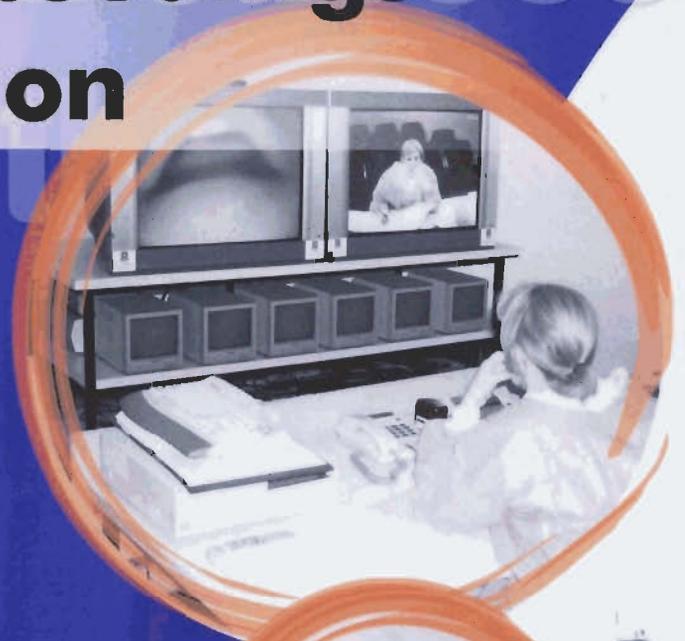


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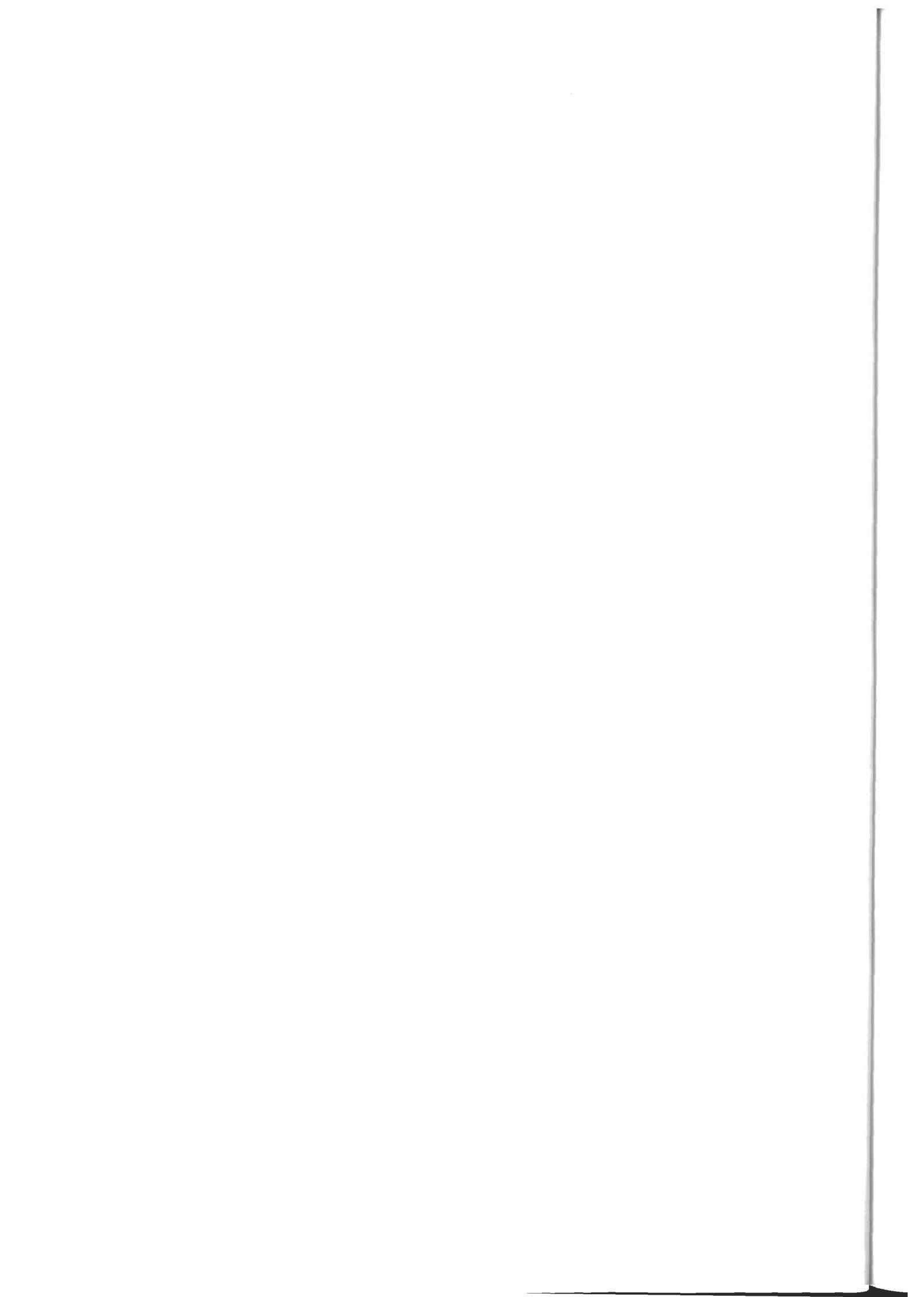
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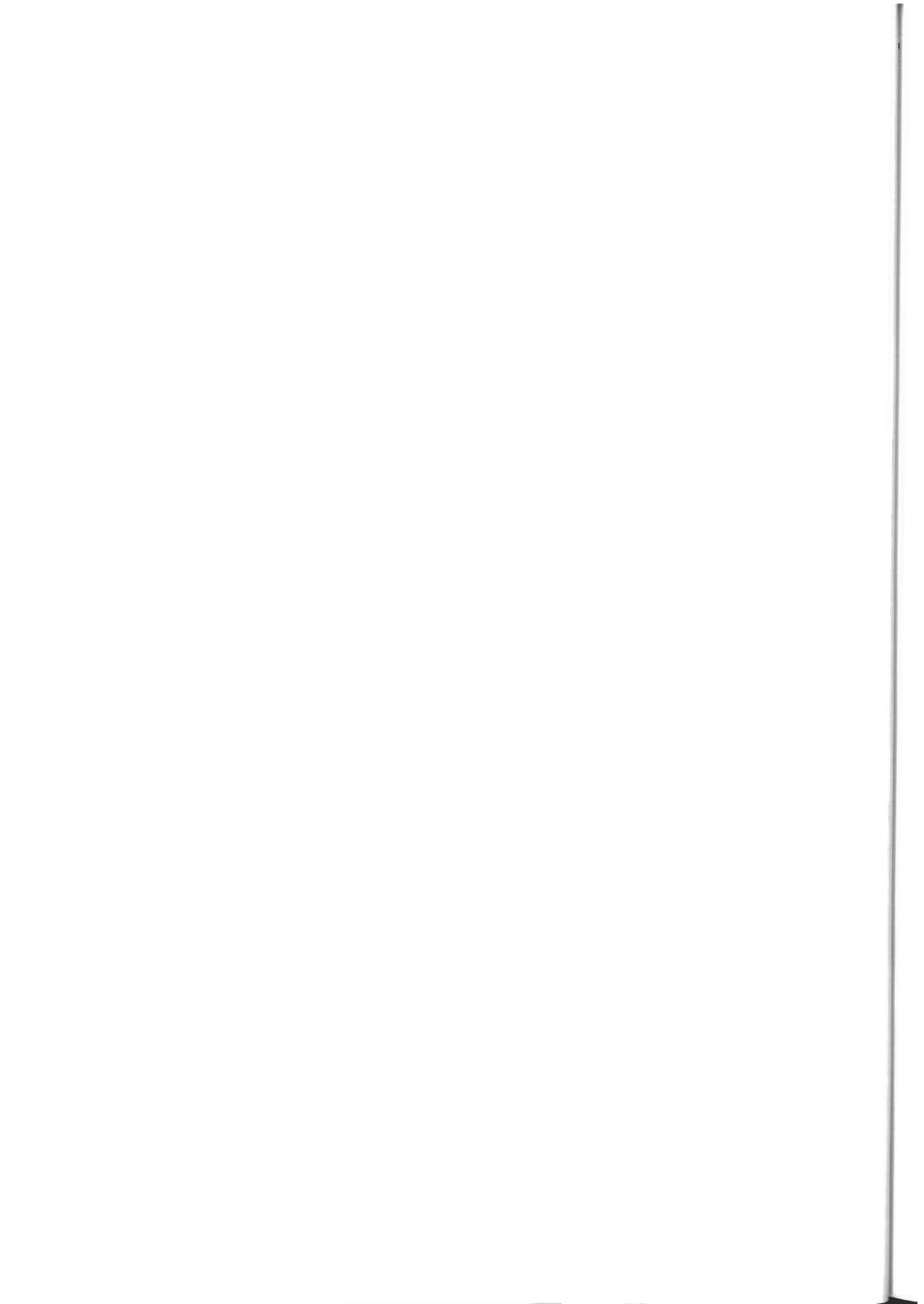


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FOREWORD

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This is now the fourth Brisbane conference on Successes and Failures in Telehealth. It has been interesting to observe the growing network of people interested in telehealth and refreshing to see both successes and failures discussed with such honesty. Valuable lessons can be learned from other peoples' mistakes, as well as learning from their successes.

As a health administrator it has been interesting both to observe and encourage the development of the telepaediatrics service in my own hospital. A wide range of disciplines in the hospital are now actively involved in our telepaediatrics service. In this process we have been testing the boundaries of service delivery by telemedicine. Our teaching rounds are broadcast to other centres in the state and now to an international audience.

Based on the progress that has been made over the last three years, I am quietly confident that our telepaediatrics service has a bright future.

PAPERS

A training network for introducing telemedicine, telecare and hospital informatics in the Adriatic-Danube-Black Sea region

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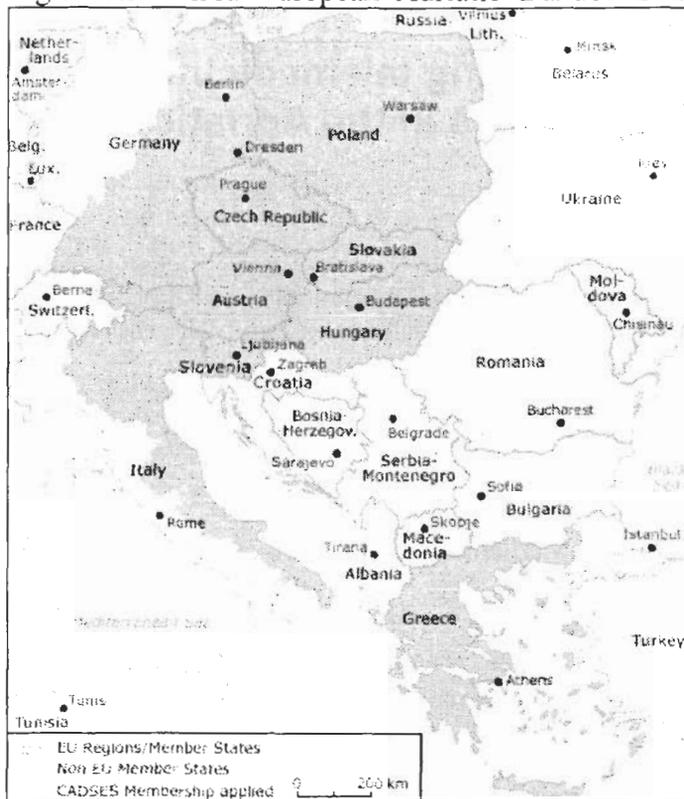
Summary

DIMNET is a training mechanism for a region of central Europe. The aim is to upgrade the IT skills of local hospital personnel and preserve their employability following the introduction of medical informatics. DIMNET utilizes Internet-based virtual classrooms to provide a 200-hour training course in medical informatics. Training takes place in the cities of Drama, Kavala, Xanthi and Varna where appropriate facilities exist. So far, more than 600 people have benefited from the programme. Initial results are encouraging. DIMNET promotes a new vocational training culture in the Balkans and is supported by local governments that perceive healthcare as a fulcrum for economic development.

Introduction

DIMNET (“Dimitrios Karlos” Network for Equal Employment in Modern Nursing) is a training mechanism for a region of central Europe, “Central European – Adriatic – Danube - Southeastern European Space” (CADSES), see Fig. 1.

Fig 1. The Central European–Adriatic–Danube–Southeastern European Space



The CADSES-area is characterized by large disparities in a number of indicators, such as:

- local income per capita. Income per capita ranges from more than US\$20,000 in the areas where the richest 25% of the population lives to less than \$1500 in the areas where the poorest 25% of the population lives
- availability of educational opportunities, especially in sectors such as continuing education or life-long learning
- IT infrastructure. There are 19.4 computers per 100 people in Italy, 8.1 in Greece and 4.4 in Bulgaria. There are 39.7 Internet hosts per 1000 people in Italy, 17.2 in Greece and 3.0 in Bulgaria
- medical personnel availability and health infrastructure. Italy has 5.9 doctors and 5.5 hospital beds per 1000 population, Greece has 4.1 doctors and 5.0 hospital beds per 1000 population and Bulgaria has 3.5 doctors and 8.6 hospital beds per 1000 population.

The DIMNET network began in 1998 when a telemedicine network was installed at the Medical University of Varna in Bulgaria [1]. This network was installed between June 1998 and December 2001, and was funded by the Greek Ministry of National Economy in the framework of the OECD Development Assistance Cooperation programme. At about the same time, between January and December 2000, the Prefecture Authority of Drama – Kavala – Xanthi, in Greece, successfully conducted a series of three training programmes for local hospital personnel about the introduction of medical informatics to their work. In this case the funding came from the 2nd Community Support

Programme for Greece, whose aim was to reduce the disparities between areas of the European Union. Both programmes were designed and, in part, implemented by the Biomedical Trans-European Association for Training, a non-profit organization established in Thessaloniki. DIMNET was the result of the lessons learned during these efforts.

The philosophy of DIMNET followed the realization that along with the creation of new types of jobs, an information society could threaten sectors that had previously been considered immune to unemployment. For example, there is a great difficulty for the nursing personnel in Balkan hospitals, to adapt to the introduction of IT in hospitals. These nurses have a varied training background ranging from nurses who are self-taught, to nurses who have had tertiary education and even postgraduate university education. IT illiteracy will, therefore, create a substantial disadvantage for many nurses and lead to their marginalisation in forthcoming, so called, "paperless" hospitals. Nurses with many years experience, but also with many years to go before retirement, may find themselves seeking other employment. In addition, the substantial influx of male nurses into an otherwise female-dominated environment creates the danger of marginalisation for female nurses, since their male counterparts tend to be more computer-literate. Finally, it is widely expected that the introduction of IT in the Balkan hospitals will lead to redistribution of authority within hospitals and it will generate social segregation and exclusion. Initiatives like DIMNET can prevent such developments by influencing the Balkan hospital corporate culture in a positive way. They can also help eliminate the effects of such exclusion phenomena insofar they have already occurred.

Methods

Since the year 2000, DIMNET partners have successfully conducted Internet based training programmes. The DIMNET network extends into the areas of Eastern Macedonia and Thrace in Greece and the Districts of Sofia and of Varna in Bulgaria. In total it covers an area that contains 20 medium and large size hospitals (ranging from 150 to over 800 beds). These hospitals employ over 10,000 nurses and other hospital staff. The DIMNET goal is:

- to upgrade their hospital IT skills
- to preserve their employability
- to combat discrimination on the basis of gender and educational background
- to introduce the necessary changes in hospital corporate culture so that the introduction of IT in the Balkan hospitals can occur with the minimum possible disruption in their internal social cohesion.

The direct beneficiaries of DIMNET are the nursing personnel who work in the local hospitals of cities where an Internet connection can be established on an individual basis (Fig 2). Nursing personnel who work in cities where computer classrooms have been established will also benefit..

Fig 2. Map of Bulgaria and North-Eastern Greece showing the cities of Blagoevgrad, Haskovo (Khaskovo), Kharzali (Kurdzhali), Smolyen, Sofia and Varna in Bulgaria and Drama, Kavala, Xanthi and Alexandroupolis in Greece



The educational programme addresses the needs of two user categories (i.e. primary and secondary care medical personnel), mainly because these two categories differ in the equipment they use and their communication needs. Tutorials are based upon the theoretical presentation of the issue. This includes:

- clear definition of the subject
- systematic presentation of the issue and the development of the suitable theoretical basis for the trainees
- systematic discussion of the subject to fully understand the theoretical concepts involved
- use of dialogue, tests and other forms of discourse in order to define the concepts and test/verify the ability of trainees to use them at work.

The training modules are published on the Internet in the form of web pages. Initially, they were hosted by the “BIOTRAST” portal in Thessaloniki (1998 to 2000) and later by the “e-one” portal in Athens (2000-2002). Since 2003 they have been hosted by the “BIOTRAST” portal in Thessaloniki. The training modules cover a range of topics, including:

- introduction to the operational environment
- introduction to the applications of text processing, spreadsheets, electronic presentation
- introduction to databases
- fundamentals on patients’ electronic files
- PC web and telematics

- planning and inserting first aid systems and hospital care
- safety and integrity of medical information
- use of health card
- use of special programs for scanning images
- general introduction to the Internet
- basic applications, such as TELNET and FTP
- familiarisation with multimedia
- search engines
- email
- news, communication programs and IRC
- teleconference systems, teleconsultation
- telemedical application: teleradiology, telecardiology, distance support
- construction of web pages using HTML and Java script
- biomedical signals
- methods of receiving and processing of images of medical information
- support system for making decision and development.

As far as the training of primary care personnel in telemedicine is concerned, the telemedical services that are targeted are [2,3]:

- text and data transfer
- transmitting static images (e.g. pathology images)
- transmitting X-ray data (e.g. plain X-rays or CT scans)
- transmitting digital ECGs
- transmission of voice and images for videoconferences
- sending and receiving fax messages.

Care has been exercised to make the material user-friendly. Finally, the training of the personnel in secondary care services includes courses in support of telemedical services which is focused on the use of PCs equipped with the necessary peripheral equipment for the communication with the doctors of primary care. The training is based on an application that allows:

- saving of the transmitted information and giving the opportunity both to the doctor and to other experienced colleagues to study the material
- the use of tools (ability to enlarge an image or use filters to control its clarity) to enable telediagnosis
- the referral of the information to a larger hospital unit, in order to get a second opinion.

