13 years—were randomly selected. Of the seven cases with no murmur, six were repeated three times, and one was repeated twice, equalling 20 cases. The 20 cases with innocent murmurs and the 20 cases with pathological murmurs were repeated twice, equalling 80 cases. These 100 cases were put in random order on a compact disc (CD). Of the innocent murmurs the pulmonary ejection murmur occurred

Table 1 Reported time spent to assess and classify the cases

Time (minutes)	Sounds (n)	Percent	Cumulated
1	111	36.6	36.6
2	108	35.3	71.9
3	62	19.5	91.4
4	19	5.6	97.0
5	3	1.0	98.0
6	3	1.0	99.0
7	0	0.0	99.0
8	1	0.3	99.3
9	0	0.0	99.3
10	2	0.7	100.0

Table 2 Observers' sensitivity and specificity in classifying the cases

Observers	Sensitivity (%)	Specificity (%)
Observer A	87.1	98.3
Observer B	100.0	100.0
Observer C	85.0	96.5
Observer D	86.8	98.3
Mean	89.7	98.2

twice, Still's vibratory murmur occurred 32 times, and a venous hum six times. Of the pathological murmurs a ventricular septal defect occurred 17 times, valvular pulmonary stenosis occurred 10 times, valvular aortic stenosis six times, and patent ductus arteriosus and atrial septal defect of secundum type occurred twice each. There were three cases with a Blalock-Taussig aortopulmonary shunt or a banding of the main pulmonary artery.

The sensor based stethoscope and soundcard in the PC allow amplification of the sounds, but in order to standardise the recordings this function was fixed. Each case on the CD was presented in a simple HTML page showing the location on the chest from where the sound had been recorded, with the accompanying text next to the image. For playback of the sounds we relied on the soundcard in the PC and the Microsoft Media Player found as a part of the Microsoft Windows 98 operating system.

The CD with the cases, a headset of high quality (AKG K-100), and a laptop PC (Toshiba Satellite 4090XCDT) computer were sent to a panel of four paediatric cardiologists at different hospitals in Norway. They listened to the sounds and recorded for each, on a provided form, the time needed to categorise each case into one of the following three categories: no murmur; innocent murmur; pathological murmur. They also recorded the degree of certainty in this categorisation and whether referral for further investigation was recommended or not.

The recorded data on the form were punched in an Epi Info database and analysed by Epi Info.[13]

RESULTS

The four observers assessed 398 of the 400 cases, of which the time consumption was recorded in 303. One of the observers did not record the time spent on each case, but estimated the average time to categorise each case as two minutes. We excluded these from the estimation of the time consumption, thus basing our estimation on 303 cases. Of the cases with a time recording, the observers spent 2.1 minutes on average assessing each case. This included the time to retrieve the sound track(s), to listen through the recording(s), to categorise the case, and to record the category decided. Table 1 shows the distribution of time spent.

The observers had a mean sensitivity of 89.7% and a mean specificity of 98.2%. Table 2 shows the sensitivity and the specificity of each observer.

Table 3 shows the inter-observer variability (external variability) within pairs of observers. The mean of the sum of the kappa values of all the pairs was 0.81. Table 3 also gives the proportional variability (observed variability)[14] of each category of heart sounds.

The intra-observer variability of each observer, when they blindly categorised randomly repeated cases, is shown as kappa estimations in table 4. The mean of the sum of the kappa values of all the observers' internal variability was 0.87.

Table 5 shows all the observers' recommendations of referral to hospital for further investigation. Of the cases with

