A formal gluten challenge is rarely indicated, particularly if serology is informative and the biopsy characteristic, but this may be helpful in difficult cases, particularly if there is diagnostic uncertainty (eg, lack of clarity about the initial diagnosis, gluten exclusion with no biopsy). The challenge should be supervised by a paediatric dietician. Relapse can occur many months after the challenge.

There is very little data on the outcome of coeliac disease in children who are asymptomatic at presentation and picked up through screening, although a pragmatic presumption that the same long-term health benefits occur as in children symptomatic at diagnosis and therefore the recommendation is that all biopsy positive children should be treated. There is some evidence that children apparently asymptomatic at diagnosis have mild impairment of growth and are more likely to have symptoms (irritability, lethargy, distension and gas) than control subjects.[15] It is likely, therefore, that some patients are considered asymptomatic when they are not with ill health, only being noticed in retrospect.

Type 1 diabetes has been the most widely studied with respect to high-risk screening and outcome, with the prevalence of coeliac disease in children with type 1 diabetes being around 4%.[16] There is no evidence for an improvement in diabetic control short term. The medium and longer term effects of diabetic control are also unknown; in particular, it is unclear whether treatment of coeliac disease impacts on the potential to develop other autoimmune conditions.

It is important to remember that children in high-risk groups whose serology is initially negative on screening may develop a positive serology subsequently. It is sensible to repeat testing if children at high risk develop suspicious symptoms.

The NASPGHAN recommends that screening should begin at 3 years in asymptomatic, high-risk children who have been on an adequate gluten-containing diet for at least 1 year before testing.[2] There is no consensus on how often screening should be carried out. Guidance from the National Institute of Clinical Excellence (UK) recommends screening those with type 1 diabeties at diagnosis and then every 3 years.[17]

It is clearly necessary to have a low threshold to investigate for coeliac disease in a child with either frank or occult gut symptoms. It should be a routine part of the initial screening in children of short stature. It is crucial that the diagnosis is made correctly, and a trial of gluten exclusion in children in whom the diagnosis is suspected is not recommended. The high prevalence of coeliac disease is a major healthcare issue and is relevant to healthcare planning. We need to know the natural history of undetected coeliac disease to determine, whether we should screen the whole population or high-risk groups or only those who are symptomatic. Until these issues are resolved, we, as the team from Cardiff emphasise, must maintain a high index of suspicion for this condition so that the potential problems associated with untreated coeliac disease can be prevented.

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Telemedicine

One hundred years of telemedicine: does this new technology have a place in paediatrics?

E M Strehle, N Shabde

100 years of telemedicine

Although hard to believe, this year we celebrate the 100th anniversary of telemedicine. The term telemedicine was coined in the 1970s by the American Thomas Bird and, literally translated, means ‘‘healing at a distance’’ (from Latin ‘‘medicus’’ and Greek ‘‘tele’’). However, the origins of this evolving technology date back to the early 20th century, when Willem Einthoven, a Dutch physiologist, developed the first electrocardiograph in his laboratory in Leiden. With the use of a string galvanometer and telephone wires, he recorded the electrical cardiac signals of patients in a hospital 1½ km away. He stated: ‘‘Where there is a link, actual and figurative, between laboratory and hospital, and collaboration between physiologist and clinician, each remaining master in his territory, there one may fruitfully utilize these new electrical methods of research’’. Einthoven’s electrocardiograph was very large but over the years was transformed into a mobile or even portable monitoring device. Nevertheless, he can be regarded as the first clinician scientist to develop and systematically apply a technique that is very similar to telemedicine in the modern sense.

Figure 1 Cover article on telecare in the magazine *Radio News* from 1924 and state-of-the-art telemedicine unit (courtesy of DJ Streveler (University of Hawaii, Hawaii, USA) and Tandberg (Lysaker, Norway)).