The element of the course that is considered most important is the development of the user's ability to judge the gravity of the cases at hand, something that is accomplished through training in distant diagnosis.

Results

Training takes place in the cities of Drama, Kavala, Xanthi and Varna where appropriate facilities exist. This offers the students the sense of belonging to a physical classroom. It appears that people in the Balkans still trust the education they get in a

formal environment much more than that they get in a virtual or informal one. So far, more than 600 people have benefited from the programme, and funding is being sought to extend the number of physical classrooms from 4 to 15. These will be equipped with 20 PCs each and will have multimedia and desktop publishing capabilities. The target is to have trained 3000 people (2000 nurses and 1000 administrators) for 200 hours each by 2007, which is the year when Bulgaria is expected to join the European Union.

Discussion

The DIMNET project is an integrated system for the distribution of vocational training material and for the promotion of life-long learning. The system provides extensive e-learning opportunities, and is the repository of training modules to which all its subscribers have access. DIMNET promotes a new vocational training culture in the Balkans. It is supported by local governments that perceive healthcare as important to local economic development. The success of the project hinges on local factors and on the financial commitment of the local governments that support it. Initial results are encouraging: not only have the DIMNET graduates returned to the DIMNET site after graduation, but they have requested continued access to the educational material, long after their graduation from the programme. In response to that, a CDROM version of selected training modules will be distributed to all past graduates towards the end of 2004.

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The Varna-Thessaloniki telemedical collaboration in setting up a regional transborder transplantation network

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Summary

In most Balkan countries, with the exception of Greece, transplantation is very rare and equality of access does not exist. In 2003, a Balkan partnership was established called SETNET (South-Eastern European Transplantation Network) for the promotion of transplantation. The objectives are to bring about the diffusion of transplantation techniques and practices in the Balkans, to increase public support and participation in transplantation and to eliminate the disparities in access to good healthcare. SETNET is already beginning to generate data for an analysis of transplantation related needs for the Balkans and to accelerate cross-border data exchange in transplantation related emergency cases. In the next few years, an interregional training programme will be introduced for all health care staff involved in transplantation. A regional organ procurement and transplantation network will be set up to utilise the existing telemedicine infrastructure. If successful, it will also prove that telemedicine infrastructures, however modest, can be the backbone for other, far-reaching human networks.

Introduction

Good health of a population is synonymous with equal access to healthcare; it is also fundamental to economic development. It is therefore of cardinal importance that an investment in health accompanies any economic development scheme: clean water for sub-Saharan villages, extensive child vaccination programmes in South America or other forms of public health interventions elsewhere, have always preceded economic development investment in the developing world.

When it comes to economic development, the Balkans is the most disadvantaged area of Europe. In terms of size and population, it is comparable with France. However, 83% of its population live outside the European Union (EU), and their “purchasing power parity” is only 15% that of the French people. If Greece (a member of the EU) is excluded, this falls to 8%. Nonetheless, even the poorest of the Balkan countries are not classified as underdeveloped or even as developing. Their income per capita is far above the threshold for such a classification. As a result, their needs in healthcare investment are different, but just as pressing, as the needs of developing countries.

Whereas good health is a prerequisite for the economic development of underdeveloped countries, in the Balkans it is a prerequisite for balanced regional development. Good health, however, still remains synonymous with equality of access to healthcare. Transplantation is a viable clinical strategy for combating disease and disability, and is perceived in these countries as the hallmark of a well functioning healthcare system.

Starting in June 1998, a telemedicine network was installed between Varna in Bulgaria and Thessaloniki in Greece. Between January and December 2000, a series of training programmes in new technologies was conducted for local hospital personnel [1]. Overlaps in these two projects, along with local population sensitivity to transplantation issues, resulted in the identification of a common interest in transplantation policies and the emergence, in 2003, of a Balkan partnership (SETNET or South-Eastern European Transplantation Network) for the promotion of transplantation.

South-Eastern European Transplantation Network

SETNET is the result of an analysis of local disparities in transplantation surgery and of the efforts to redress inequalities of access to transplantation. It includes partners from both the public administrative and the academic domain. The network includes local authorities, clinics, laboratories and regional hospitals, all with a history of coordinating developmental efforts. The local and regional authorities participating in SETNET have a history of implementing public education programmes and cooperating with regions with which they share common borders to reduce disparities in cultural approaches to problems. Recently, they have co-ordinated with partners from across the border who use different standards, reference systems and languages. SETNET, therefore, is an effort to bring about:

- the diffusion of transplantation techniques and practices in the Balkans
- an increase in public support and participation in efforts to promote transplantation
- the elimination of disparities in access to good healthcare
- a contribution to the welfare of the area.

Transplantation management involves a number of critical issues, including speed, accuracy, reliability of information and data protection. Successful operation of a transplantation network can become an instrument for saving lives, and improving the quality of life for patients. In addition, legal issues related to organ donation must be addressed. Uniform approaches are necessary in order to ensure the proper links and relationships between all facets of transplantation, including:

- procedures for the certification of brain death
- procedures for organ and tissue extraction, as well as procedures for transport coordination
- establishment of donor banks
- implementation of a uniform transplantation information system
- procedures for the analysis and management of donor procurement.

SETNET addresses these transplantation policy and practices problems through the:

- availability and interoperability of transplantation related data in the border regions of Eastern Macedonia and Thrace
- utilization of transplantation related data by the participating public administrations for uniform health services planning
- assurance of the quality of any transplantation related decision making
- co-ordination of bilateral regional development in the appropriate regions.

Transplantation is considered as the hallmark of a well functioning healthcare system. However, there is very little public trust in the government's ability to keep the procedures transparent and ensure equal access to the process for rich and poor alike. In order to develop the public's trust, it is imperative that doctors who perform transplantations must be well trained. Not only in terms of medical but also in terms of ethical and legal aspects of transplantations. This is the reason that a great emphasis is placed by SETNET on physician training. This training is done under the auspices of the University of Thessaloniki in Greece and the Medical University of Varna in Bulgaria. It is expected that between 2004 and 2007, sixty medical doctors will have undergone training in transplantation related issues under the auspices of SETNET.

Finally, a publicity campaign is planned to start in March 2005 to introduce the Uniform Donor Card. Through this publicity campaign it is expected that it will be possible to overcome the public distrust in the government as the guarantor of transparency in transplant procurement and distribution. It is also hoped that lawmakers on both sides of the inter-Balkan national borders will work towards a common legal framework for transplantation. As part of the campaign, a SETNET portal has been established and three publications will be distributed. These cover the subjects of:

- establishing brain death
- organ procurement and setting up of a required referral system
- using the SETNET Regional Organ Procurement and Transplantation Network.

Objectives

The overall objective of SETNET is to create the infrastructure for promoting transplantation as an integral part of the health services in the Balkans. Organ transplant networks exist in most EU states. Thus SETNET was designed so that:

- it will ensure the development of procedures and the implementation of information processing infrastructures over the existing telemedicine networks in the area. This will be achieved by embedding in the recipient selection process the knowledge and criteria to facilitate recipient selection and proper decision making in the field of organ transplantation
- it will provide for the continuous monitoring of the cost-effectiveness of transplantations
- it will establish collaborative links with existing European networks and centres.

SETNET is already beginning to generate data for:

- an analysis of transplantation related needs for the Balkans, starting with Greek–Bulgarian Border of the Eastern Macedonia and Thrace region, which is expected to be complete by the end of 2004
- the acceleration of cross-border data exchange in transplantation related medical emergency cases
- the improvement of transplantation related decision making
- the development of a regional information system (in compliance with EU and national efforts) for transplantation related regional planning.

Discussion

The outputs of SETNET which can be expected in the next few years include:

- an interregional training programme for all medical specialties involved in transplantation. The program will also train nursing and paramedical personnel in the hospitals of the region
- a regional organ procurement and transplantation network will utilise the existing telemedicine infrastructure
- a public education programme will be established and a “Uniform Donor Card” will be introduced
- a referral system for organ and tissue transplantations will be set up in the region. This will be supported by a tissue bank and immunology laboratory
- three publications will be produced for physicians.

It is hoped that these actions will improve access to transplantation surgery for patients in the Balkans and have a positive effect on the organ recipient's life. If successful, it will also prove that telemedicine infrastructures, however modest, can be the backbone for other, far-reaching human networks.

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A simple telemedicine system to provide second opinion advice to the patients of an Albanian diagnostic centre

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Summary

Since August 2003, the "IKEDA Klinika" diagnostic center in Tirana, Albania, has offered patients telemedical help from Greece. The teleconsultation service is based on Internet technologies adapted to telemedical use, including the use of forms (e.g. the patient history), multimedia file exchanges (e.g. X-rays and EEGs), and videoconferencing. The teleconsultants assist in treatment planning and, when necessary, in organizing the transfer of patients to Greece. The provision of second opinions by telemedicine, assistance in treatment planning, assistance to patients during transfer and the continuity of medical care on their repatriation, are the four cornerstones of the service. Based on the first six months of operation, we estimate that, if bureaucratic visa restrictions to patient movement between Albania and Greece are removed, more than 2000 patients per year will benefit from the service and more than 400 patients will be transferred to Greek hospitals for treatment.

Introduction

The fall of Communism in Europe left Albanians with one of the lowest national incomes per capita (US\$1183) and Albania with an inadequate healthcare system which is spending about \$28 per year per capita for the healthcare of its citizens. Health professionals typically serve a large patient load and have limited access to support services. Compounding this, health professionals have limited access to health care information, since both expert consultants and libraries are rare. As a result, patients are forced to accept inadequate health care, pay for private medical services and, sometimes, face extensive travel to obtain information and services abroad, mainly in Greece. With only one doctor for every 769 patients, Albanians often receive the majority of their primary health care from nurses, medical assistants and health care workers. The skill shortages are further compounded by the emigration of trained personnel, particularly nurses and paramedics, mainly to neighbouring Greece. In addition, since Albanian emigrants living in Greece produce almost 20% of the Albanian Gross Domestic Product, an increasing segment of the Albanian population is in a position to seek medical help in Greece.

The advent of new technologies and the rapid growth in Internet access offers a new and cost effective way of delivering medical services [1]. In Albania, however, there are three main obstacles to the country-wide use of information and communications technology in medicine. First, rural hospitals have limited access to computers, which in turn restricts access to medical resources on-line. Second, current health education materials are largely not available in a suitable format or language. Third, health care providers are not adequately trained to use online and computer-assisted resources.

On the other hand, there is an opportunity for successfully establishing telemedical services in Albania. The private health sector is thriving in urban Albania and, especially, in Tirana, its capital. There, the continuously expanding Internet connectivity offers novel and, in many cases, cost-effective ways for foreign medical providers, especially from Greece, to deliver their medical services to Albania. Conduits for these services are Albanian private medical clinics and diagnostic centres that offer their patients the ability to seek help from medical specialists in Greece through teleconsultation.

Telemedicine clinic

The first private medical establishment in Albania to offer their clients the ability to seek medical help outside their immediate locale was the "IKEDA Klinika" in Tirana. Since August 2003 this clinic has provided its patients with the opportunity of receiving quality assured health care [2] in collaboration with the "General Clinic" of Thessaloniki, Greece, under the supervision of members of the medical staff of the Aristotle University of Thessaloniki. The majority of the patients opting for this service have serious conditions and need to be treated in hospitals with substantial medical and technological resources. The teleconsultation service is based on Internet technologies adapted to telemedical use, including use of forms (e.g. the patient history), multimedia file exchanges (e.g. X-rays and EEGs), and videoconferencing [3].

When the need arises, the participating physicians from Greece not only act as teleconsultants and second medical opinion providers, but they also assist in treatment planning or act as facilitators of patient transfer to the receiving Greek medical

institutions, thus minimizing the necessary formalities. The four aspects of the "IKEDA Klinika" service, i.e. provision of second opinions by telemedicine, tele-assistance in treatment planning, provision of assistance to patients during their possible transfer abroad and the continuity of medical care upon their repatriation, are all based on virtual home care platforms for patients and, where necessary, portable care and alert systems. These four aspects are expected to become the means for quantifying, measuring and verifying the quality of the telemedical services offered.

An initial estimate of the clientele of the "IKEDA Klinika" indicated that at least 100 patients per year will need to travel to Greece for coronary vessel angioplasty or coronary vessel bypass surgery. This number is very high if one takes into account that in Albania, only the very rich can afford treatment abroad. On the other hand, invasive cardiology procedures are almost never performed in Albania since they require heavy investment in human and technological resources. Following coronary angioplasty and coronary bypass surgery, the demand for renal transplantation represents the second most compelling reason for Albanian patients to travel for treatment to Greece. It is interesting to note that although the Albanian family structure and cohesiveness makes it relatively easy for patients with terminal renal failure to find a relative willing to act as a living organ donor, renal transplantation is very seldom performed in Albania, while any necessary follow up is always performed abroad.

Other surgical procedures that were identified by the "IKEDA Klinika" as potential candidates for teleconsultation and medical migration included those for: (a) colon, (b) pancreas, (c) adrenal glands and (d) gall bladder surgery. Finally, laparoscopy, artificial insemination and treatment of thromboembolism completed the list of the most requested teleconsultation services for Albanian patients.

Results

All "IKEDA Klinika" telemedicine is done by email. A typical case of Internet message exchange regarding a typical case of cancer of the larynx is given in Box 1 and Figs 1a-1c. These messages indicate that with very limited resources sound medical advice can be transmitted over the Internet and lives can be saved. As very few Greek doctors speak Albanian and very few Albanian doctors speak Greek, English is used as the common language of communication. The text of the exchanges has not been edited, so that it is possible for the reader to gain a first-hand impression of the level of the ease and accuracy of communication.

During the first six months of the service, 38 patients took advantage of the second opinion service that "IKEDA Klinika" offers to their patients. In five of these cases the teleconsultants were directly involved in treatment planning. In three cases (two requiring surgical intervention and one requiring invasive cardiology procedures) it was decided that the patients should be transferred to Greece for treatment. However, visa restrictions and bureaucratic obstacles made this possible in only one case (tumour of the adrenal gland). It should be noted that since Greek laws guarantee that every person in Greece should have open access to healthcare [4], the Greek government is enacting restrictions on travel for medical reasons in order to avoid abuse of its healthcare system by immigrants (Greek Ministry of Foreign Affairs; personal communication).

Based on the experience gained from the first six months of the system's operation and a survey of patients about their desire to travel to Greece in order to obtain better treatment, we estimate that, if obstacles to patient movement between Albania and Greece are removed, more than 2000 patients per year will benefit from the service and more than 400 patients will be transferred to Greek hospitals for treatment.

Discussion

The simplicity of the "IKEDA Klinika" network and its adaptation to local needs confirms that much can be done to give access to health care, where little had been available before. Traditionally, telemedicine has been described as benefiting populations in remote, rural areas. In the US for example, almost all of the government-funded demonstration programmes have depended on an academic medical centre at the hub connected to rural primary care clinics. However, since economic growth is associated with a decreasing dependence on agriculture, it is inevitable that rural populations will decline and urbanization will be the first step towards industrialization in most underdeveloped countries. Thus although telemedicine demonstration programmes similar to those funded by the US government have proven the efficacy and effectiveness of telemedicine, they may be irrelevant to the overall growth of telemedicine in the future since they do not demonstrate the potential effect of telemedicine on the delivery of health care for the populations of the urban areas. Indeed, telemedicine will have a profound effect on the overall delivery of health care, especially to under-served urban populations of the developing countries.

The example of Albania shows that accessing specialty care services is far more important to underserved urban populations than reducing the cost of medical services. As long as what is considered commonplace, even in moderately developed countries, is not available to the urban populations of developing countries, there will be a strong financial incentive for foreign medical establishments to use telemedicine to gain a larger market share and foreign "for profit" health care organizations will be competing in locking up referrals from primary care physicians (as well as by specialists whose function is limited due to lack of appropriate medical infrastructures) into their own institution.

Conclusions

As far as the urban populations of the developing countries are concerned, the Internet is emerging as the logical choice of the vehicle for medical care delivery. What will its effect be on urban populations in the developing countries? It will certainly help redress the problem of maldistribution of medical specialists and it will help increase the availability of medical care into underserved communities. Whether it will increase the ability of low-income inner-city residents to gain access to care at lower costs remains to be seen.

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Box 1. A case study demonstrating communication between "IKEDA Klinika" and "General Clinic" regarding a patient with cancer of the larynx. The names of doctors have been removed. Grammar and syntax left intact.

Date: Fri, 10 Oct 2003 06:33:12 -0700 (PDT)
From: *****
Subject: Request for treatment!
To: *****@****.gr

Dear Mr. *****.

We are interested to get your opinion for one our patient GJ.B of age 50, who has problems of voice and in laryngoscope examination we get this information:

In the entering part on larynx is an stricture, as product of an formation with contours non-uniforms that goes till "sub cordial-region" touching and the first cartilage of trachea. The left vocal cords is fixed. (immovable) with ulceration and that does not get part in voice function.

Diagnose: Suspects for Carcinoma of the larynx.

Sending the images of the examination please to give your professional opinion for the treatment and the total cost of these treatment at your hospital.

Best regards
Dr. *****
P.S. Please find attached the three images.

Date: Mon, 13 Oct 2003 11:29:23 -0700 (PDT)
From: *****
Subject: Request for treatment!
To: *****@****.gr
Bottom of Form

Dear *****,

As I told you over the telephone this afternoon, here are the results of our looking over the laryngoscopy pictures that you send me.

The pictures were examined by Dr. ***** of the General Clinic of Thessaloniki, one of the major private health care institutions in our area.

His opinion is that Dr. ***** is right. However, on the basis of the laryngoscopy pictures alone, the case cannot be fully decided. A CT or MRI scan is definitely needed for us to fully explore the extend of the tumour infiltration and, based on that, a laryngoscopy under anaesthesia followed by biopsy.

In this way we will be able to "stage" the carcinoma and decide if it is operable (and to what extend), as well as what the treatment should be.

This will take 2 days of stay in the hospital plus the cost of the CT or MRI scan and/or laryngoscopy under anaesthesia. Of course this is a maximum effort we are talking about and it may be that the CT scan is sufficient, together with the clinical exam to let us plan the treatment.

The cost of an MRI scan is about 450 EURO and the rest like a small operation. The eventual operation will be about 3000 EURO.

I believe that this is the best course to follow and in case you decide that the patient comes to Thessaloniki then we can proceed with all the rest of the preparations.

Carcinoma of the larynx is treatable and, if caught early enough, it has a life expectancy of more than 15 years. This is why I think that the course we propose is the best one.