Table 3 Inter-observer variability in classifying the cases

Pairs of observers	Kappa	Observed variability of each sound category: No murmur	Innocent murmur	Pathological murmur
A v B	0.88 (0.72 to 0.92)	0.88 (0.76 to 1.00)	0.85 (0.74 to 0.96)	0.92 (0.68 to 1.00)
A v C	0.89 (0.81 to 0.97)	0.96 (0.87 to 1.00)	0.91 (0.82 to 1.00)	0.93 (0.64 to 1.00)
A v D	0.78 (0.67 to 0.88)	0.92 (0.82 to 1.00)	0.81 (0.70 to 0.93)	0.85 (0.53 to 1.00)
B v C	0.79 (0.68 to 0.89)	0.88 (0.74 to 1.00)	0.82 (0.70 to 0.93)	0.89 (0.47 to 1.00)
B v D	0.80 (0.70 to 0.91)	0.86 (0.73 to 1.00)	0.83 (0.71 to 0.94)	0.91 (0.37 to 1.00)
C v D	0.77 (0.66 to 0.88)	0.92 (0.81 to 1.00)	0.81 (0.70 to 0.93)	0.85 (0.53 to 1.00)
Mean	0.81 (0.77 to 0.85)	0.90 (0.86 to 0.95)	0.84 (0.79 to 0.88)	0.89 (0.76 to 1.00)

95% confidence intervals in parentheses.

Table 4 Intra-observer variability in classifying the cases

Observers	Kappa	Observed variability of each sound category: No murmur	Innocent murmur	Pathological murmur
A	0.97 (0.97 to 1.00)	1.00 (1.00 to 1.00)	0.97 (0.91 to 1.00)	0.97 (0.89 to 1.00)
B	0.89 (0.79 to 0.99)	0.88 (0.74 to 1.00)	0.89 (0.76 to 1.00)	1.00 (1.00 to 1.00)
C	0.87 (0.76 to 0.98)	0.95 (0.85 to 1.00)	0.88 (0.74 to 1.00)	0.92 (0.80 to 1.00)
D	0.73 (0.59 to 0.88)	0.86 (0.72 to 1.00)	0.74 (0.56 to 0.91)	0.88 (0.72 to 1.00)
All	0.87 (0.82 to 0.92)	0.93 (0.87 to 0.98)	0.87 (0.80 to 0.94)	0.94 (0.89 to 1.00)

95% confidence intervals in parentheses.

Table 5 Observers' recommendation of referral

	No murmur (n=61)		Innocent murmur (n=151)		Pathological murmur (n=151)	
Referral	n	%	n	%	n	%
Yes	3	4.9 (1 to 13.7)	19	12.6 (7.8 to 18.9)	141	93.4 (88.9 to 96.8)
No	58	95.1 (86.3 to 99.0)	132	87.4 (81.1 to 92.3)	10	6.6 (3.2 to 11.8)

95% confidence intervals in parentheses.

pathological murmurs (n = 160), 151 were classified. Ten of these cases (6.6%) were classified as "not recommended to be referred". These cases consisted of three patients with moderate valvular pulmonary stenosis and two with moderate valvular aortic stenosis.

The observers reported a high degree of certainty when classifying the cases.

DISCUSSION

The present study shows that this sensor based electronic stethoscope allows digitalised heart sounds to be e-mailed easily, with maintained sound quality.[12] It further indicates that telemedicine is a safe and convenient method for referral of heart murmurs in children for evaluation by paediatric cardiologists.

In our study the prevalence of cases with pathological heart sounds presented on the CD was 40%. This is a higher prevalence than what most referral hospitals experience. There is no true prevalence of pathology among the referrals, as this may vary as a function of referring doctors' profiles of referrals. The variation in prevalence will change the pretest and post-test predictive values, but will have less effect on the sensitivity and specificity.[14] We have therefore presented the method's ability to select the cases with pathological murmurs among those with a cardiac lesion, and the cases with no or innocent murmurs among the healthy children by estimating the method's sensitivity and specificity, and not the predictive values.

The transferred murmurs were assessed with a sensitivity and specificity close to[5] or even higher than[15] those reported when patients with heart murmurs are evaluated in person by specialists in paediatric cardiology. In a prospective series of 161 patients, with innocent or pathological heart murmurs being clinically examined by paediatric cardiologists, Smythe *et al* showed that the clinical examination alone has a sensitivity of 96% and a specificity of 95%.[5] Rajakumar and coworkers reported a clinical evaluation of 128 heart murmurs by paediatric cardiologists and general paediatricians.[15] They found no difference in sensitivity between the two groups (85% *v* 79%, p = 0.53). Paediatric cardiologists, however, had a higher specificity than the general paediatricians (76% *v* 55%, p = 0.001). In a study of the accuracy of clinical assessment of heart murmurs by general paediatricians, the mean sensitivity and specificity were 82% and 72%, respectively.[16] All these figures are lower than those reported in our study. We therefore concluded that referring the heart sounds with a brief clinical history as e-mail attachments is a safe and accurate method of assessing children presenting with heart murmurs at their primary care doctor.