The results of his experiments were published in 1906.[1] During the 1920s, Norwegian doctors provided advice for sick ship crew members at sea via radio link. In 1967, Bird and colleagues established an audiovisual microwave circuit between the Massachusetts General Hospital in Boston, USA, and the nearby Logan Airport. They conducted and evaluated >1000 medical consultations for airport employees and travellers who were ill.[2] Since then, the number of scientific studies relating to telehealth has steadily increased, and many countries have launched their own electronic health (e-health) programmes, which combine medical informatics, public health and business. Telemedicine constitutes a small part of e-health and is particularly suitable for large geographical areas with a sparse, underserved population. Examples are Canada, India and Norway.[3–5]

DEFINITION

The European Commission's definition of telemedicine is "rapid access to shared and remote medical expertise by means of telecommunication and information technologies, no matter where the patient or relevant information is located". Two complementary methods of transmitting data, images and sound can be differentiated: (1) the live technique, where the health professional has direct video contact with the patient; and (2) the store and forward technique, where information—for instance, an *x* ray—is acquired in one location and reviewed in another at a later stage. The Integrated Digital Service Network (IDSN) and broadband or global satellite networks, such as Intelsat and Healthnet, are used for high-speed data transmission. Most current definitions of telemedicine exclude medical advice given only via a telephone.[6] Telepaediatrics, a new branch of telemedicine, enables doctors and patients to access expert knowledge and assessments, which otherwise could be achieved only with great difficulty, and which may not be financially feasible. This new technology can also assist paediatricians to fulfil their role as leaders of multidisciplinary teams through improved communication, education and teaching.[7] During a typical telemedicine consultation, a paediatric nurse practitioner or technician carries out an examination or investigation at a distant healthcare facility, while a general paediatrician or paediatric subspecialist in a tertiary care centre monitors and evaluates the clinical findings or test results on a television screen.

APPLICATIONS

Over the past few years, telemedicine has been increasingly used for the benefit of sick and disabled children, mainly in feasibility studies funded by research grants. Robinson *et al*[8] set up two telemedicine clinics in rural areas of Texas, which were linked to the University of Texas Medical Branch, Texas, USA. A paediatric nurse conducted developmental assessments on 269 children with special needs, which were transmitted online to the evaluating team consisting of a neurodevelopmental paediatrician, various therapists, a psychologist and a dietitian. In a questionnaire survey, parents rated the service provided over a distance as satisfactory. The main benefits were reduced time off work and savings in travel costs.[8] Several studies have investigated the possibility of performing echocardiography by means of telecommunication technology in children, including neonates. They found that diagnoses were reached faster and with the same accuracy as the face-to-face encounter. Telepaediatric cardiology did not, however, lead to an overall cost reduction.[9 10] Teleradiology programmes have been in use since the 1970s, and today, many hospitals have established the picture archiving and communication system (PACS), which allows access to paediatric *x* rays, computed tomography, magnetic resonance imaging and ultrasound scans. More recently, concerns have been raised regarding the disadvantages of distancing the radiologist from the patient.[11 12] Only a few research projects associated with telemedicine have been conducted in specialties related to paediatrics which are visually intensive—for instance, dermatology, clinical genetics and pathology.[6] Child and adolescent psychiatry and child protection are highly sensitive areas where telemedicine may enable children to express their feelings more openly and to report disturbing experiences to healthcare workers, but there is little research evidence available in these areas.[13 14] In the UK, a child or a young person is able to give evidence in court via a televideo link. This means the child does not need to be present in the same room as the defendant, which can be very stressful.

COSTS

Setting up a new high-quality telemedicine link is not inexpensive and therefore requires careful planning and repeated auditing. Apart from television monitors with integrated video and hand-held cameras, special stethoscopes, auroscopes, ophthalmoscopes and spirometers are available. However, examples of low-cost teleradiology projects can be found in developing countries which use digital images sent via e-mail or personal computers equipped with radiological film digitisers and appropriate software, and existing satellite links.[15] In their systematic review, Jennett *et al*[16] examined 82 research papers relating to paediatric telehealth. In all, 24 (30%) of these articles provided reasonable evidence for the socio-economic benefits of telemedicine, as defined by accessibility of services, decreased costs, client satisfaction and quality of care.[16] This review shows that at present we cannot determine whether the advantages of telemedicine outweigh its disadvantages, some of which are outlined below.