I am at your disposal for any other information you may need

Best regards

Aristotle University Faculty of Medicine

Fig 1a. View through laryngoscope transmitted between Albania and Greece via the Internet (JPEG file, 533x501 pixels, 46 kByte)



Fig 1b. View through laryngoscope transmitted between Albania and Greece via the Internet. (JPEG file, 549x445 pixels, 45 kByte)

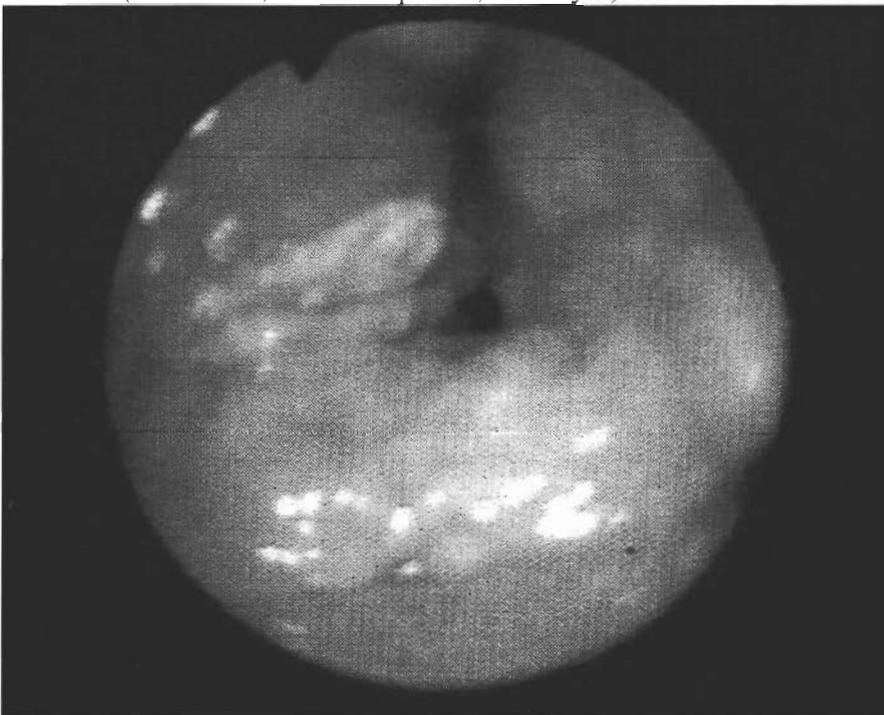
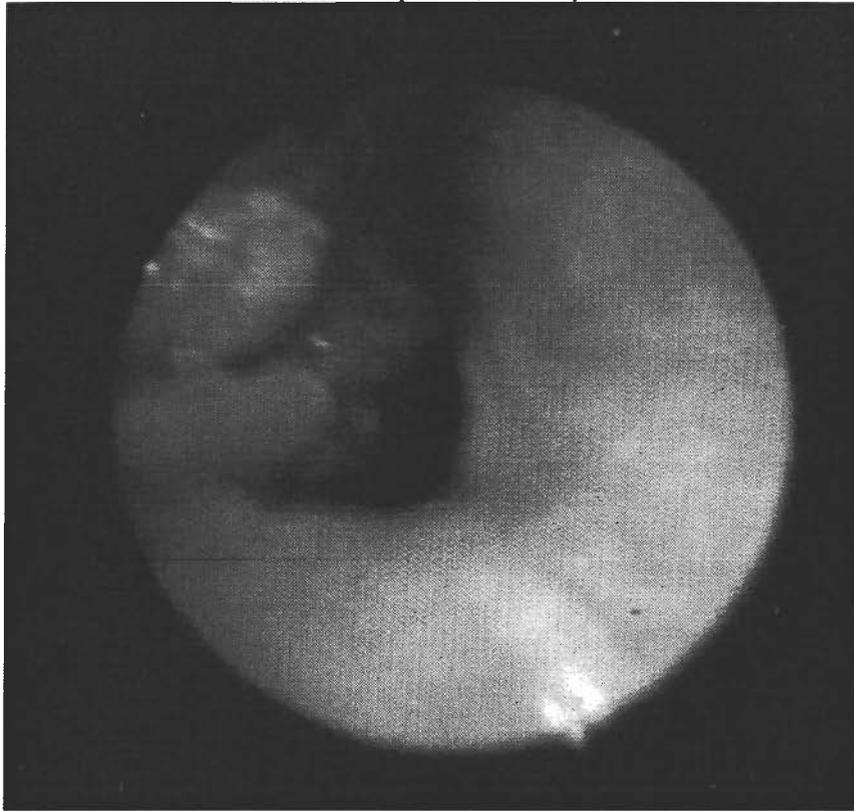


Fig 1c. View through laryngoscope transmitted between Albania and Greece via the Internet. (JPEG file, 529x505 pixels, 44 kByte)



Paediatric palliative home care with Internet-based videophones: lessons learnt

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Summary

We have designed and trialled an Internet-based videophone suitable for use in the homes of paediatric palliative care families. The equipment uses an ordinary telephone line and includes a personal computer, web camera and modem housed in a custom made box. In initial field trials, six clinical consultations were conducted in a one-month trial of the videophone for a palliative care family living in the outer suburbs of Brisbane. Problems with variability in call quality, namely audio and video freezing and audio break-up prompted further laboratory testing. We completed a programme of over 250 test calls. Fixing modem connection parameters to use V.34 modulation protocol at a set bandwidth of 24 kbit/s improved connection stability and the reliability of the videophone. In subsequent field trials 47 of 50 calls (94%) connected without problems. The freezes that did occur were brief (with greatly reduced packet loss) and had little affect on the ability to communicate unlike the problems arising in the home testing. The low-bandwidth Internet-based videophone we have developed provides a feasible means of doing telemedicine in the home.

Introduction

The Paediatric Oncology Service at the Royal Children's Hospital provides a palliative care service to children and their families across Queensland, areas of northern New South Wales and the southwest Pacific. Sixty-eight percent of the patients cared for by the service are from rural and remote areas[1]. The specialist paediatric palliative care team members do not normally make home visits to these families due to the travel, time and cost involved. Instead, most support is provided by telephone. We are interested in palliative care support delivered by videophone.

Our own trials, and others, using commercial PSTN videophones in Australia[2,3] have reported reliability problems. We have therefore designed a PC-based, low-bandwidth Internet-based videophone. Using a PC platform means that telecommunications can be controlled via software (e.g. modem settings).

The telepaediatric videophone

The telepaediatric videophone (Fig 1) is housed in a custom made box with the PC mounted behind a 38 cm flat panel monitor. The PC's operating system is configured to start without a password. Home users are simply required to turn the system on using a single button. Connection to the Internet and start-up of the videoconferencing software proceed automatically. A web camera is mounted above the monitor and provides video and audio data. The videoconferencing software used is based on NetMeeting and adapted from previous work in telerehabilitation[4,5]. It provides a simple home user interface (Fig 2). The clinician videophone software initiates all calls with a similarly configured interface. Added functions including still image capture, file transfer, dialling facility and dialling directory.

Initial field trials of the videophone were conducted in a patient's home. This was followed by a period of laboratory testing, and then a second period of field testing.

Initial field testing

A paediatric palliative care family was approached to test the videophone in the home (Fig 3). The videophone was installed and basic training was provided to both parents and to the palliative care clinical nurse consultant (CNC) in the hospital (taking approximately 15 minutes and including a demonstration test call). Telemedicine visits between the family and the CNC were arranged twice each week. In the first month, six clinical consultations were conducted. All of the clinical consultations were scheduled calls initiated by the palliative care CNC (Table 1).

Table 1. Home testing clinical call data

Call no	Initiator	Nature	Participants	Activities	Outcome
1	CNC	Scheduled	Patient, mother, father, sibling and community nurse	Support and assessment	Follow-up televisit
2	CNC	Scheduled	Patient, mother and community nurse	Support and assessment	Follow-up televisit
3	CNC	Scheduled	Patient, mother and community nurse	Support and assessment	Follow-up televisit
4	CNC	Scheduled	Patient, mother, father, sibling and community nurse	Assessment	Hospital visit
5	CNC	Scheduled	Patient, mother and community nurse	Support and assessment	Follow-up televisit and phone call required
6	CNC	Scheduled	Patient, mother and community nurse	Support and assessment	Telephone call required

In order to monitor call quality objectively, arrangements were made with the Internet service provider (ISP) to obtain data on packet loss and modem performance for each call.

Home testing results

No problems were experienced in establishing connections between the videophones. However, there were a number of unusable calls, due to audio and video freezing, and audio break-up. Each time audio and video freezing and audio break-up was seen, the data obtained from the ISP showed the occurrence of packet loss. The cause of this packet loss was unknown. The modem performance statistics showed a number of significant differences in the connections made with the two videophones (Table 2).

Table 2. Summary modem performance statistics for initial home testing calls

	Home videophone	Clinician videophone
Download bandwidth (kbit/s)	24.0–31.2	21.6–26.4
Upload bandwidth (kbit/s)	33.6–56.0	24.0–54.6
Retrains	13	29
Speed shifts	91	138
Mean % packet loss (SD)	1.6 (2.0)	4.8 (5.3)
Mean signal-to-noise ratio (dB)	40	35

The clinician videophone used less bandwidth, had more than twice as many retrains and 1.5 times as many speed shifts. Differences in mean signal-to-noise ratio (SNR) indicated that telephone line quality was poorer for the clinician videophone (a higher

SNR indicates a cleaner and more noise-free line[6]). The result was calls with large amounts of packet loss (up to 15% for the clinician videophone on one call).

Laboratory testing

Stability of connection was a critical factor identified. Modems are designed to dynamically adjust during connections to achieve the highest possible bandwidth available. The packet loss seen during calls was a direct result of this dynamic adjustment, seen subjectively as video and audio freezing, and audio break-up. Fixing modulation protocol and bandwidth via modem settings (V.34 modulation protocol and 24 kbit/s bandwidth) stabilised the connections (Table 3).

Table 3. Results of 20 test calls comparing videophone calls made with standard modem settings and those made with the modem settings fixed

	Standard modem settings		Modem settings fixed	
	Home videophone	Clinician videophone	Home videophone	Clinician videophone
Total modem retrains	51	45	0	0
Total modem speed shifts	140	35	10	10
Mean % packet loss (SD)	6.0 (12.1)	3.5 (10.0)	0.2 (0.1)	0.1 (0.1)

Field-testing was completed to investigate the reliability of the videophones with these changes.

Subsequent field testing

Five test calls were conducted from each of ten different locations in Brisbane and outlying areas to the Royal Children's Hospital (Table 4). The call quality issues identified in the home testing, specifically audio and video freezing and audio break-up, were used as indicators of videophone reliability.

Table 4. Results of field reliability tests: 50 test calls from ten locations

Location	Distance from RCH (km)	Occurrence of-			Mean % packet loss (SD)	
		video freezing	audio freezing	audio break-up	Home videophone	Clinician videophone
1	5	-	1 (2s long)	-	0.4 (0.8)	0.0
2	6	-	-	-	0.0	0.0
3	7	-	4 (2s long)	-	1.1 (2.5)	0.0
4	9	-	-	-	0.0	0.0
5	10	-	-	-	0.0	0.0
6	12	-	-	-	0.0	0.0
7	15	-	-	-	0.0	0.0
8	58	-	-	-	0.0	0.0
9	90	1 (3s long)	1 (3s long)	-	0.9 (2.1)	0.0
10	92	-	-	-	0.0	0.0

Forty seven of the 50 calls (94%) connected without problems. Two calls failed to connect to the ISP due to a remote server issue and the other failed to connect due to a software issue (pressing the dial command before dial-up had time to complete caused the software to crash. This was noted for inclusion in staff training). Results show that fixed modem settings greatly reduce call quality problems. The freezes that did occur were brief (with greatly reduced packet loss) and had little affect on the ability to communicate unlike the problems arising in the home testing.

Discussion

Most of the development activity for Internet-based videoconferencing has focused on the use of broadband connections. There was very little information and experience to guide our low-bandwidth approach. We have learnt a number of valuable lessons from the home testing undertaken so far, as well as from the prolonged phase of experimentation that resulted in response to issues of call quality.

Our experience to date suggests that videotelephony provides benefits over and above that provided by conventional, audio-only telephony. The videophone allows more personalised communication between family members and paediatric palliative care team members. Conference style communication is facilitated by the videophones which improves the effectiveness and efficiency of communication. Visualisation of the patient allows a limited physical assessment to be undertaken, which assists with patient management and care. The inclusion of local primary health care providers involved in home care with videophone calls facilitated continuity of care and responsiveness to patient and family needs. Staff members using the videophone were satisfied and confident with care provided using the videophone and families felt an added sense of security from the interpersonal contact with team members.

The development of a close relationship with key personnel within the ISP was critical to the problem solving process. Without this relationship we would have been unable to investigate the issues with call quality that arose from the home testing. The data obtained on packet loss and modem performance, as well as the technical advice provided, enabled us to identify connection stability as a key factor. This stability was achieved by adjusting telecommunications via modem settings. Initially, the very design of modems worked against us as the ability to dynamically negotiate and adjust connection parameters at the commencement and during calls had a devastating impact on call quality. Adding a modem initialisation string to force V.34 and fix the bandwidth at 24 kbit/s stabilised calls connections, reduced packet loss and improved the reliability of the videophone.

The use of low-bandwidth, Internet-based videoconferencing for home care is not easy. It took time and commitment to identify, understand and address the call quality issues arising. However, the end result was well worth the investment. In the process we discovered two important factors relating to audio settings. The first is to set standard error detection/correction and not to disable this function via modem initialisation. Disabling this feature caused unusable distortions in audio. The second is to adjust the NetMeeting silence detection to the uppermost limits. Using silence detection resulted in clipped audio that was harder to understand. Limiting silence detection to the upper most limits provided more easily understood and clear audio.

Conclusion

The results of the study suggest that the low-bandwidth Internet-based videophone we have developed provides a feasible means of supporting paediatric palliative care in the home over standard telephone lines. Videophone reliability appears to be linked to call connection stability, which we have been able to improve by careful adjustment of the modem settings.

Acknowledgements

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Fig 1. The telepaediatric videophone in use