The inter-observer variability and the observed variability of each sound category within pairs of observers were low, as were the intra-observer variability and the observed variability within each sound category. The kappa estimates were much higher than often seen when clinically well established procedures are interpreted,[17–22] giving credibility to this method of murmur assessment by paediatric cardiologists.

Five patients suffering from moderate valvular pulmonary stenosis (n = 3) or moderate valvular aortic stenosis (n = 2) were not recommended for referral by this method. This proportion (6.6%) of misdiagnosed cardiac lesions is lower than the 20.6% (7/34) reported by Rajakumar and colleagues,[15] and the 11.1% of pathological lesions (5/45) missed at clinical examination in the study by Smythe and colleagues.[5] As in our study, the cardiac lesions missed in these studies were moderate, producing murmurs that may be misdiagnosed as innocent. Of the 151 cases with innocent murmurs categorised for referral or not in our study, 19 (12.6%) were incorrectly recommended to be referred for further investigations. Thus 132 (87.4%) were correctly recommended not to be referred and so spared from referral.

In the present study, the panel of paediatric cardiologists was aware of the referrals being fictitious, and they examined the sounds accordingly. This could have induced a less guarded attitude to the assessments. The high degree of perceived certainty, recorded when categorising the heart sounds in the present study, is in line with these speculations. Genuine referrals introduced one at a time with fair intervals could have resulted in a higher degree of caution and fewer misdiagnosed pathological murmurs, leading to an increased sensitivity approaching that reported by Smythe *et al* of 96%.[5] An increased awareness will probably also lead to a higher level of caution when assessing innocent murmurs and thus to a decline in specificity.

The main difference for the cardiologist, between a real clinical versus a telemedicine consultation, is the fact that in the latter, the cardiologist has to rely on the sounds selected and recorded by somebody else, perhaps with far less experience. This is the weak point in any "store and forward" electronic referral system. In spite of this, the accuracy of the method was very good in our study.

The time spent to evaluate each murmur was very brief. Probably the time needed to evaluate a murmur during real telemedical referrals will be longer, as the quality of the transferred sounds might be inferior to those in the present study, and also a result of increased caution. However, the potential for saving time, compared to ordinary consultations, is substantial for the cardiologist. This adds to the considerable time and inconvenience saved for the parents and society.

Telemedicine has previously been used, mainly in rural areas, in paediatric cardiology for remote stethoscopy and interpretation of echocardiogram, and has proved to be useful.[23–26] Participant as well as patient satisfaction with telemedicine has been evaluated.[27 28] Systematic review of studies on patient satisfaction has however concluded that, as a result of improper evaluation methods, we still do not know whether patients are quite satisfied with telemedicine consultation.[28] Will the parents of children with heart murmurs trust in this method? From our study it is not possible to answer this question. Much will probably depend on their confidence in their GP, and whether she/he will accept this way of referring a child with a heart murmur.

It is claimed that auscultation skills of paediatric residents are suboptimal.[29] Reliance on the stethoscope has gradually decreased, and medical students are today spending less time on learning how to use the stethoscope properly than they did in the past.[30] If telemedicine is accepted as a safe method to assess heart murmurs in children it may develop to the method of choice not only in rural, but also in urban areas. Linked to their telemedical reply the cardiologist may also provide the general practitioner with some simple advice on how to separate a pathological from an innocent murmur,[2] and thus improve their auscultation skills.

Conclusion

The present study indicates that telemedicine consultations may develop into a safe and convenient method for remote assessment of heart murmurs in children. It has the potential for saving time and reducing inconvenience and cost. The study confirms that skilled auscultation alone is adequate to separate innocent from pathological murmurs in children.