RISKS

Teleradiology can be regarded as a paradigm for other applications of telemedicine owing to its long history and the large number of studies carried out in this discipline.[11 12 15 17–19] Teleradiology allows the transmission of radiological images from remote hospitals to expert radiologists in tertiary centres for evaluation and advice. This service can be delivered 24 h a day and reduces the need for transport of patients who can be treated locally. Interdisciplinary case conferences can be held between radiologists and clinicians to discuss complex images that are difficult to interpret. A teleradiology service faces several potential problems, which can be divided into legal aspects, communication and quality assurance. The reporting radiologist must be registered with a regulatory body in the European Union and must adhere to European Union-wide legislation regarding duty of care, health and safety, patient confidentiality and radiation exposure. The National Health Service (NHS) Trust purchasing the service remains fully responsible for the patient. Communication between the referring clinician and the radiologist can have a considerable effect on patient management, and standard teleradiology reduces the opportunity for a discussion between professionals. In addition, direct contact with the patient is no longer possible, which may be necessary for obtaining consent and to explain clinical findings. Teleradiology can compromise the quality and continuity of care if the reporting radiologist does not have complete access to the relevant clinical information and if he or she is not kept informed of the progress made by the patient. It is also important that the transmitted images be of a consistently high quality.

With the advent of the computerised administration of patient data, concerns have been raised about their security and confidentiality. In this respect, telemedicine poses a specific risk as it includes a recordable two-way audio-visual transmission of sensitive personal data from children, parents and health professionals.[17 18] Consequently, written consent should be sought from the parent or carer before every telemedicine session, and every effort should be made to comply with the national data protection legislation. The Royal College of Radiologists has produced extensive guidance on this important area of concern.[19]

RESEARCH

During the past decade, there has been a drive in the UK towards satellite paediatric ambulatory care units distributed around large paediatric (tertiary) care centres and staffed by general paediatricians or paediatric nurse practitioners and nurses. Telepaediatrics, which includes computer-aided prescribing, can help to ensure that a high standard of care is maintained in these ambulatory care units.[20] Currently, nurses are able to independently prescribe and give drugs to patients using patient group directions—for instance, when giving nebulised salbutamol to patients with asthma. Alternatively, paediatricians based in a district general hospital could issue electronic prescriptions to children in nurse-led units.[21 22]

There is a requirement for a uniform, consistent and safe approach for developing paediatric telemedicine facilities in the UK, which can be achieved only through further qualitative and quantitative research into this subject. The following suggestions are examples of where telemedicine could be applied, but they are by no means exhaustive. In certain situations it can be difficult for general paediatricians to describe accurately the severity of a child's illness, which often changes quickly, to their colleagues in the paediatric intensive care unit. A televideo link would allow the paediatric intensivist to assess the condition of the patient more accurately and assist with further management, thus improving the quality of care and possibly reducing the number of retrievals. In the UK, there are few supra-regional craniofacial teams that have the expertise to perform corrective surgery on children with craniosynostoses. A telemedicine consultation that includes the local paediatrician, the affected child and the specialist surgeon could be used as a screening tool, and may help to avoid long journeys. We work in a geographically large National Health Service Trust, which combines three district general hospitals and several community hospitals and nurse-led units. The Trust has four telemedicine units in operation for adult medicine and is currently evaluating their role in paediatrics.

CONCLUSION

On an international scale, paediatric telemedicine has already made a positive contribution to the quality of healthcare provided for children. We believe that telepaediatrics can be advantageous to children with acute and chronic illnesses in the UK in selected areas, but it must be evaluated in comparison with traditional forms of care through controlled trials (useful websites: http://www.amdtelemedicine.com, http://www.publictechnology.net, http://www.teis.nhs.uk/). The important issues of patient safety and confidentiality, clinical accountability and cost effectiveness have to be carefully considered before the introduction of this evolving technology.