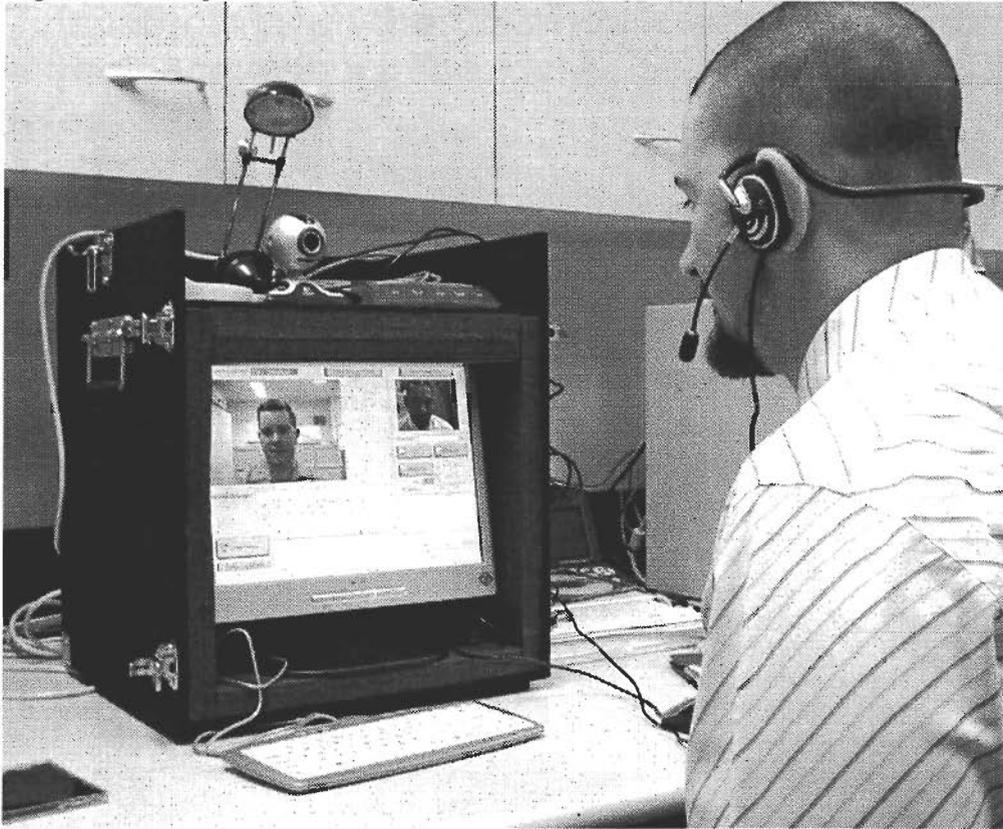


Fig 2. Home user interface

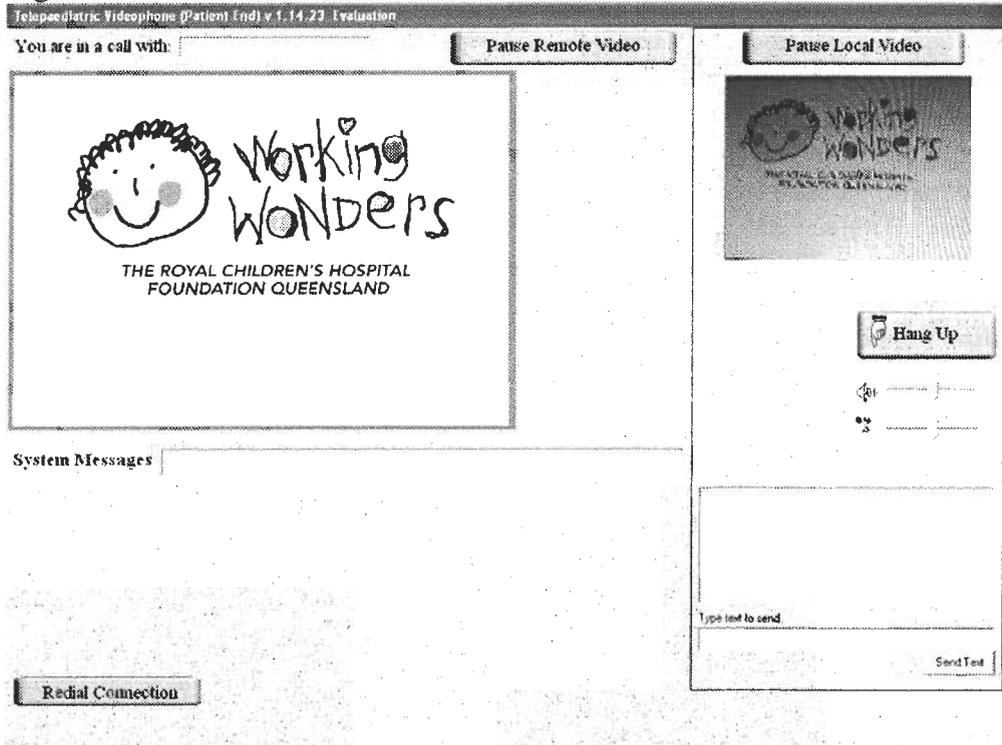
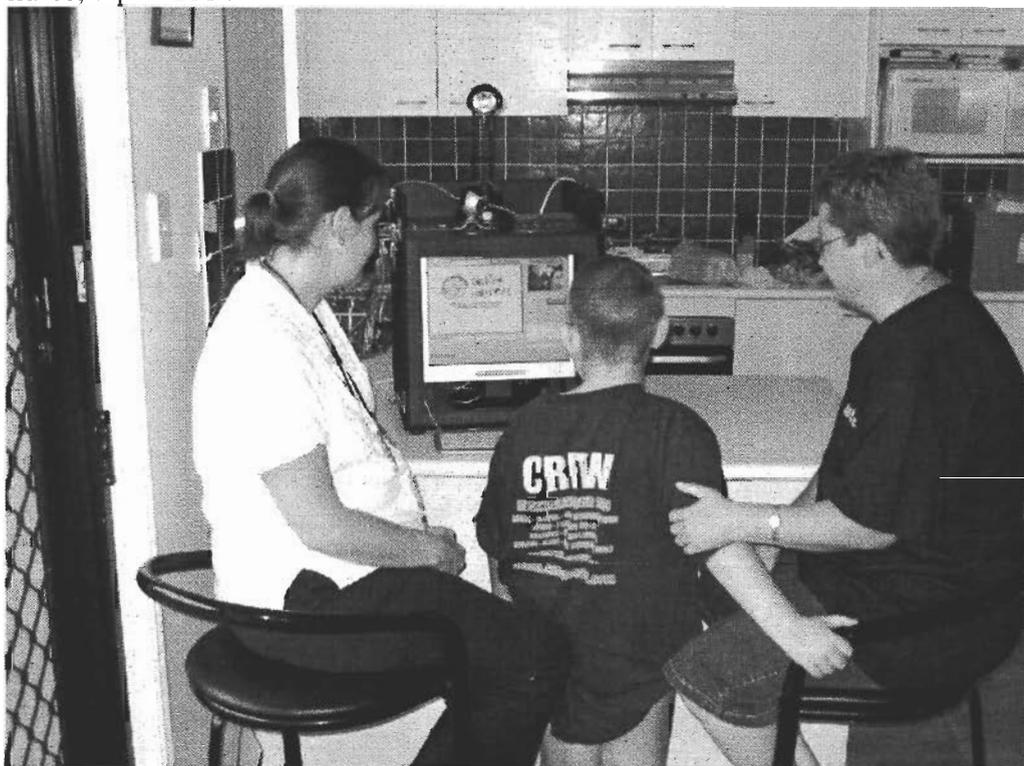


Fig 3. Telepaediatric videophone in the home with patient, mother and community nurse, April 2004



Telepathology on the Solomon Islands - two years' experience with a hybrid web- and email-based telepathology system

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Summary

Since September 2001 the National Referral Hospital in Honiara, Solomon Islands has used an Internet based system in Switzerland for telepathology consultations. Due to the limited bandwidth of Internet connections on Solomon Islands, an email-interface was developed, which allows users in Honiara to operate the basic functions like submission of cases and receiving reports by plain email. At the other end, consultants can use a more sophisticated web-based interface, which also allows discussion of cases among an expert panel. The result is a hybrid email- and web based telepathology system. Over a period of two years a total of 333 consultation were performed, of which 94% could be diagnosed by a remote pathologist. A computer-assisted "virtual institute" of pathologists was established. This form of organisation helped to reduce the median time from submission of the request to a report from 28h to 8.5h for a preliminary diagnosis, and 13h for a final report. A final report was possible in 77% of all submitted cases.

Introduction

The National Referral Hospital (NRH) in Honiara is the only major hospital in the Solomon Islands, an independent state with approximately 450,000 inhabitants, in the south west of the Pacific ocean. The NRH is the only referral hospital for the eight provincial hospitals. The country has about 40 doctors but not a single pathologist and consequently tissue samples for histological examination have to be sent by airmail to the nearest pathology service in Brisbane, Australia. With the decline in tourism after

the civil disorder in 1999 transport to the Solomon Islands has become even more limited. It is common for the doctors at the NRH to wait for 3-6 weeks before a histological diagnosis is available from Brisbane.

Patients from remote islands have to travel by boat for days to reach the NRH on the main island. For many patients it is difficult to return home to wait until a diagnostic result has arrived at the NRH and as a consequence, treatment decisions often have to be made without a firm histological diagnosis. Recent advances in telecommunications and telemedicine suggest ways of overcoming such problems. There is a growing evidence in the literature that telemedicine is a feasible tool, even for countries with less well developed telecommunications infrastructure[1-7]. However, most of these reports deal with teledermatology[6,7] and teleradiology[3] and there is little published experience in the field of telepathology in developing countries (only one citation in PubMed[8]).

We have therefore employed iPath, a hybrid web- and email-based telemedicine system developed at the University of Basel[9-11]. Basically, iPath is a collaborative platform that allows a group of specialists to discuss cases which typically consist of a clinical description and attached images or other multimedia objects. A special feature of iPath is that it offers static as well as dynamic telepathology[12] and also several interfaces for access to data. A user can work via an email- and a web-interface, but there is also interactive remote control of a robotic microscope when available. iPath is available as free software[13]. In October 2001 when the project was started, the Solomon Islands telecommunications provider had a 128 kbit/s link to the Internet, which had to be shared by all Internet users in the country. Because of this limited bandwidth, only static telepathology was practicable.

Methods

A small histology laboratory was established at the NRH in Honiara in September 2001, allowing the preparation of haematoxylin and eosin-stained sections. The processing of the specimens was done manually, because repair and maintenance of any specialised automatic equipment is difficult. The gross specimens are prepared by the surgeon and the slides are usually ready two or three days later.

From the microscopic sections prepared in this laboratory, digital photographs are taken using a digital camera (CoolPix 990, Nikon) mounted on a microscope (OptiPhot 2, Nikon). These pictures are usually scaled to approximately 600x400 pixels (typically 20-70 kByte) then sent via email to the telepathology server at University of Basel.

The telepathology server in Basel is based on iPath[13]. Originally, iPath was developed as a web-based consultation platform offering access through a web browser. However, the experience in the Solomon Islands led to the development of email-based access. The server can automatically import cases from email. The email text is stored as the case description and the attached images are placed in an image gallery.

These cases are then reviewed by an international group of pathologists. These pathologists are organised as a "virtual institute" (VIRIN[11]) using the "expert group" facility of iPath. As in a real institute there is always one pathologist on call. When a new case arrives, the pathologist on call is automatically notified by email. The

pathologist will then use the web interface to review the case (Fig 1). If a diagnosis can be given easily, the expert on call will simply write the diagnosis and label it as final. The system will then close the case and send the diagnosis automatically to the NRH by email. If the case is more complicated, the expert on call may state a preliminary diagnosis and will then link the case to the VIRIN. Other members of the VIRIN are informed of the case by email and can report their opinion. These opinions are collected inside the VIRIN and are not directly accessible by the sender of the case. Finally, the expert on call will summarise the opinions of his or her colleagues and will write it down in the original case. The referring doctors can read this diagnosis online or, in places where online web access is difficult, the server can automatically send the final diagnosis by email.

Results

During a two year period from January 2002 and December 2003, a total of 333 pathology consultations were submitted from the NRH to the telepathology server in Basel. These consultations were submitted by email with a short clinical description and with images as attachments (average 8.8 images per consultation). In 50% of all consultations a first report from a pathologist was issued in 12h or less (Table 1).

Table 1. Telepathology consultations from the National Referral Hospital in Honiara. Phase I consultations took place from January 2002 to October 2002. Phase II consultations took place from November 2002 to December 2003.

	Phase I	Phase II	Total
Number of consultations	73	260	333
Median time to first response (h)	28	8.5	12
Consultation possible	93%	94%	94%
Additional images requested	25%	10%	13%

The cases were separated in two groups: phase I included all cases that were submitted before the introduction of the VIRIN in October 2002, while Phase II included all cases after establishing the VIRIN. During phase I, 73 cases were submitted. During this 10-month period, the pathologists were not organised in any particular way. Every pathologist would login to the system now and then and report on new cases. As Table 1 illustrates, in 50% of the cases a response from a pathologist was submitted no later than 28 h after submission of the case (on average within 32 h). In 25% of all submitted cases, the pathologists asked for additional images and indicated location and magnification of these requested images. Overall, in 94% of the cases, the submitted material was suitable for at least some degree of diagnostic interpretation.

One of the major problems of this method of collaboration was that the doctors in Honiara were left to summarise the comments from the different pathologists into a conclusive diagnosis. This led to the idea of forming a virtual institute, where second opinion consultations were gathered in a closed discussion among the pathologists. Eventually one pathologist summarises the discussion and attaches a conclusive response to the original case. This response is then automatically emailed to the doctors in Honiara.

Table 2. Results of the virtual institute

Median time to final diagnosis (h)	13 (average 31)
Consultations with final report	77%
Second opinion consultation in the VIRIN	17%
Median time to final diagnosis after VIRIN consultation (h)	74 (average 89)
Average number of second opinions in the VIRIN	3.7

The software to support the VIRIN was developed during October 2002 and in November, the eight participating pathologists were reorganised as a VIRIN. A duty plan was prepared and each week one pathologist was on call. The iPath system automatically notified the pathologist on call about any new cases and also about new comments from other pathologists. In addition, the pathologist on call was asked to mark a diagnosis as final if in his or her opinion, a diagnostically conclusive response was possible based on the submitted material.

In phase II, from November 2002 to December 2003, a total of 260 cases were submitted. In 50% of the cases the response time for a preliminary diagnosis was less than 8.5 h (mean 22 h). In 77% of all submitted cases, the pathologist on duty submitted a final diagnosis (see Table 2). The median response time for a final diagnosis was 13 h (mean 31 h). 83% were signed out directly by the pathologist on duty without further consultations, but in 17% a second opinion was requested from the VIRIN. On average, these cases received 3.7 comments from the VIRIN and for the cases discussed in the VIRIN a final diagnosis was available after 74 h (the median response time).

It is noteworthy that from the 94% of cases where a consultation was possible, only 77% were signed out with a final diagnosis. In other words, in 6% of the submitted cases the material was not sufficient for any kind of medical interpretation. The main reasons were technical problems or communication failures. For a further 17% of all cases, a preliminary medical interpretation was possible, but the material submitted did not suffice for the experts to reach a conclusive diagnosis.

Discussion

Telepathology dramatically reduces the time from specimen collection to results. Now that the system in the Solomon Islands has been established, it is fast, convenient and cheap. The relatively quick results are a great relief for the patients, and for the relatives who are responsible for providing food and basic services for the patients while they are in hospital. The rapid results are also very helpful for the doctors and help to overcome the professional isolation which is a problem in remote places like the Solomon Islands. In particular, the direct interaction with the remote pathologist is a great benefit for the surgeons in Honiara. Finally, any reduction in hospitalisation time should reduce costs and pressure on bed space.

The two years of using the system have shown several advantages of the hybrid system:

- consultants mainly work with the web-interface and thus they can see all the

cases and comments, and can easily identify difficult cases, e.g. those that have been erroneously submitted twice. Probably the most important advantage is that the experts can collaborate easily and discuss difficult cases within the expert group

- for submitting cases and receiving reports, the email interface has proved to be very time- and resource-efficient. The email interface does not implement all functions, but there is always the possibility of looking up all previous consultations using the web interface
- system administration is very simple. Most settings can be adjusted by the users themselves.

There are also some disadvantages and limitations. Some training of the consultants is necessary for their proper collaboration in a virtual institute. The time necessary to organise and train the experts should not be underestimated. Besides, there are some limitations that are inherent in all types of store-and-forward telepathology. The main problem is that it is possible for the operator in Honiara to miss areas important to the pathologist when taking pictures from the slides. This could be a pitfall, although a comparison of the telepathology diagnosis with the diagnosis based on reviewing the original glass slides has shown that in our series this is not a serious problem in practice (unpublished data).

In addition, taking pictures, processing and sending them takes some time, and therefore it needs dedication. Thus it is important that the benefits are clearly visible in Honiara. Another specific limitation lies in the remoteness of Solomon Islands - it is much more difficult to get broken equipment repaired than in Europe. It is therefore important to choose equipment for robustness rather than performance.

There are also some areas that need to be improved:

- a major limitation is the insufficient laboratory space that is available in Honiara. However, now that the positive results of the project have become obvious, it will be much easier to convince the hospital administration of the importance of such a laboratory
- a substantial number of samples are still sent to the pathology laboratory in Brisbane and it would be helpful to improve that collaboration. For reasons of quality control and ongoing training, a collaboration with a relatively nearby pathology institute would be very desirable
- besides histology there is a major need for cytology. It would be desirable to develop sampling procedures that allow an acceptable level of tele-cytology quality control for cytological diagnosis without a resident specialist
- a fully automatic scheduling system needs to be developed for the telepathology software (iPath). This should include adjustable, automatically supervised time limits for each sub process (first response, final diagnosis) so that if an expert does not respond, another expert or an administrator is automatically informed. Such supervision would prevent some cases from being overlooked.

Our experience is that it is not difficult to produce good quality slides in a simple histology laboratory and send them by email to an expert on the other side of the world to provide a diagnosis. Once set up properly, this is cheap and reliable, and would be useful for remote places where there is no histopathology service.

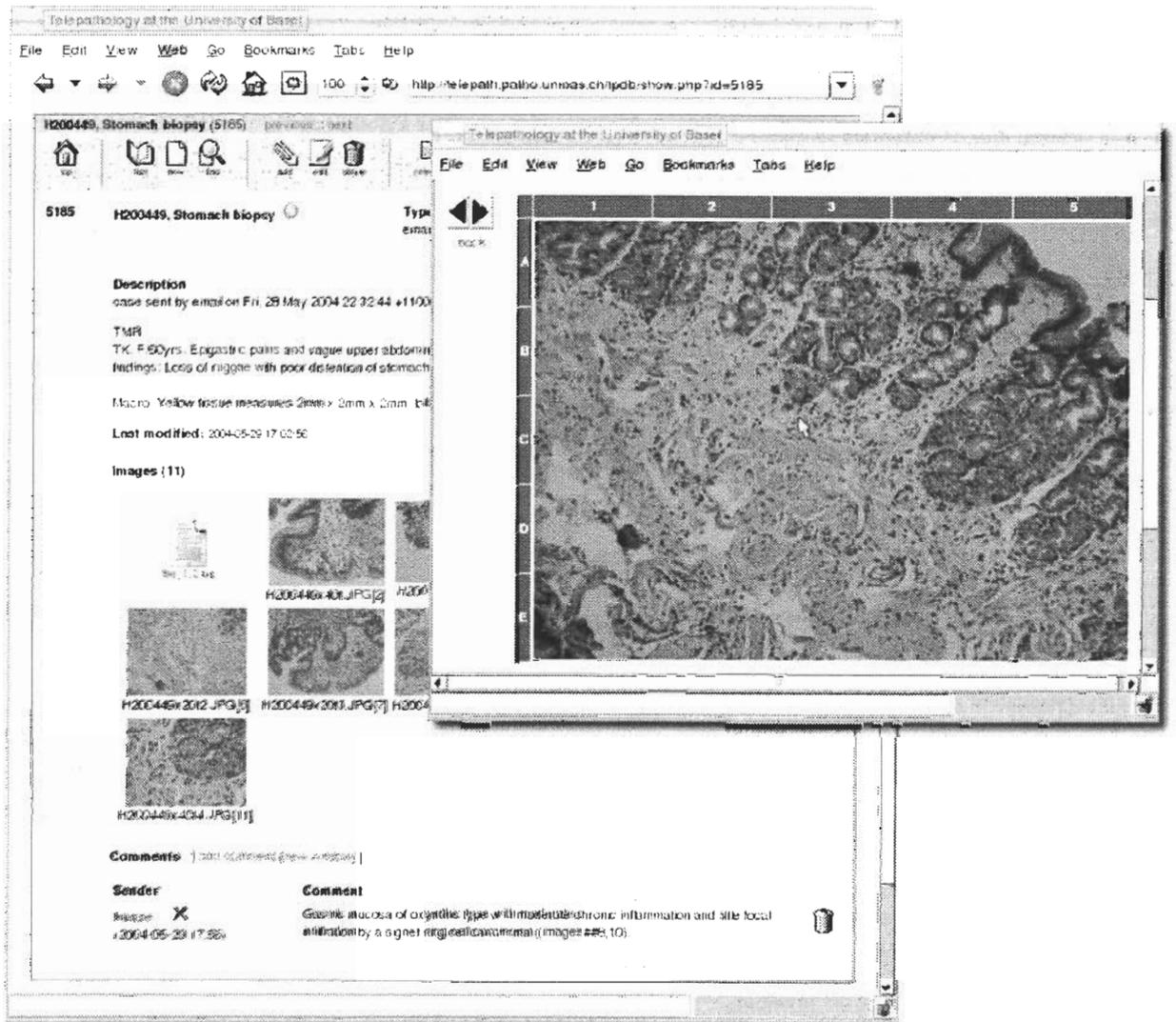
Acknowledgements

We thank Ana and Mike of the laboratory team at the NRH for their dedication and production of excellent quality slides. We also acknowledge the "Verein Meidzin im Südpazifik" and the Stanley Thomas Johnson Foundation for financial support of the project, and the University Computing Center (URZ) for their technical support.

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Fig 1. The iPath web-interface. Every case consists of a header with information about the sender, date, title, followed by a clinical description and an image gallery. Images can be enlarged and the experts can enter their comments and diagnosis at the bottom of the page.