Authors' affiliations
L B Dahl, Department of Paediatrics, University Hospital of Tromsø, Norway
P Hasvold, E Arild, Norwegian Centre for Telemedicine, University Hospital of Tromsø
T Hasvold, Institute of Community Medicine, University of Tromsø, Tromsø, Norway

REFERENCES

1 **Fogel DH**. The innocent heart murmur in children: a clinical study of its incidence and characteristics. *Am Heart J* 1960;**59**:844–55.
2 **McCrindle BW**, Shaffer KM, Kan JS, *et al*. Cardinal clinical signs in the differentiation of heart murmurs in children. *Arch Pediatr Adolesc Med* 1996;**150**:169–74.
3 **Freedom RM**, Benson LN, Smallhorn JF. *Neonatal heart disease.* London: Springer-Verlag, 1992.
4 **Advani N**, Menahem S, Wilkinson JL. The diagnosis of innocent murmurs in childhood. *Cardiol Young* 2000;**10**:340–2.
5 **Smythe JF**, Teixera OHP, Vlad P, *et al*. Initial evaluation of heart murmurs: are laboratory tests necessary? *Pediatrics* 1990;**86**:497–500.
6 **Geva T**, Hegesh J, Frand M. Reappraisal of the approach to the child with a heart murmur: is echocardiography mandatory? *In J Cardiol* 1988;**19**:107–13.
7 **Newburger JW**, Rosenthal A, Williams RG, *et al*. Noninvasive tests in the initial evaluation of heart murmurs in children. *N Engl J Med* 1983;**308**:61–4.
8 **McCrindle BW**, Shaffer KM, Kan JS, *et al*. An evaluation of parental concerns and misperceptions about heart murmurs. *Clin Pediatr* 1995;**34**:25–31.
9 **Young PC**. The morbidity of cardiac nondisease revisited. Is there lingering concern associated with an innocent murmur? *Am J Dis Child* 1993;**147**:975–7.
10 **Danforth DA**, Nasir A, Gumbiner C. Cost assessment of the evaluation of heart murmurs in children. *Pediatrics* 1993;**91**:365–8.
11 **Wong JA**, Meyer RA. Cost-effective evaluation of heart murmurs in children. *Arch Fam Med* 1996;**5**:381.
12 **www**.meditron.no (31.07.2001).
13 **Dean AG**, Dean JA, Coulomier D, *et al*. Epi Info version 6: a word processing, database, and statistics program for epidemiology on microcomputers. Center for Disease Control and Prevention, Atlanta, GA, USA, 1994.
14 **Sackett DL**, Haynes RB, Tugwell P. *Clinical epidemiology. A basic science for clinical medicine.* Boston/Toronto: Little, Brown and Company, 1985:76–8.
15 **Rajakumar K**, Weisse M, Rosas A, *et al*. Comparative study of clinical evaluation of heart murmurs by general pediatricians and pediatric cardiologists. *Clin Pediatr* 1999;**38**:511–18.
16 **Haney I**, Ipp M, Feldman W, *et al*. Accuracy of clinical assessment of heart murmurs by office (general practice) paediatricians. *Arch Dis Child* 1999;**81**:409–12.
17 **Berg WA**, Campassi C, Langenberg P, *et al*. Breast imaging reporting and data system: inter- and intra-observer variability in feature analysis and final assessment. *AJR* 2000;**174**:1769–77.
18 **Grant JM**. The fetal heart rate trace is normal, isn't it? Observer agreement of categorical assessments. *Lancet* 1991;**337**:215–18.
19 **Elmore JG**, Wells CK, Lee CH, *et al*. Variability in radiologists' interpretations of mammograms. *N Engl J Med* 1994;**331**:1493–9.
20 **Nielsen PV**, Stigsby B, Nickelsen C, *et al*. Intra- and inter-observer variability in the assessment of intrapartum cardiotocograms. *Acta Obstet Gynecol Scand* 1987;**66**:421–4.
21 **Donker DK**, van Geijn HP, Hasman A. Inter-observer variation in the assessment of fetal heart rate recordings. *Eur J Obstet Gynecol Reprod Biol* 1993;**52**:21–8.
22 **Tandberg D**, Kastendieck KD, Meskin S. Observer variation in measured ST-segment elevation. *Ann Emerg Med* 1999;**34**:448–52.
23 **McConnell ME**, Steed RD, Tichenor JM, *et al*. Interactive telecardiology for the evaluation of heart murmurs in children. *Telemed J* 1999;**5**:157–61.
24 **Murdison KA**. Telemedicine: a useful tool for the pediatric cardiologist. *Telemed J* 1997;**3**:179–84.
25 **Belmont JM**, Mattioli LF, Goertz KK, *et al*. Evaluation of remote stethoscopy for pediatric telecardiology. *Telemed J* 1995;**1**:133–49.
26 **Mulholland HC**, Casey F, Brown D, *et al*. Application of a low cost telemedicine link to the diagnosis of neonatal congenital heart defects by remote consultation. *Heart* 1999;**82**:217–21.
27 **Hicks LL**, Boles KE, Hudson ST, *et al*. An evaluation of satisfaction with telemedicine among health-care professionals. *J Telemed Telecare* 2000;**6**:209–15.
28 **Mair F**, Whitten P. Systematic review of studies of patient satisfaction with telemedicine. *BMJ* 2000;**320**:1517–20.
29 **Gaskin PRA**, Owens SE, Talner NS, *et al*. Clinical auscultation skills in pediatric residents. *Pediatrics* 2000;**105**:1184–7.
30 **Tavel MI**. Cardiac auscultation. A glorious past—but does it have a future? *Circulation* 1996;**93**:1250–3.