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Acute otitis media

Searching for the Holy Grail of acute otitis media

S L Block

Use of PCV7 causes a major shift in the microbiology of AOM towards *H influenzae*, but the search for the Holy Grail of AOM still remains elusive

For decades, investigators have been searching for one of the Holy Grails of acute otitis media (AOM)—that is, an easy non-invasive marker that would identify or even suggest the specific pathogen causing AOM. Antibiotic selection by clinicians for almost all episodes of AOM is empirical. Most episodes of AOM usually result from congestion of the eustachian tube by an antecedent virus infection, which then allows one or two of the four typical aerobic bacteria, such as *Streptococcus pneumoniae*, *Haemophilus influenzae*, *Moraxiella catarrhalis* or *Streptococcus pyogenes*, to ascend into the middle ear space, causing the painful purulent effusion of AOM. Viruses seem to be an uncommon aetiology of AOM, as positive cultures for viruses being the sole pathogen of AOM occur in only 5–6% of cases.[1 2]

How commonly do bacteria cause AOM? Many multicentre studies report bacterial culture-positive rates between 55% and 75% of children, depending on whether the study is multinational or from a single country or region.[3–7] But, the devil is in the details—that is, the culture methods. Consequently, when microbiologically rigorous clinical studies use a single tympanocentesis with optimal bacterial culture techniques in children with AOM, a bacterial pathogen is obtained in 87–95% of tympanocentesis aspirates.[5–7] Thus, AOM itself is most always found to be caused by bacteria—when stringent criteria to diagnose AOM are used and highly experienced investigators carry out tympanocentesis.

Can any dataset show the Holy Grail of AOM? Can any physical or symptom markers differentiate bacterial from non-bacterial AOM, or *Streptococcus pneumoniae* from *H influenzae* or *M catarrhalis*? Can any set of clinical or otological scores evaluating severity of fever, irritability and tympanic membrane redness and bulging differentiate the specific bacterial pathogens of AOM? Remember that families who participate in a study that includes a single or a repeat tympanocentesis would probably be exceedingly motivated by the severity of symptoms and the investigator's physical findings regarding this particular episode of AOM. So, as would be expected, the mean symptom and tympanocentesis finding scores for any child enrolled in this type of study would initially be high. In addition second tympanocentesis rarely shows much microbiological information as well, as a pathogen is rarely recovered in the second tympanocentesis while receiving antibiotics. On the other hand, over the decades before the heptavalent pneumococcal conjugate vaccine (PCV7) became routine practice, some investigators[8] in the US had noted an almost clinically significant difference between children with AOM who had *Streptococcus pneumoniae* versus those who had Gram-negative pathogens. Children with *Streptococcus pneumoniae* had a tendency towards higher fever and more otalgia, but the observed difference was not enough to suggest that practitioners could ignore the Gram-negative pathogens when empirically selecting an antibiotic for the "sicker" child with the AOM.

Enter the routine use of the heptavalent pneumococcal conjugate vaccine since the summer of 2000 in the US (and recently introduced in the UK).[9] Preliminary investigational studies with PCV7 showed merely a 6–7% reduction in rates of overall AOM in the study population,[9 10] hardly perceptible by any clinician. However, as people in entire regions were vaccinated with the PCV7, clinicians began reporting rates of AOM reduction in the magnitude of up to 20% among young children in certain predominantly white populations.[11] Furthermore, our own rural Kentucky general paediatric group has witnessed a nearly 60% reduction in the rates of sinusitis diagnosed in the first 36 months of life (unpublished data).

When PCV7 is routinely used, will it also have an effect on the microbiology of AOM? Resoundingly, yes. In the 1990s, *Streptococcus pneumoniae* was the predominant pathogen of AOM, accounting for nearly 50% of all AOM isolates in the US and European countries, whereas *H influenzae* was usually found in 30–35% of AOM cultures.[12 13] By contrast, although the pneumococcal conjugate vaccine has not been routinely available in Israel, *H influenzae* has, for unknown reasons,been the predominant pathogen recovered in AOM for years.[14]

The beneficial effects of PCV7 on AOM have been further corroborated by the shift in microbiology from two geographically and demographically disparate groups, who were predominantly white and from communities where PCV7 was routinely used. These recent observational studies in the 2000s documented that the microbiology of AOM from tympanocentesis aspirates has shifted markedly towards Gram-negative pathogens among young children who have received PCV7. Casey and Pichichero[15] along with Block and cohorts,[16] respectively, reported that of the AOM isolates recovered, *H influenzae* now accounts for about 56%, *Streptococcus pneumoniae* for 31% and high-level penicillin non-susceptible *Streptococcus pneumoniae* (PNSP) for about 5% of pathogens. Among *H influenzae* isolates, β-lactamase producers were seen in 55% and 64%, respectively, of *H influenzae* as well. The