Implementation of a web based teleradiology management system

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Summary

Five Queensland hospitals have been equipped with PACS. Patient transfers from one facility to another involve transferring images from PACS to PACS. We have developed a web-based Teleradiology Management System (TMS) that automates the tasks of image and radiologist report transfer, and quality control and housekeeping associated with teleradiology. The TMS was installed at all five hospitals. During a two-month study period, a total of 752 studies were transmitted between them. All studies and associated radiologists' reports arrived correctly at the destination hospital, together with the notification email for the system administrators. PACS support personnel agreed that the TMS significantly reduced the amount of time they spent on image transfers. Staff at the busiest site estimated that image transfer times had decreased from 10 hours per week of staff time to 1 hour per week.

Introduction

Picture Archiving and Communication Systems (PACS) have recently been installed at five Queensland hospitals, namely the Royal Brisbane and Women's Hospital (RBWH), the Royal Children's Hospital (RCH), the Princess Alexandra Hospital (PAH), the Prince Charles Hospital (TPCH) and the Townsville Hospital (TTH); the first four hospitals are located in Brisbane. All hospitals are now filmless. There are frequent patient transfers between these hospitals and the need to transfer the patient's radiological history when their care was transferred from one facility to another was recognised long before the implementation of PACS. Prior to PACS this was achieved by transferring the film packets via courier or post. With the introduction of filmless hospitals it became necessary to transfer images and radiologists' reports electronically.

The tools provided by the PACS manufacturer can be used to transfer images from one PACS to another. However, various problems prevented this being done efficiently:

- the Patient's Medical Record Number (MRN) was not unique across Queensland. Therefore it was necessary to append the hospital prefix to make the MRN unique, e.g. PAH123456
- routing of images is based on the name of the modality station producing them. It was found impossible to maintain a table of all modalities for all PACS hospitals that could be used for automatic image routing. Thus the station name had to be set manually, prior to image transfer, to include the hospital name
- the radiologist's report could not be transferred electronically from PACS to PACS, and it was necessary to print it and fax it at time of image transfer
- for quality control reasons PACS administrators needed to notify, by email, their colleague at the receiving hospital
- because of the steps required, image transfer could only be performed during the office hours of the PACS Support Unit.

For successful teleradiology to be implemented it was necessary to have a means of image transfer that:

- automated the manual steps of image transfer to reduce the time required of the PACS administrator
- reduced human error in image transfer, so images were automatically routed to the intended clinical recipient
- allowed transfer of images outside normal office hours.

We have developed and implemented a web-based Teleradiology Management System (TMS) to improve the teleradiology service.

Methods

The TMS was installed at the five PACS hospitals and all image transfers requested by clinicians were dealt with using this system during March and April 2004. The TMS transferred the full DICOM image set and radiologist's report from PACS to PACS. The existing PACS infrastructure was used to route, archive and display the images. PACS support personnel at each site were asked to estimate the reduction in their time to complete image transfers compared to using the tools provided by the vendor.

System overview

The TMS was implemented using a series of web pages for both the image transfer and configuration of the system at each site. The system performs the following functions:

- image transfer
- radiology report transfer
- automatic updating of a patient MRN to create a unique MRN
- automatic updating of the details necessary for clinical routing of images
- email notification for quality control purposes.

The transfer of images can be initiated by a web browser remote to the PACS Support Unit to allow other authorised personnel to transfer studies, see Fig 1.

One of the early limitations of electronic transfer of medical images was a lack of availability of the radiologist's report on viewing the studies at the destination facility. To overcome this limitation, the report text is converted to a DICOM image when the transfer is initiated. At the time of the image transfer an email notification is sent to the destination site informing the PACS Support Unit of transfer details including:

- patient details (name, ID, date of birth)
- study details (accession number, description, number of images)
- contact details (who requested the study).

This allows the PACS Support Unit to confirm the arrival of the study and that all images have been received. Each site configures all destination hospitals on their TMS, details including:

- description
- DICOM application title
- IP address
- addresses for recipients of email notification messages.

This is done by completing an HTML form on one of the transfer web pages, Fig 2. The PACS Support Units at each site can thus keep the destination lists up to date. Short-term changes due to upgrades, system outages and personnel changes can be accommodated easily.

Technical details

Image delivery takes place via the Queensland Health intranet. This network connects the health care sites using ATM (Asynchronous Transfer Mode) at speeds ranging from 4 Mbit/s (PAH – TTH) to 155 Mbit/s (PAH – RBWH). Each PACS site has a core installation comprising an Apache Hypertext Transfer Protocol (HTTP) server [1] and the Windows port of Perl by ActiveState Corporation [2]. The Apache HTTP server is installed on an existing PACS computer at which is typically a Pentium III 1 GHz (or greater) PC running Windows 2000 Professional Operating System.

The TMS comprises Common Gateway Interface (CGI) scripts written in Perl, Javascript, Cascade Style Sheets (CSS) and a collection of Perl Modules. These include modules for database functions, Hypertext Markup Language (HTML) functions, common data conversion functions and a module to convert the report text to a DICOM image.

Each site is configured with site-specific information, maintained via CGI scripts. Access to the system is limited to valid users by username and password authentication. The transfer CGI script consists of four main parts, image transfer, report transfer, email notification and update of image details. When called, the CGI script connects to the PACS system (Impax 4.5 AGFA) via an Open Database Connectivity (ODBC) connection and studies are then selected using an HTML form which is dynamically generated from the return of all available studies for a particular patient.

The HTML form allows entry of contact details of the doctor who requested the image transfer and selection of the destination site from a drop-down list. The transfer of the DICOM data sets is initiated by calling PACS command line utility for each study to be transferred. The DICOM fields Station Name, Institution Name, Department Name and Patient ID are altered so that the destination PACS site treats each site as an individual modality for automatic image routing purposes and ensuring that the patient MRN is unique.

The transmission of the report text as a DICOM image follows successful image transfer. The Report Text for each study to be transferred is acquired as plain text via an ODBC connection to the PACS Broker (Mitra). This plain text, along with Patient demographic information, is written to a Portable Greymap (PGM) image file. The PGM file is then converted to a DICOM pixel data file using Perl. A DICOM header is generated for each study, merged with the pixel data and the resultant DICOM file is transferred to the destination site using the StoreSCU utility from the Offis DICOM Toolkit (DCMTK) [3].

To complete the image transfer process an email notification is automatically sent to the PACS Support Unit personnel at the destination site identified in the transfer configuration CGI script. Successful completion of each step is noted on the web page used to perform the transfer, Fig 3.

The workflow between hospitals was audited for the period 1st March to 30th April 2004.

Results

During the study period, a total of 752 studies were transmitted between the five sites using the TMS, Table 1.

Table 1. Total number of studies transferred in March and April 2004 using the TMS.

From	To			
	PAH	RBWH/RCH	TPCH	TTH
PAH	–	61	11	1
RBWH/RCH	97	–	287	13
TPCH	36	162	–	0
TTH	42	42	0	–

All 752 studies and associated radiologists' reports arrived correctly at the destination hospital, together with the notification email for the system administrators. The transmission speeds of 177 studies transferred during a two-week period were analysed. The time taken for transfer was proportional to image size, Table 2.

Table 2. Image transfer times for a sample of 177 studies.

Studies	Image transfer time (s)		
	Minimum	Maximum	Average
Computed radiography (60 studies)	2.3	44.0	11.0
Computed tomography (67 studies)	0.5	1.6	0.8
Magnetic resonance (15 studies)	0.5	1.3	0.8
Ultrasound (7 studies)	0.9	1.7	1.2
X-ray angiography (28 studies)	0.7	1.4	1.0

There was no capital outlay and no recurrent costs for implementation of the TMS, as all sites installed it on existing PACS hardware and the software was developed using free licence products. PACS support personnel agreed that the TMS significantly reduced the amount of time they spent on image transfers. Staff at the busiest site, RBWH, estimated that image transfer times had decreased from 10 hours per week of staff time to 1 hour per week.

Discussion

Since implementation of the TMS all images have routed correctly because of the automatic update of the station name in the DICOM header of images. Human error in updating this field was a significant problem in the previous manual system. The transmission speed was considered acceptable because the TMS was used in parallel to patient transfers and not as a real-time teleradiology system. During the study, there were two periods when image transfers were significantly delayed. These occurred when the sasser worm and Blaster virus infected Queensland Health's intranet.

Significant confusion has occurred to clinicians searching the local PACS for the transferred images, because they are recorded under the sending hospitals MRN. This has been addressed by training and Queensland Health's plan to implement a statewide MRN will obviate this confusion in the future. By making image transfer possible via a simple web-based user interface, late-shift radiographers can perform image transfer with little training. This has allowed after-hours transfer to occur. Converting the radiologist's report to a DICOM image file and attaching it to the corresponding images has eliminated problems associated with lost faxes.

The implementation of the web-based teleradiology system has successfully addressed the problems associated with the manual transfer of images. It has reduced the staff time required to perform the transfers, improved accuracy and allowed a transfer service to be offered after hours.

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Fig 1. User interface to the transfers web page

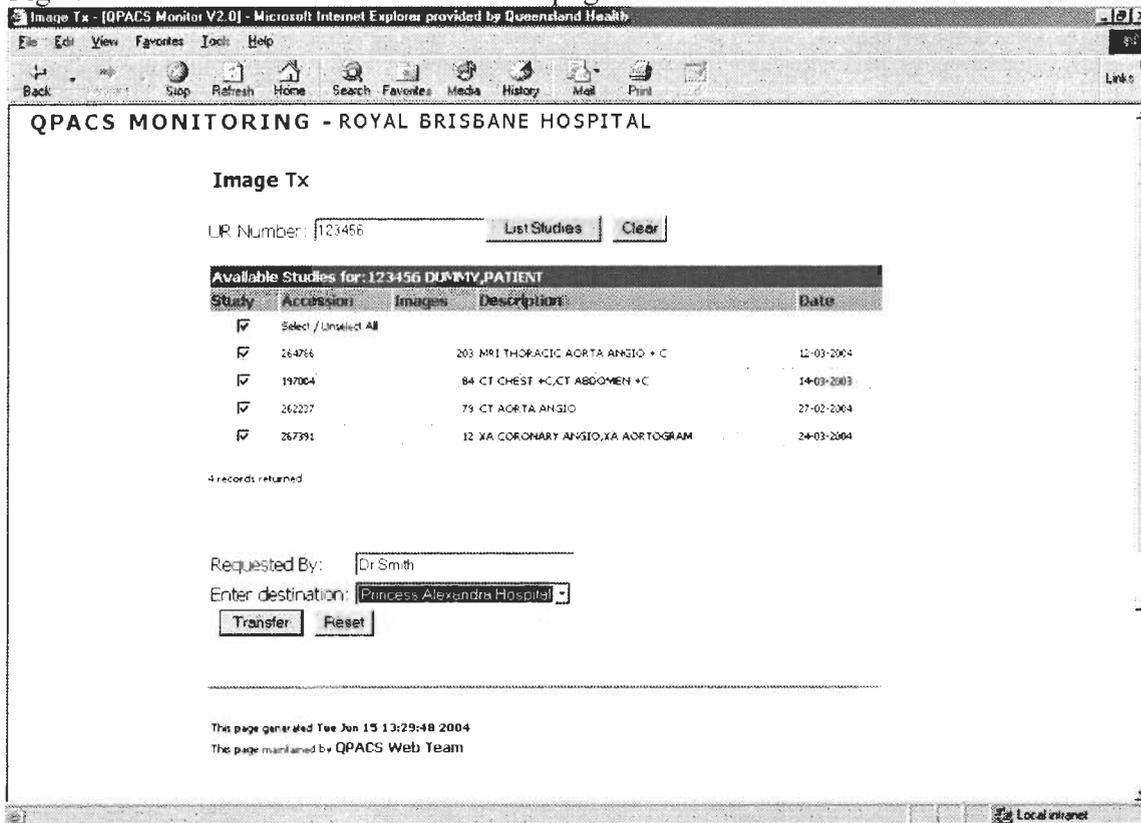


Fig 2. Method of configuring destination sites.

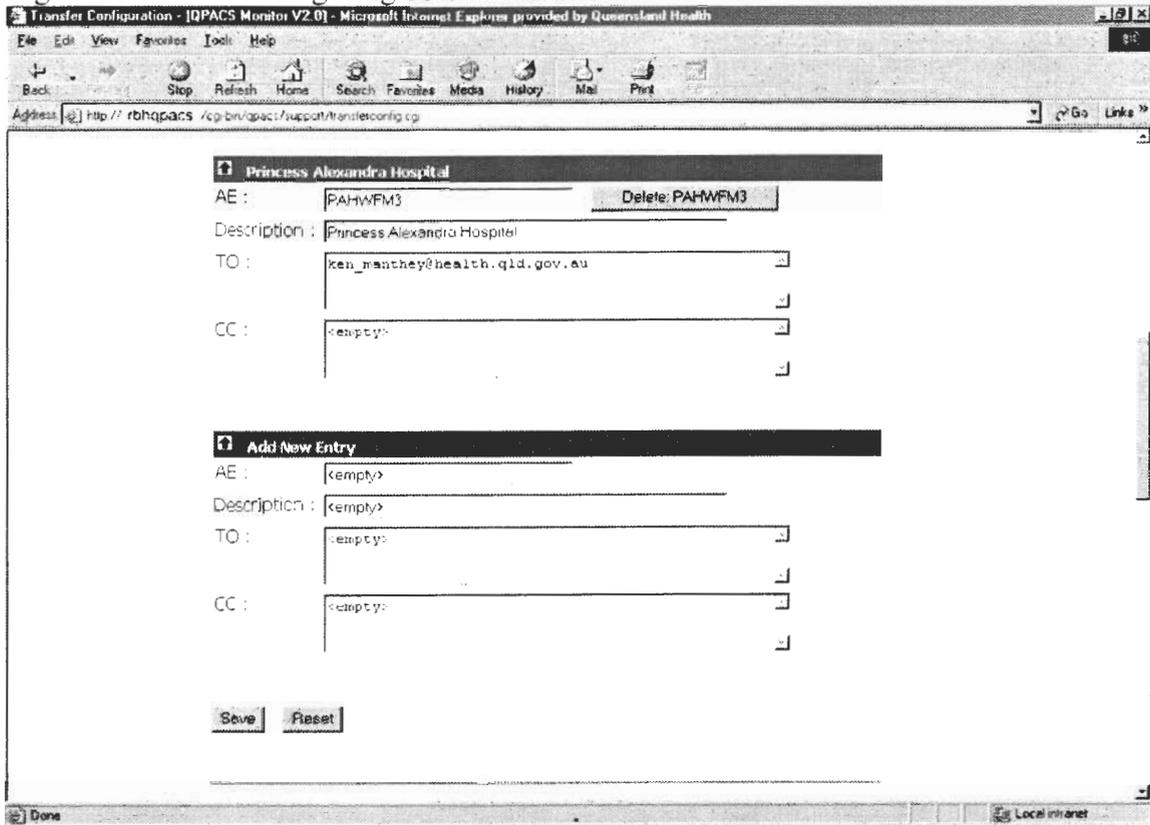
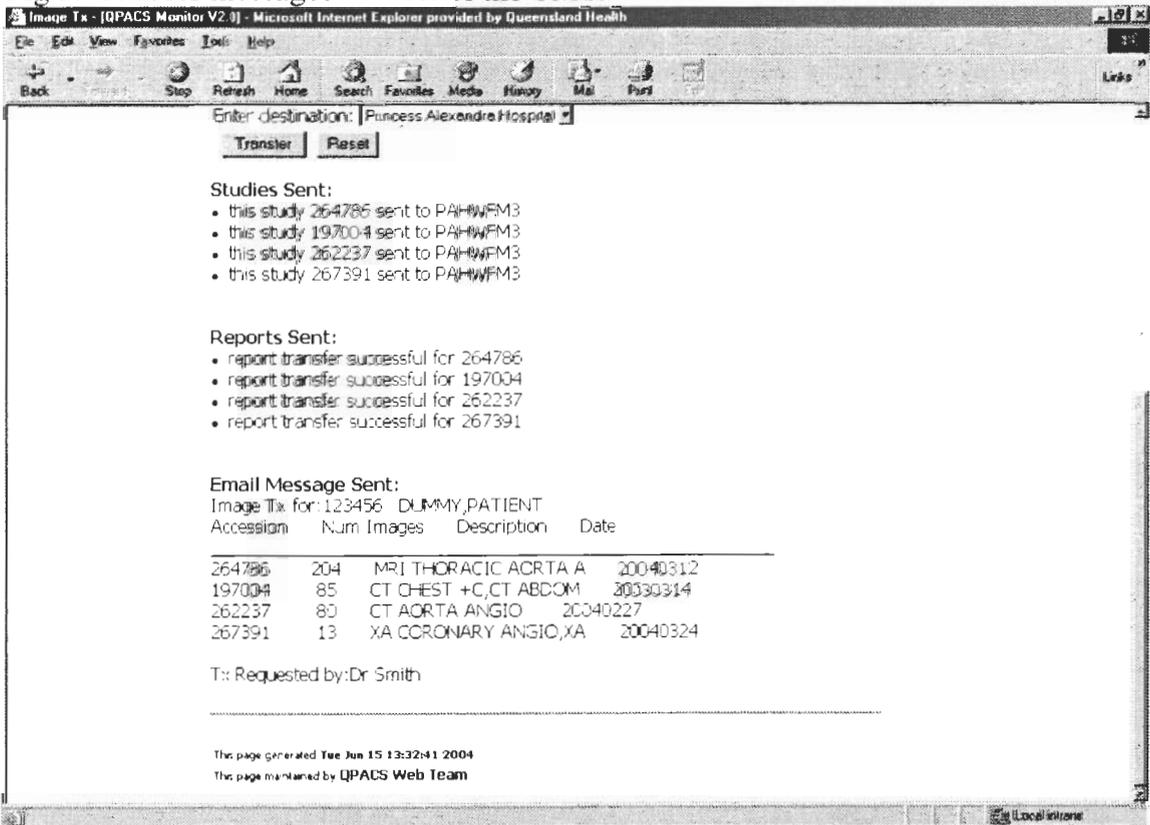


Fig 3. Success messages for user of the TMS.



Automatic message-handling for a national counselling service

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Summary

An automatic email handling system was introduced at a national counselling service in Australia. In 2003, counsellors responded to a total of 7421 email messages. Over a period of 9 days in early May 2004 the administration person responsible for the management of the manual email counselling service recorded the time spent on managing email messages. The automatic email handling system was then introduced. Since the implementation of the AutoRouter the administration person's management role has become redundant; an average of 12 hours and 5 minutes per week of staff time has been saved. There have been further savings in supervisor time. Counsellors were taking an average of 6.2 days to respond to email messages (n=4307), with an average delay of 1.2 days from the time counsellors wrote the email to when the email was sent. Thus the response was sent on average 7.4 days after receipt of the original client email message. A significant decrease in response time has been noted since implementation of the AutoRouter, with client responses now taking an average of 5.4 days, a decrease of 2.0 days. Automatic message handling appears to be a promising method of managing the administration of a steadily increasing email counselling service.