COMMENTARY

TECHNOLOGICAL ADVANCES AND ASSESSMENT OF CHILDREN WITH MURMURS

History taking and clinical examination are fundamental skills in medicine which determine the need for further examination. Most murmurs detected by paediatricians come to notice as part of a routine examination (which is often seen as a "screening" examination) or during assessment of children with intercurrent illness. Some murmurs in neonates, many in infants, and most in childhood are benign or innocent. The challenge for the paediatrician is to separate the many innocent murmurs from the few which are significant.[1]

Many paediatricians find auscultation difficult, hence the frequency of referral of children to paediatric cardiologists for a clinical opinion and further investigation. The diagnosis of an innocent murmur requires the absence of symptoms referable to the cardiovascular system, the absence of other abnormal cardiovascular signs, and recognition of the characteristic sound of an innocent murmur as opposed to a pathological murmur. Paediatricians can readily take a history, examine the pulses, and measure the blood pressure, but sometimes lack confidence in differentiation between innocent and important murmurs. This may result in part from a lack of practice—the individual paediatrician encounters relatively few innocent murmurs and fewer pathological murmurs. Studies of the clinical performance of paediatricians in assessment of murmurs give conflicting results,[2 3] but usually find high diagnostic accuracy.[4] However, given the low disease prevalence, this may be falsely reassuring.

Some paediatricians acquire skill in echocardiography, but it takes time and practice to be able to recognise subtle but important abnormalities with confidence.[5] The use of an adult echocardiography service for examination of babies and children in a general hospital may also be misleading as important diagnoses may be overlooked.[6]

Because paediatric cardiologists mostly work in a few larger centres, paediatricians and their patients do not necessarily have ready direct access to a specialist opinion. However, recent technological advances have provided access to specialist paediatric cardiologists without having to refer or transfer the patient. The main use of this technology thus far has been in investigation. Thus an opinion can be sought on an ECG sent via fax or e-mail; telemedicine transmission of echocardiographic images also provides direct access to a specialist interpretation.[7 8]

Dahl *et al* describe a technique for sending a recording of heart sounds via e-mail, providing a specialist opinion on auscultation without the need for the patient to travel. Although the project comes from northern Norway, which has a sparse population spread over a large area, the technique is obviously applicable more widely. A logical further step might even be to replace the paediatric cardiologist by computer as well—a recent report shows 100% sensitivity and specificity of an artificial neural network in assessment of murmurs, a better performance than the average paediatric cardiologist.[9]

One worry is that paediatricians may become deskilled if they never have to make a decision about the diagnosis in a child with a murmur. Concern has also been expressed recently that paediatricians in training lack the skills required for recognition and assessment of murmurs.[3] The best solution overall is not to give up and replace auscultation with electronic specialist opinion, but rather to teach and develop clinical skills, even in an era of rapid technological advance and evolution.[1 10]

C Wren

Freeman Hospital, Newcastle upon Tyne, UK

L B Dahl, Department of Paediatrics, University Hospital of Tromsø, Norway

P Hasvold, E Arild, Norwegian Centre for Telemedicine, University Hospital of Tromsø

T Hasvold, Institute of Community Medicine, University of Tromsø, Tromsø, Norway

REFERENCES

1 **Danford DA**. Clinical and basic laboratory assessment of children for possible congenital heart disease. *Curr Opin Pediatr* 2000;**12**:487–91.
2 **Van Oort A**, Le Blanc-Botden M, De Boo T, *et al*. The vibratory innocent murmur in school children: difference in auscultatory findings between school medical officers and a paediatric cardiologist. *Pediatr Cardiol* 1994;**15**:282–7.
3 **Gaskin PRA**, Owens SE, Talner NS, *et al*. Clinical auscultation skills in pediatric residents. *Pediatrics* 2000;**105**:1184–7.
4 **Rajakumar K**, Weisse M, Rosas A, *et al*. Comparative study of clinical evaluation of heart murmurs by general pediatricians and pediatric cardiologists. *Clin Pediatr* 1999;**38**:511–18.
5 **Katumba-Lunyenya JL**. Neonatal/infant echocardiography by the non-cardiologist: a personal practice, past, present, and future. *Arch Dis Child Fetal Neonatal Ed* 2002;**86**:F55–7.
6 **Stanger P**, Silverman NH, Foster E. Diagnostic accuracy of pediatric echocardiograms performed in adult laboratories. *Am J Cardiol* 1999;**83**:908–14.
7 **Sable CA**, Cummings SD, Pearson GD, *et al*. Impact of telemedicine on the practice of pediatric cardiology in community hospitals. *Pediatrics* 2002;**109**:1–7.
8 **Mulholland HC**, Casey F, Brown D, *et al*. Application of a low cost telemedicine link to the diagnosis of neonatal congenital heart defects by remote consultation. *Heart* 1999;**82**:217–21.
9 **DeGroff CG**, Bhatikar S, Hertzberg J, *et al*. Artificial neural network-based method of screening heart murmurs in children. *Circulation* 2001;**103**:2711–16.
10 **Tavel ME**. Cardiac auscultation. A glorious past—but does it have a future? *Circulation* 1996;**93**:1250–3.

ARCHIVIST

Children seeking asylum

In 1991, 3349 unaccompanied children and adolescents (under 18 years) applied for asylum in the United Kingdom (Carolyn Bann and Ruth Tennant. National Children's Bureau 2002; Highlight no 190. ISSN: 1365–9081). Towards the end of 2001 there were 4196 such children in London: almost a quarter of them (987) were under 16 years old. Most come from Yugoslavia, Afghanistan, Somalia, Sri Lanka, or Turkey.

Children travel alone to seek asylum because their desperate parents have sent them away from danger or because they are orphans or separated from their parents. Some, from West Africa or China, it is reported, are the victims of child traffickers for sexual exploitation. Predictably, when they arrive in the UK the children are frightened, lonely, confused, and downhearted. Despite a 2001 Home Office White Paper recommending that they be given proper advice and care from the time of their arrival, some appear to have been left to their own devices and some have slept overnight on the airport concourse. Government policy is that these children should not be detained but it seems that this policy has not always worked out in practice and the Refugee Council has worked with at least 135 unaccompanied children in detention since the beginning of 1997. Most children applying for asylum are not given refugee status but instead are granted leave to remain in the UK only until they are 18. Local social services departments are responsible for the care of these children but several recent reports have pointed to deficiencies in the provisions made.

Caring for their health presents difficulties. Their previous medical and immunisation histories are usually unknown. They inevitably have emotional problems because of their separation from family, friends, and their own culture. They may experience antipathy and prejudice in the local population and psychological problems may include post-traumatic stress disorder. Physical conditions vary with the countries of origin but malnutrition, tuberculosis, hepatitis, malaria, schistosomiasis, and HIV infection may need to be considered. In addition, the children may be living in poor accommodation (the charity Shelter claimed that private rented accommodation provided for asylum seekers was "unfit for human habitation" in one case in six). Finding a school place may be difficult and school examinations times of great anxiety, and the provision of legal advice may be inadequate.

These children often come from places where civilisation has broken down. It should be a mark of our civilisation that children receive kindness and compassion whoever they are and wherever they come from.