Introduction

The Kids Help Line (KHL) is a free, 24-hour telephone, online and email counselling service for young people in Australia aged five to 18 years. The majority of counselling takes place by telephone – 1.1 million telephone calls were received in 2003 [1]. The KHL has been counselling young people by email since September 1999. The number of email messages received has steadily increased and in 2003, counsellors responded to a total of 7421 email messages. These messages were handled manually, a process which became steadily more and more resource-intensive.

Manual handling of email messages

An administration employee managed the process. Email messages were downloaded to a computer in the administration office, distributed by paper copies to the counsellors, and responded to by counsellors using a word processor (Word, Microsoft). The Word document was opened, copied and pasted into the email program and then sent from the computer in administration. The administration employee also looked up an archive of email messages to see if there was an existing relationship between each client and a particular counsellor. This was used to determine who should respond to a message.

Manual email handling consumed a substantial proportion of one full time employee staff resource. There was also a significant delay between the time that a counsellor responded to an email message and the time that the message was sent to the client.

Counselling supervisors were responsible for collecting the paper copies of email messages, reading and prioritising them, then distributing them to the appropriate counsellor. The supervisors recorded each email in a logbook, so that the counsellors could sign off when they responded to an email. The supervisors were also responsible for the management of the email counselling service over the weekend. While managing the service they had to come off the counselling floor and go to the administration office where the emails were kept. During this period the supervisors were not available to the counsellors.

AutoRouter

An automatic email handling system, the AutoRouter, was first developed for the Swinfen Charitable Trust (SCT) telemedicine network[2]. The SCT provides, via email, specialist medical opinion on cases sent from doctors in the developing world. The AutoRouter allows all incoming emails and responses to be channelled through a single point, making case allocation, auditing and usage statistics much easier to manage. It also allows central archiving of emails and responses.

The original AutoRouter concept was extended by incorporating a web-based graphical user interface (GUI) to:

- allow KHL supervisors to see outstanding cases, assign priority, delete spam messages and send automatic responses to clients acknowledging the receipt of their email
- allow KHL counsellors to read and reply to client emails
- view usage statistics online
- perform housekeeping operations, such as adding a new counsellor.

The AutoRouter works on a thirty second cycle. On each cycle it polls a POP3 email server and writes any new client email messages to a database. It also assigns a counsellor to the case, if there is already a relationship between the client and a counsellor. An HTTP (Hypertext Transfer Protocol) web-server with ODBC (Open Database Connectivity) linked to this database serves up a number of web pages by way

of Perl CGI scripts. These web-pages are the GUIs used by KHL staff. The architecture is shown in Fig 1.

Instructions related to an email and reply messages are written back to the database via KHL staff interacting with these web pages. Examples of such instructions include the delete, reply and re-send functions, Fig 2. On each cycle the AutoRouter engine selects the email messages which have been flagged as requiring action and then performs the relevant action, e.g. sending a reply to client. The AutoRouter also collects statistics automatically at midnight, and sends a daily status report by email to the system managers (supervisors).

Live operation

After development during 2003, the KHL carried out an eight-week trial of their AutoRouter where two counsellors performed email counselling using the system. On 17 May 2004 the system was put into full live operation, with over 50 counsellors using the system for email counselling.

Methods

Over a period of 9 days in early May 2004 the administration person responsible for the management of the manual email counselling service recorded the time spent on managing email messages. Following live operation of the AutoRouter, this was repeated. Supervisors were asked to estimate how much time was spent on manual handling of email messages prior to the implementation of the AutoRouter. They were also asked to estimate how much time was spent away from the counselling floor managing the email system at weekends, both pre and post implementation of the AutoRouter.

KHL used a separate database to record non-identifying statistics about the manual email service. Six months' response time data from this database was coupled with data collected over a 16 day period to identify the delay between the counsellor replying to the email and the administration person actually sending the response to the client. This was compared to the response time data that is automatically collected in the AutoRouter database, Fig 3.

Results

Time spent on processing emails manually

Administration time. Over the period of 9 days the administration person spent an average of 2 hours and 27 minutes per day managing email messages manually. Since the implementation of the AutoRouter the administration person's management role has become redundant. An average of 12 hours and 5 minutes per week has been saved.

Supervisor time. The supervisors reported that an average of 30 minutes per shift was being saved with the new system. This totalled on average 8 hours per week. Supervisors still dedicate a part of their shift to email messages but this workload is now distributed evenly between supervisors on different shifts throughout the day. Previously supervisors rostered on morning shifts would receive the majority of the workload as the email messages were downloaded by administration in the mornings.

At weekends, supervisors spent an average of 2 hours per day dealing with email away from the counselling floor and unavailable to counsellors. This time spent away from counsellors has now been eliminated.

Email response time

KHL counsellors were taking an average of 6.2 days to respond to email messages (n=4307), with an average delay of 1.2 days from the time counsellors wrote the email to when the email was sent. Thus the response was sent on average 7.4 days after receipt of the original client email message. A significant decrease in response time has been noted since implementation of the AutoRouter, with client responses now taking an average of 5.4 days, a decrease of 2.0 days.

Discussion

The efficiency of the email counselling service is analysed every week by the KHL Call Centre team. If the number of email messages waiting to be replied to, and the email response times reach an unacceptable level, then rostered counselling email hours are increased. This practice has an effect on the email statistics, as the recorded response rates dropped significantly during higher rostering periods (Fig 3b). The statistics reported in this paper were not adjusted to take into account the rostering changes. The time delay between counsellors writing the message and the email being sent (1.2 days) is an accurate index of the minimum time saved following the implementation of the AutoRouter.

Due to the ubiquitous nature of web applications, counsellors and supervisors can access the AutoRouter email system from anywhere in the building. Previously, the workflow of the manual handling of emails restricted receiving and sending emails to office hours (08:30 to 16:30). In effect this would delay the email response being sent to clients to office hours as well. Since the AutoRouter is available at any time of the day from any workstation, email messages are sent as soon as they are written.

Although counsellor time was not recorded, the counsellors have reported a significant reduction in time spent manually handling the emails. Prior to implementation of the new system, counsellors had to leave their workstations to collect email messages and to return emails to administration for sending. Paper copies of email messages were kept in a filing system in which each counsellor had a dedicated pigeonhole. Counsellors collected their emails, signed a logbook, returned to their workstations, answered the emails in Word and returned these to the administration person for sending. Counsellors also had to file the paper copies of the emails in a filing cabinet. Counsellors referred back to this filing system when they had to recall a previous email transaction. The counsellors are now able to respond to and access previous emails from their workstation, Fig 4. This has saved a significant amount of time that was spent on the manual handling of the emails.

Implementation of the AutoRouter has also resulted in the job of prioritising emails being distributed between supervisors and counsellors. Using the manual handling of email, supervisors had the responsibility of reading every message that came into the service for priority before distributing them to counsellors. With the AutoRouter,

ongoing emails are automatically distributed to the clients' counsellor; this has allowed counsellors to prioritise their own emails consequently reducing time supervisors spend on this task.

Automatic message handling appears to be a promising method of managing the administration of a steadily increasing email counselling service.

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Fig 1. Architecture of the KHL AutoRouter.

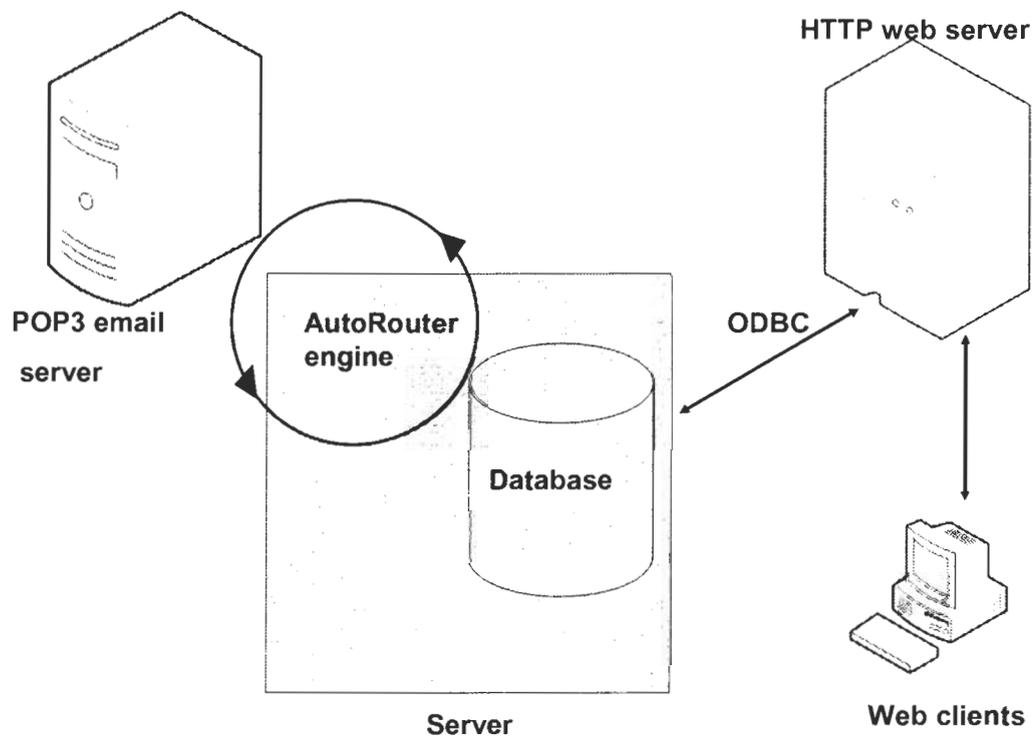


Fig 2. Screen shot of KHL AutoRouter message screen showing the actions that a counsellor can perform on a message

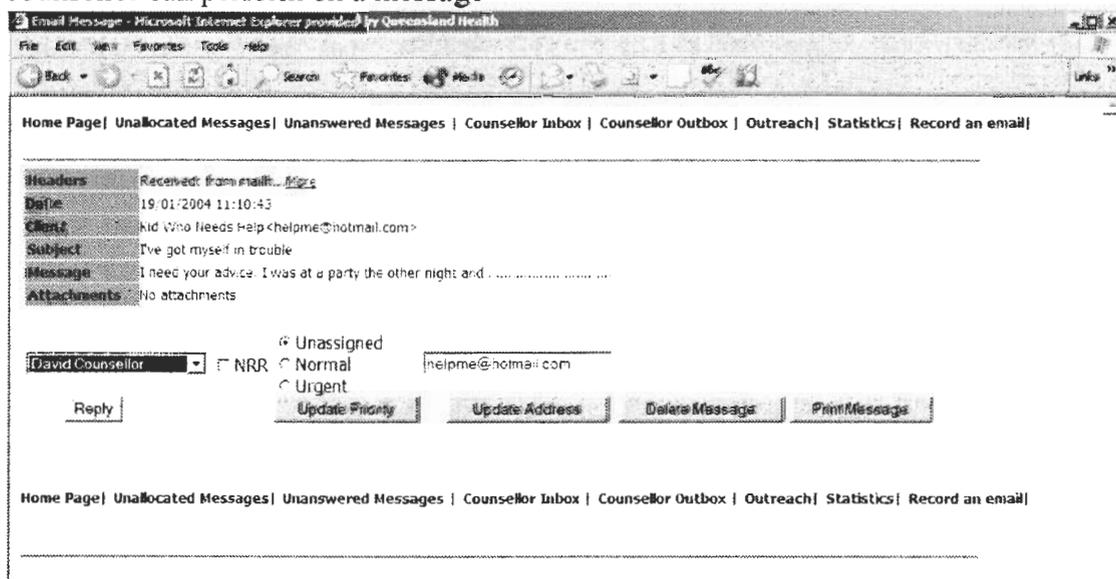
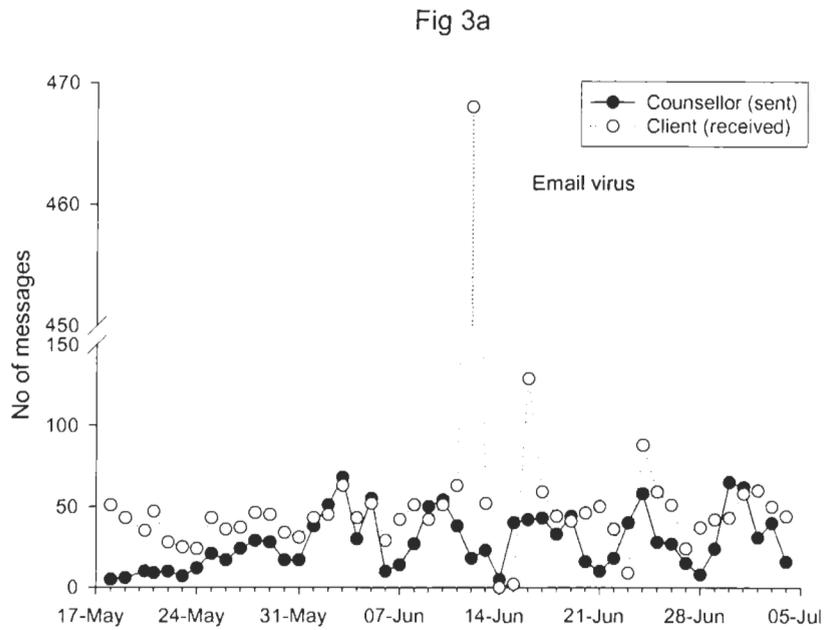


Fig 3. Statistics collected automatically during the first seven weeks of live operation. (a) numbers of messages sent and received. The peak in the number of messages received on 12 June 2004 was due to an email virus



(b) median interval between client messages arriving and counsellor responses being sent

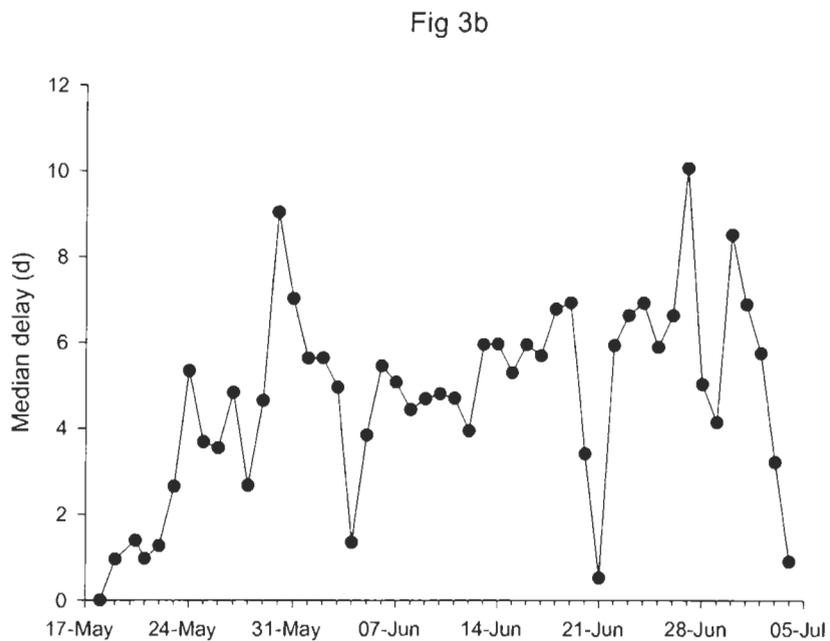
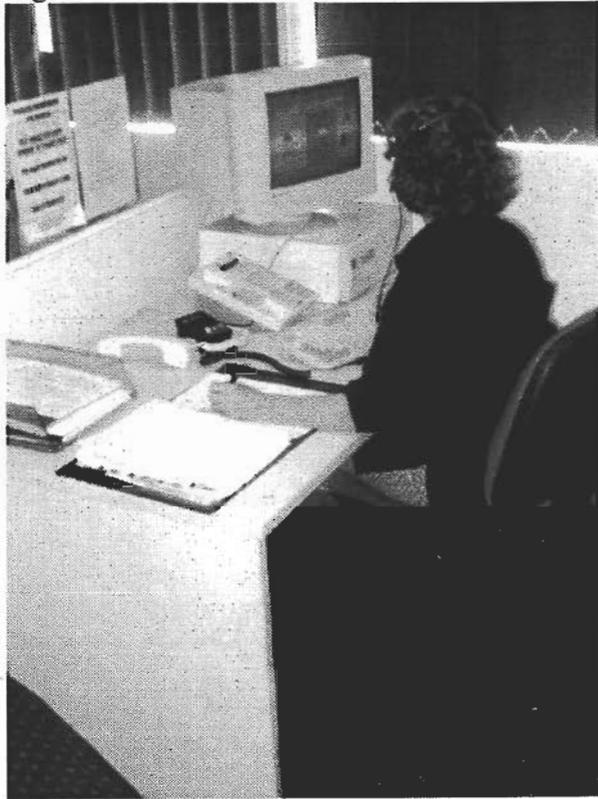


Fig 4. Work environment of a KHL counsellor



Implementation of a RIS/PACS and an image transfer system at a large public teaching hospital – assessment of success of adoption by clinicians

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Summary

In 2001 a RIS/PACS system was installed at the Princess Alexandra Hospital (PAH) in Brisbane, with electronic image transfer links to other major hospitals in Queensland. An assessment study is being performed of the effect of the ready availability of radiology results on clinicians, clinical decision making and the time taken to treat patients. A series of structured interviews with senior clinicians at the PAH began in July 2002. Administrative data are being collected from the PAH computer system. Preliminary results from the first six months of the study suggest that the introduction of RIS/PACS at the PAH has been well received by senior clinicians and has been helpful in clinical decision making. Patient management has been improved and the time taken to arrive at clinical decisions has been reduced, particularly in neurosurgery. The RIS/PACS has significantly improved access to imaging resources for teaching due to the ability to retrieve reference images and to project high quality images during teaching sessions. However, the introduction of the RIS/PACS has not improved patient length of stay.

Introduction

In 2001 a RIS/PACS system was installed at the Princess Alexandra Hospital (PAH), a large public teaching hospital in Brisbane. The system provides image transfer links to other major hospitals in Queensland [1]. The supporting information systems at the PAH, are mainly those selected on a state-wide basis by the Queensland Department of Health. The Department of Health is a large organization, employing some 60,000 staff and providing services to a population of over 3 millions. It has tended to take a co-ordinated approach to the implementation of hospital computer systems.

The information systems in use at PAH are as follows:

- Patient Admission and Separation - Homer HBCIS - iSOFT
- Pathology Information System - AUSLAB
- Outpatient System – Cerner OSIM
- RIS/Scheduling - Cerner Millennium RADNET
- PACS - Agfa IMPAX and Agfa WEB 1000
- Cardiology - Philips INTURIS with images stored on CD
- Intensive Care Unit - HP Care View
- Emergency Department - HAS Emergency Department System
- Financial Administration System - LATTICE
- Desktop Services – MS Office (Word/Excel/Powerpoint/Access).

The information systems environment at the PAH therefore consists of a combination of old systems and new systems, such as the RIS/PACS. An assessment study was commissioned of the effect of the ready availability of radiology results on clinicians, clinical decision making and the time taken to treat patients.

Methods

The assessment study involves a series of structured interviews with senior clinicians at the PAH over an 18-month period. The study began in July 2002. Qualitative approaches to assessment include sampling, ethnography, surveys and interviews. The information gained from interviews is being supplemented by the collection and analysis of data from the PAH computer system. The purpose of the assessment study is to determine:

- the effect of the ready availability of clinical results from RIS/PACS on clinical decision making
- the effect of the ready availability of images and reports on clinical communication between registrars and consultants
- the effect of the RIS/PACS on variables such as the time taken to treat patients, length of stay and number of outpatient visits
- the effect of RIS/PACS on clinical teaching and research at PAH.

Results

The present work reports the initial findings in the first six months of the study. The PACS system has reached a stable operating state at the PAH with the introduction of version 4.5 of the IMPAX software. Training of clinicians in the use of PACS has been undertaken and continues. With the implementation of version 4.5, a requirement was identified for additional training of clinicians in new system features, including the ability to set up teaching files.

The majority of PAH clinicians surveyed considered that the introduction of the RIS/PACS had a significant effect on the ready availability of patients' images and reports. The time previously spent searching for missing X-ray films had decreased markedly, with a number of departments reporting savings of up to an hour a day in staff time.

The ability to manage patients transferred to the PAH from other major hospitals in Queensland has been improved, following the introduction of electronic image transfer of patients' images to PAH. Patient management has been improved and the time taken to arrive at clinical decisions has been reduced, particularly in neurosurgery. The level of communication between clinical colleagues was considered to have improved. The RIS/PACS has significantly improved access to imaging resources for teaching, due to the ease of retrieving reference images and projecting them during teaching sessions.

However, the introduction of the RIS/PACS does not appear to have improved patient length of stay. There is also a need to connect the RIS/PACS system to a Clinical Information System (CIS) to allow quality audit and follow up of studies requested by clinicians.

Discussion

A RIS/PACS is a technology which requires a variety of qualitative approaches in its evaluation [2]. The immediate product of a RIS/PACS is information, rather than the outcome of a treatment or procedure. Clinical support systems involve two aspects, the diffusion and uptake of IT-related innovation and the effect on work practices of senior clinicians in a complex area of medical activity, clinical decision making. Assessment outcomes are often qualitative and may rely on the opinions of senior clinicians, rather than quantitative changes in hospital activity statistics.

The introduction of the RIS/PACS at the PAH has been well received by senior clinicians and is considered to have been helpful in clinical decision making and patient management. These findings are consistent with the work of others, such as Reiner [3], McEnery [4] and Tamm [5], who found that RIS/PACS system utilisation indicated a greater availability of image studies and improved time management by clinicians.

Given the frequent transfer of patients between hospitals throughout the State of Queensland, an important aspect of clinician satisfaction at the PAH is the integrated nature of the RIS/PACS with the inter-hospital electronic image transmission system.[6] The successful implementation of the image transfer system has ensured that patients' previous radiology images and reports are made available electronically in a timely manner for review and clinical decision making.

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A cost analysis of a tele-oncology practice in the United States

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Summary

Oncology services have been provided by telemedicine from the University of Kansas Medical Center (KUMC) for almost 10 years. We have analysed the costs associated with providing tele-oncology clinics to a rural Kansas town for two fiscal years, 1995 and 2000. The aim was to compare recent tele-oncology costs with those of the first year of tele-oncology practice. A study conducted in 1995 showed that the average cost was \$812 per telemedicine consultation. Data from fiscal year 2000 showed that the average cost was \$410 per telemedicine consultation, a decrease of almost 50%. As the tele-oncology practice in Kansas continues to grow, it can be expected that the costs associated with providing tele-oncology services will continue to decline.

Introduction

Providing cancer care via telemedicine for patients in rural Kansas began in 1994. It is now a well-established telemedicine practice, which links an oncologist from the University of Kansas Medical Center (KUMC) with patients at a rural hospital, the Hays Medical Center (HMC) located about 480 km west of KUMC. In addition to service provided by telemedicine, the KUMC oncologist flies to Hays periodically to conduct outreach clinics. The combined telemedicine/outreach practice has been successful due to collaboration between health care professionals from both sites, including oncology-trained nurses, administrative personnel and technical support staff.

While several studies have examined patient and provider perceptions of tele-oncology [1-3], there have been few analyses of the costs associated with providing cancer care via telemedicine. Since the long-term success of any telemedicine practice depends on

its economics, we have examined the costs of the tele-oncology practice in its first year of operation, 1995, and, more recently, in 2000.

Methods

Numerous individuals involved with the tele-oncology practice assisted in gathering cost data for the analysis. From the HMC, the administrative director of oncology services, the tele-oncology nurses, the office manager and the telemedicine coordinator collaborated with the assistant director of telemedicine and the oncology services office manager from the KUMC to track expenses. Cost tracking instruments developed for the original study[4] were used to collect data for the fiscal year 2000 (FY00).

Expenses unique to providing telemedicine services – technology-related costs – included such items as the cost of the telemedicine room, telemedicine equipment, telecommunication line charges, technical personnel and miscellaneous supplies. Most expenses for the service fell into the ‘practice’ category, i.e. those costs that would be associated with running any medical outpatient clinic. These included personnel costs, office rent, and telephone, fax and photocopying fees. Expenses for the practice were born by both the KUMC and the HMC, and were tabulated separately. Only the costs of tele-oncology were considered, not those associated with the outreach service.

Results

In fiscal year 1995 (FY95) the KUMC technology-related expenses were \$8890 and the practice costs were \$5305. Thus the total KUMC expenses for tele-oncology were \$14,195, see Table 1.

Table 1. KUMC tele-oncology clinic expenses (US\$): Fiscal Year 1995[4]

	Technology	Practice
Telemedicine room	547	
Telemedicine equipment	1883	
Line charges	2815	
Equipment maintenance	231	
Technician expense	3414	
Administrative salary		900
Scheduler		2529
Secretarial staff salaries		573
Fax and telephone		449
Photocopying		39
Supplies		185
Network access		34
Office rent		596
Total technical expenses	8890	
Total practice expenses		5305
<i>KUMC grand total</i>		<i>14,195</i>

In FY95, the HMC technology-related expenses were \$3534, while the practice costs were \$65,877. Thus the total HMC expenses for tele-oncology were \$69,411, see Table 2.

Table 2. HMC tele-oncology clinic expenses (US\$): Fiscal Year 1995[4]

	Technology	Practice
Telemedicine room	100	
Telemedicine equipment	2313	
Equipment maintenance	0	
Technician time	72	
Technician training	1049	
Physician contract		46,200
Nursing staff salary		17,144
Administrative expense: nursing		686
Administrative expense: hospital		643
Secretarial staff salaries		0
Billing expenses: oncology nurse clinician		50
Fax and telephone		605
Transcription		549
Total technical expenses	3534	
Total practice expenses		65,877
<i>HMC grand total</i>		<i>69,411</i>

In FY00, KUMC costs related to technology dropped to \$3255, and practice expenses decreased to \$2922. Thus the total KUMC expenses for tele-oncology fell from \$14,195 to \$6177, see Table 3.

Table 3. KUMC tele-oncology clinic expenses (US\$): Fiscal Year 2000

	Technology	Practice
Telemedicine equipment / room	612	
Technician expense	2643	
Supplies		113
Fax, telephone and copier		381
Office rent		332
Scheduler		2096
Total technical expenses	3255	
Total practice expenses		2922
<i>KUMC grand total</i>		<i>6177</i>

In FY00, the HMC costs related to technology rose to \$8433, but practice expenses decreased to \$35,054. Thus the total HMC expenses for tele-oncology fell from \$69,411 to \$43,487, see Table 4.

Table 4. HMC tele-oncology clinic expenses (US\$): Fiscal Year 2000

	Technology	Practice
Telemedicine room	364	
Equipment	1194	
Equipment maintenance	1750	
Technician time	1525	
Line charges	3600	
Physician contract		18,000
Nursing staff		7684
Secretarial staff		7758
Billing costs		660
Fax and telephone		242
Transcription		710
Total technical expenses	8433	
Total practice expenses		35,054
<i>HMC grand total</i>		<i>43,487</i>

During FY95 103 patient consultations were carried out by tele-oncology; during FY00 121 consultations were conducted, see Table 5.

Table 5. Cost per tele-oncology clinic visit (US\$) in FY95 and FY00

	Fiscal Year 1995	Fiscal Year 2000
KUMC costs	14,195	6177
HMC costs	69,411	43,487
Total costs	83,606	49,664
Total telemedicine visits	103	121
Cost per tele-oncology visit	812	410

The cost per tele-oncology visit for the first year of the practice was \$812[4]. In FY00 the cost per visit fell significantly to \$410, a decrease of almost 50%.

Discussion

Financial viability is not easily achieved in a specialty telemedicine clinic of any kind. In the present study, the average cost per tele-oncology visit was higher than ideal, although it has decreased significantly in the last few years. Our analysis documents a significant reduction in cost from the \$812 average cost per consultation in 1995[4]. Furthermore, the costs are offset by the revenue generated from services such as laboratory fees, X-rays and chemotherapy administration for the hospital system when patients remain in their local communities.

There are several reasons that may explain the reduction in costs per visit. First, in common with many technological advances, the technology-related expenses have decreased significantly since the start of the tele-oncology practice in 1994. The equipment (videoconferencing units, electronic stethoscope and document camera) has decreased significantly in cost as a result of more widespread usage. In addition, the

technician expenses decreased as the oncologist and nurses became familiar with the equipment and no longer required the continual presence of a technician for the duration of the clinic. Second, cost is closely linked to workload as evidenced by the fact that many expenses associated with telemedicine relate to personnel rather than technology, i.e. they represent fixed costs. While these costs have not decreased over time, personnel responsibilities have changed. Following the first cost study, job responsibilities were reviewed in an effort to use personnel time – particularly physician time – more efficiently. The greatest decrease in expenses related to reduction in time on the part of the consultant physician and the nurse overseeing the project.

As the practice continues to grow, it can be expected that the costs associated with providing tele-oncology services will continue to decline.

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Development and evaluation of a point-of-care interactive patient education kiosk

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Summary

We have developed an interactive patient education kiosk. The kiosk provides access to stored health information and to selected web sites via a high speed Internet connection. The output is bilingual (English or Spanish) and an enclosed printer allows information to be printed and taken home for later reading. Each kiosk records patient usage, as well as the results of a brief, voluntary, on-line evaluation questionnaire. Three kiosks were placed in the patient waiting area of busy multi-specialty clinics. Two kiosks were active for 2.5 years and one was active for 1.5 years. There were 38,868 user sessions recorded. 2878 users participated in the online survey questionnaire (7% of all user sessions). There was good patient satisfaction, e.g. 68% of respondents found some or all of the information they were looking for on the kiosk. In the year following the introduction of the first kiosk (the 2001/02 flu season), there was a 24% increase in the number of patients receiving flu vaccinations within the Palo Alto Health Care System, compared to the previous year. Experience to date suggests that the kiosks may increase patient compliance with selected clinical guidelines and instructions.

Introduction

It has been estimated that 25,000 health-related sites are maintained on the World Wide Web, originating from an amazing variety of individuals and organizations, and representing widely varying quality and approach [1]. Those who are able to use this resource may benefit, but only if the information they select is accurate and beneficial [2]. Health information on the Internet is of variable quality and patients may not necessarily be able to distinguish truthful from speculative claims. Rational and well-

conceived investments in patient education can lead to healthier and better informed patients requiring less costly medical interventions [3-7], and such patients are more likely to follow their health care providers' instructions [8-10]. Concomitantly, people are often stratified between those who have no or little access to health-related information and those who have easy, extensive information via the Internet [11,12]. We have attempted to equalize this disparity by providing easy-to access and validated health information. As others have acknowledged, "...if the Internet is to be successful in improving the delivery of health care, it must not be reserved only for academic institutions: the process must begin in the doctor's office." [13].

Health kiosk

We have developed an interactive patient education kiosk. The kiosk location is public, as has been attempted in the past by others [14], yet it is designed to provide patient privacy during use (spoken content may be muted). An important feature is the ability for the patient to print vouchers redeemable for clinical care after viewing multimedia, validated content. The care includes diabetic eye and foot examinations, as well as flu and pneumonia shots, and mental health appointments, for suitable patients. The overall aim of the kiosk, besides allowing patients to take control of their health, is to increase compliance with guidelines designed to improve health.

The touch screen kiosk has been designed to have a user-friendly interface between the patient and validated health information (Fig 1). Large radio buttons on the touch screen provide the primary user input tool and both visual and auditory output is incorporated in the content, unless muted by the patient. A printer provides a hard copy of patient-selected information. People can choose their preferred language (Spanish or English) and use the buttons to navigate pre-selected multimedia information on the kiosk's hard drive, or they can choose to view Internet medical web sites (Fig 2). Approximately twenty selected English and Spanish language health-related web sites are accessible, via a high-speed connection. Sites include those providing information on AIDS, heart and lung disease, cancer, urological conditions, several mental health web sites, as well as several general health web sites and the National Library of Medicine site. Material is also available on: diabetes, cancer, disabilities, hypertension, cholesterol, back pain, heart disease, traveller's tips for staying healthy, a complete compendium of medications, herbal medications and drug interactions, as well as an electronic library of illnesses and conditions, explained at an elementary school educational level. The information content can be updated and changed easily by the kiosk administrator.

Three kiosks were installed in the waiting area of the California County or Veterans Affairs clinics. Patient use of the kiosks is voluntary and initiated either at the recommendation of a health care provider, clinic volunteer, or by the patient who notices the kiosk. Evaluation of kiosk usage is largely automatic, built into the systems integration and touch-screen recording software.

Methods

The study was prospective and non-randomized. Kiosk survey results from three different hospital or clinic locations were examined. Survey responses were pooled for all three sites. The survey questionnaire, completed at the kiosk during the time of use,

contains a number of repeated internal validation questions. Statistics on clinical compliance with diabetic eye and foot examinations, and flu and pneumonia immunizations, were provided through the medical record database (coding evidence). We also conducted random chart reviews on a small number of patients receiving care at a given clinic. This was only possible at the VA sites (two kiosks).

The study protocol was approved by the appropriate ethics committees, and privacy and research statements were included in the opening page of the kiosk.

Results

The three kiosks were in place for 2.5 years. Two kiosks were active for the entire period and one was installed a year after the original devices, i.e. two devices were active for 2.5 years and one was active for 1.5 years. There were 38,868 user sessions recorded. 2878 users participated in the online survey questionnaire (7% of all user sessions). Respondents did not have to answer all questions if they did not wish to, however users averaged 1873 responses for each question in the survey. The results showed that 73% of kiosk users were doing so for the first time and that 70% were using the kiosk at their own volition, rather than at the recommendation of their doctors or staff.

Patient reactions to the kiosks were positive:

- 84% of respondents thought that the kiosk was generally well located
- 82-84% (repeat internal validation questions) said the instructions for the kiosk were easy, or fairly easy, to follow
- 90% of respondents stated that the information on diabetes was helpful to them
- 68% of respondents found some or all of the information they were looking for on the kiosk
- 85% said they would use the kiosk in the future
- 71% of people said that the information on the kiosk was helpful in understanding their health
- 87% of people said the clinic had more to offer because of the patient education kiosk
- 82% said it was very likely (56%) or somewhat likely (27%) that what they learned at the kiosk would help them follow a health provider's advice.

In the year following the introduction of the first kiosk (the 2001/02 flu season), there was a 24% increase in the number of patients receiving flu vaccinations within the Palo Alto Health Care System, compared to the previous year, see Table 1.

Table 1. Increase in flu vaccinations dispensed after kiosks were introduced

	2000/01	A	2001/02	B	2002/03	2003/04
No of flu vaccinations given	9724		12,006		13,756	14,028
Change in flu vaccinations from 2000/01 (%)			24		42	44

A First kiosk introduced (Livermore)

B Second kiosk introduced (Monterey)

This increase continued in the 2002/03 flu season. In general, those sites in greatest compliance with selected clinical guidelines were those where kiosks had been installed, see Table 2.

Table 2. Healthcare provider compliance with selected clinical guidelines (Dec 2002)

Clinic	Diabetic eye examination (%)	Diabetic foot examination (%)	Pneumovax done (%)	Flu vaccination (%)
<i>Kiosk present</i>				
Livermore	89	90	95	75
Monterey	100	100	82	57
<i>No kiosk</i>				
Palo Alto	73	79	80	68
San Jose	79	85	81	66
Modesto	78	88	79	73
Stockton	75	76	74	46

Discussion

The health information presented in the kiosk was developed using tested principles of health education since patient control of certain health variables can affect the clinical outcome of disease [15,16]. Kiosks also offer patients an opportunity to use their free time, around or between appointments, to acquire useful health information. Most patients found the kiosk easy to use and stated that they were likely to use it again.

Allowing patients to print out and take home accurate detailed information for later review, facilitates them retaining and utilizing health-related information. In addition, the printed information can be shared with family and friends, increasing the likelihood that patient caregivers have accurate information for supporting the patient. Most survey respondents found the information useful and felt that the clinic had more to offer because of the kiosk. The kiosk allowed staff to provide their patients with the maximum amount of information during each clinic visit and to ensure that the information was relevant to the patient's needs and interests.

The majority of patients felt they would be more likely to follow the advice of health care providers because of the kiosk, and there was an increase in the number of flu vaccinations after the introduction of the kiosk, although there may have been other factors involved. The kiosk has the potential to make every patient encounter a chance to influence clinical outcome and allow people to have more control over their health.

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Fig 1. A patient using the kiosk (reproduced with the patient's permission)

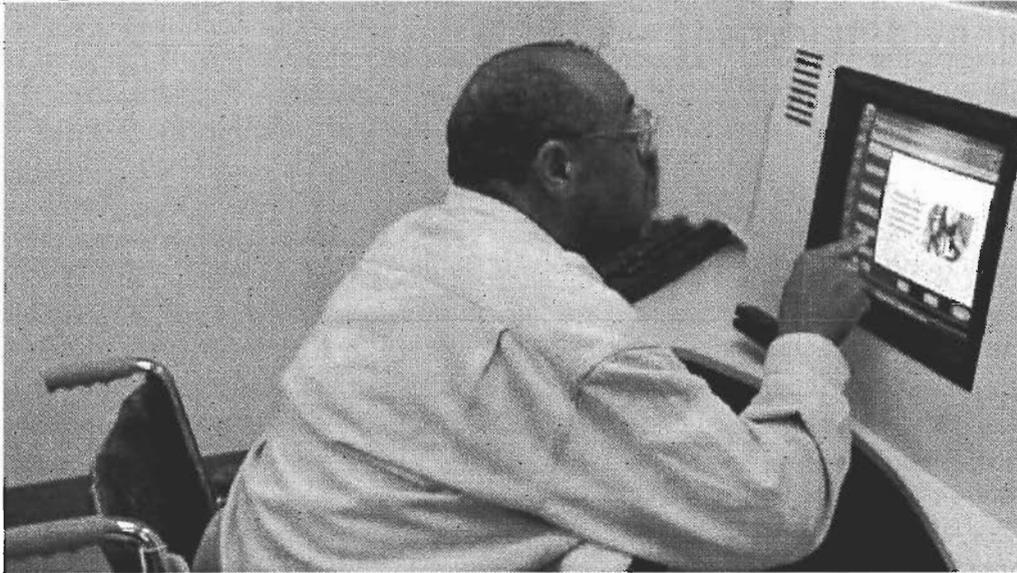
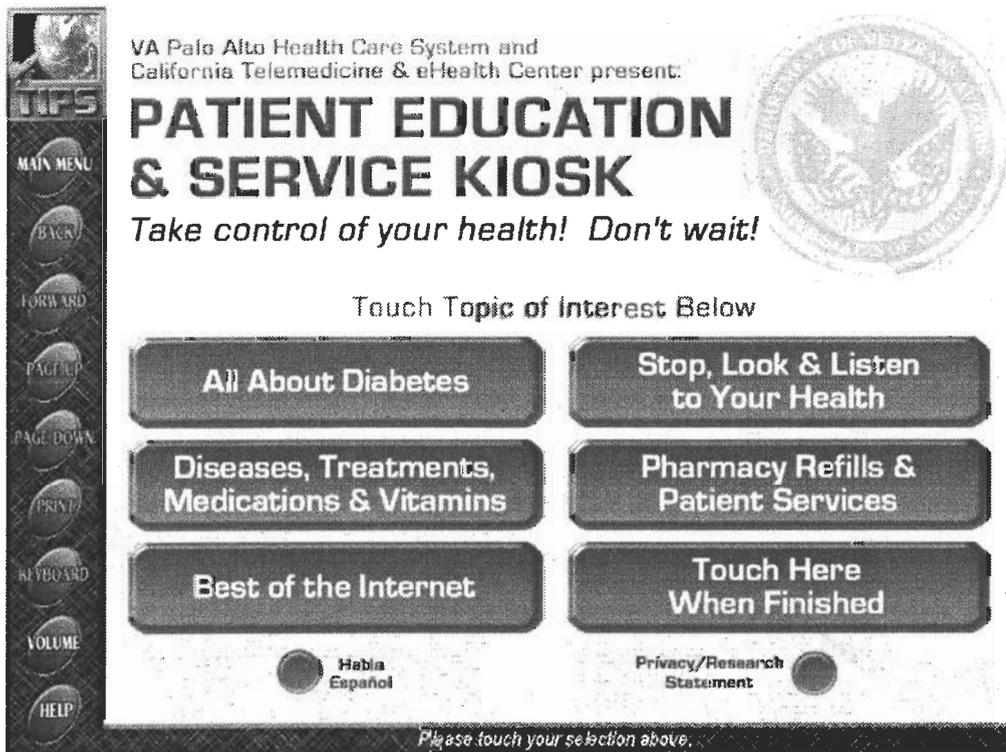


Fig 2. Introductory screen image from the kiosk



A study of the use of hand-held devices in an emergency department

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Summary

In a project conducted in 2002 and 2003, the use of hand-held computing devices was examined in a hospital emergency department in Western Australia. Personal digital assistant devices (PDAs) were used for the wireless development. The study addressed three major issues: (1) development methodology, (2) communication issues between the mobile device and existing databases, and (3) user interfaces. The software was trialled by about 20 healthcare staff including nurses, doctors, administration staff, IT staff and front desk receptionists. The wireless development provided valuable experience to everyone involved. The product is currently undergoing rigorous testing to meet the standards of the healthcare industry.

Introduction

Wireless technology provides increased flexibility in the use of information technology. The costs and complexities of managing patient data are increasing [1] and it appears that wireless technology will enable better access to data and thus provide better services [2]. Previous studies have argued the need for wireless technology in healthcare in terms of solutions to the financial problems affecting many healthcare systems [1], in addressing the increasingly complex information challenges [3], in complying with the rigorous regulatory framework [4], in reducing medication errors [5] and in generating affordable healthcare applications that allow greater mobility and ease of use in entering, sending and retrieving data [6].

While the use of wireless technology can be justified, it should be remembered that it cannot solve all problems encountered in healthcare [4]. Even though the technology is rapidly improving and the cost declining, there are still some disadvantages, including slower speed compared with desktop computers [7], lack of real time connectivity due

to the mobility of the device [8], the limited size of the screens and hence difficulties in displaying data, and few high quality graphic displays [9].

In a project conducted in 2002 and 2003, the use of hand-held computing devices was examined in a hospital emergency department, that of St. John of God Health Care in Western Australia.

Software development

Personal digital assistant devices (PDAs) were used for the wireless development. The PALM series of PDAs was chosen by the healthcare provider in preference to the HP series of PDAs because of the flexibility of the operating systems. At the time of development, various software development environments, especially for data base connectivity, were available for PALM platforms and these matched the preferences of the healthcare provider.

The study addressed three major issues: (1) development methodology, in order to properly integrate the new solution with the existing solution as the existing solution did not meet organisational objectives in terms of data management, (2) communication issues between the mobile device and existing databases, and (3) user interfaces in order to capture accurate and timely data.

Two software development methodologies were chosen, rapid prototyping and the waterfall method:

- Rapid prototyping helped to develop and test the code on a device that was emerging at the time of development, as well as obtain essential and timely feedback from the client. For the rapid prototyping method, an abbreviated representation of the requirements was needed [10]. Only after completion of this abbreviated model, could an abbreviated design specification be created. The design strategy included top-level architectural issues rather than detailed procedural issues. Rapid prototyping also ensured that the functionality of the system was kept separate from the implementation, and the specification was encompassed with the operating environment [11]. Due to the relative newness of the environment, the specifications were kept localised and loosely coupled. This facilitated changes to the coding and module development.
- For the waterfall model, procedural issues were given importance, followed by data flow consideration in order to realise a detailed design. The waterfall model allowed a sequential development procedure as this was essential to mentally map various activities required to complete the project successfully.

These approaches were followed to ensure that the wireless application was developed properly and quickly. A screenshot of a module of the wireless software running on a PALM PDA is shown in Fig 1. Software engineering principles recommend combining approaches in order to deliver better solutions.

Communication

The communication issues involved data access, validation, verification, data capture and transmission. Due to the sensitive nature of the application, it was decided not to write or over-write any data that were available on the main healthcare database. An intermediate tier was therefore developed as a holding platform for the data for various purposes. The data for this development consisted of patient details such as names, specific admission details, details of the doctors and other billing information. These data were written onto the main database only when all the validation was performed. Data were verified by healthcare staff for accuracy and relevance prior to certifying them. Nursing staff could use the PDA to verify the accuracy of the data, Fig 2. As the data were written onto an intermediate tier, the data were not stored on the device. This eliminated security issues associated with the theft of the wireless device.

The communication of data between the mobile device and the main database warranted additional discussion with the IT team in the healthcare setting as there are two main operating platforms available for the handheld devices. The PALM series of PDAs used a different operating system compared with some other devices. While some IT staff in the healthcare setting preferred the PALM devices, other staff were neutral. After discussions with the healthcare managers, it was decided that device-independent code would be developed for the application. Java 2 Micro Edition (J2ME) for handheld devices was chosen as the development tool. A trial run of PDA starting the Java interface and its communication with the main database is shown in Fig 3.

Software trial

The software was trialled by about 20 healthcare staff including nurses, doctors, administration staff, IT staff and front desk receptionists. While the main data capture was performed by the medical staff, receptionists and IT people were involved in accessing the data that emerged from the PALM PDA. The trial lasted for about three months.

The user interface was crucial, as many people were involved in entering the data. It was therefore decided that most of the data capture would be developed in the form of optional buttons and context-sensitive predefined codes, so as to enable users just to place a tick or choose an option. Furthermore, the healthcare staff were restricted in many 'writing' type procedures and provided with data from the main database to minimise any errors.

Data security

Another issue that emerged during the development was the security of data, since it was patient information. It was therefore decided that the handheld devices would not be used to store any data. The device would access the main database to retrieve any data that were needed for the context and once the context was over, the data would be flushed from the device. In addition, the system sent alerts to security people when the handheld devices crossed certain physical boundaries defined by the healthcare provider. Access to any application was secured with two levels of passwords and this also restricted the usage. Only certain healthcare personnel were allowed to access

certain data fields and hence the device was mainly used for the purpose of data entry at the point of care.

Limitations of the project

While the prototype was successful, there were a number of limitations. These included the code, integration with existing applications, user interfaces and data transmission. The code was written to be as generic as possible and parameters were kept as variables to allow flexibility. During real time testing, some of these parameters caused run-time errors, as the compiled code was not able to resolve certain data types prior to the run. This meant revising the code. Integration with existing applications caused concern, as the healthcare partner did not have uniformity across all branches. Thus data redundancy existed, adversely affecting performance. Also the applications developed by the national office followed national standards, while those developed by the local branches followed their own ad-hoc standards. The development environment (Java libraries) used for project development was superior to the existing environment and caused problems while the product was tested in the healthcare setting, as some libraries were not available in the existing environment. These caused minor difficulties while integrating the wireless application with existing applications.

The user interface created confusion as most staff were used to paper and pencil methods of data entry. During the testing, some staff found that the screen of the handheld device was not bright enough and encountered difficulties in reading the forms displayed. The size of the screen of the PDA also prohibited the display of forms in their entirety and this introduced operational difficulties. Memory restrictions on the device also restricted certain operations.

Finally, data transmission introduced certain limitations. The prototype was tested using infrared technology in a closed environment. However, the infrared link created some limitations as it was not possible to guarantee line of sight all the time, due to the layout of the emergency department. On the other hand, Bluetooth technology (another wireless technology) did not provide acceptable levels of coverage. When the project was trialled in other branches, it was not possible to transmit data using wireless technology alone (for administrative purposes such as billing), as some branches of the healthcare were about 400 km from the national office. These issues are being investigated currently.

Conclusion

The wireless development provided valuable experience to everyone involved. The product is currently undergoing rigorous testing to meet the standards of the healthcare industry. Operational difficulties are being addressed in order to prepare the product for implementation. The future development plan includes training staff in the emergency department to use the product and then to study the adoption issues of the product in the specified environment.

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Fig 1. Wireless software running on the PALM PDA along with Java Code on a terminal during testing

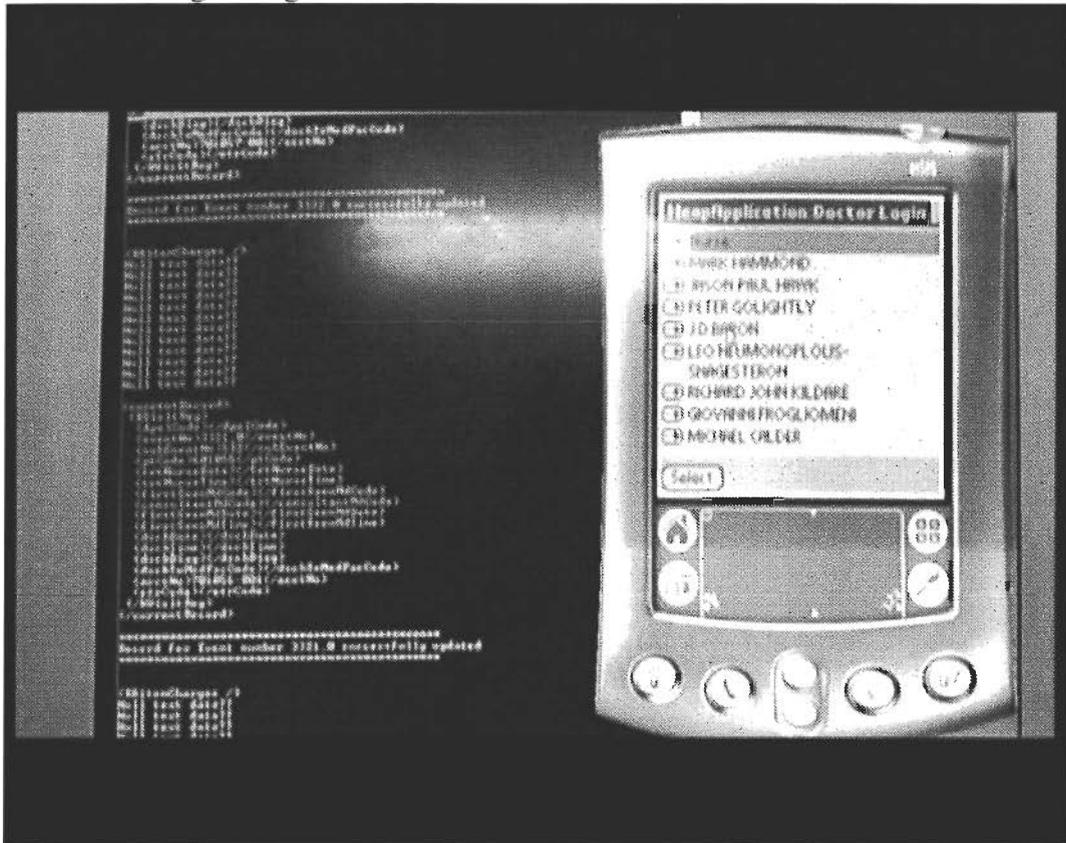


Fig 2. A nurse entering data using the training manual provided



Published evidence on the success of telecardiology: a mixed record

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Summary

We carried out a systematic review of the literature on telecardiology assessment from 1992 to September 2003, selecting articles reporting clinical, economic or administrative outcomes. Quality of evidence was assessed using an approach that considered both study design and study performance. Forty-four studies met the selection criteria. Studies of home care applications, particularly management of congestive heart failure, were of highest quality, giving a high degree of confidence in their findings. Studies on paediatric and non-emergency adult hospital applications were of poorer quality, mostly case series with relatively little detail. Economic analysis was limited to cost studies and in most cases was judged to be of poor to fair quality. While telecardiology has been widely applied, there is still limited good-quality evidence on its benefits to health care. Success in establishing the feasibility of telecardiology applications is offset by a failure to obtain convincing data on their influence on health outcomes and on their cost-effectiveness.

Introduction

Telecardiology is one of the oldest applications of telemedicine. Telephone transmission of the electrocardiogram (ECG) was undertaken as long ago as 1911 and auscultation by telephone dates back to 1924. [1] Later developments have included telephone transmission ECGs for ambulatory arrhythmia detection and diagnosis of myocardial ischaemia, rural teleconsultation and tele-echocardiography.

Telecardiology appears to provide an example of success in telemedicine. However, despite its long history, there is still a need for assessment of new technologies and changes to the organisation of health services in order to inform decisions on planning and implementation of telecardiology applications. We have therefore carried out a

review of the recent literature on telecardiology assessment. As in previous systematic reviews of the telemedicine assessment literature [2,3] we considered studies that reported administrative changes, patient outcomes or results of economic assessment. Our intention was to assess the quality of the studies using an approach developed for a previous review [3], and to relate quality to implications of study findings for decision-makers.

Methods

Literature searches were performed using the Medline, Health Star, EMBASE, PsychInfo and CINAHL databases from 1992 to September 2003. Articles were selected which described, in a scientifically valid manner, studies reporting clinical, economic or administrative outcomes of telecardiology in the specified areas of application. We included controlled studies in which there was comparison of telecardiology with a non-telemedicine alternative, and also non-controlled studies that reported appropriate outcomes and where the numbers of subjects were not less than 20. We excluded studies that considered only technical issues or those that simply established the technical feasibility of telecardiology.

The quality of the selected studies was assessed by three raters using the approach described previously [3], considering both study design and study performance. For study design, large randomized controlled trials (RCTs), defined for the purposes of this review as those with at least 50 subjects in each arm, were given a score of 5. Small RCTs were given a score of 3, prospective non-randomized studies 2, retrospective comparative studies 1 and non-controlled series a value of zero.

For study performance, five areas of interest were considered: patient selection, description of the interventions, specification and analysis of the study, patient disposal and outcomes reported. In assessment of a telecardiology study, each of these five areas was given a score of 0 (relevant information was missing or given in little detail), 1 (reasonable detail was provided but there were some important limitations) or 2 (information was satisfactory, no significant limitations).

Each study therefore had a possible maximum score of 10 for performance and 5 for design. Each rater independently assigned scores to each study, with any disagreements being resolved by consensus. For each study, the mean of the raters' individual scores was reported to the nearest 0.5.

Those studies that included cost or economic data were also judged against the ten criteria for economic analysis given by Drummond *et al.*⁴:

- was a well-defined question posed in answerable form?
- was a comprehensive description of the competing alternatives given?
- was the effectiveness of the programmes or services established?
- were all the important and relevant costs and consequences for each alternative identified?
- were costs and consequences measured accurately in appropriate physical units?
- were costs and consequences valued credibly?
- were costs and consequences adjusted for different timing?

- was an incremental analysis of costs and consequences of alternatives performed?
- was allowance made for uncertainty in the estimates of costs and consequences?
- did the presentation and discussion of the study results include all issues of concern to users?

For each study that included economic analysis, a score of 1 was given for each criterion that was fulfilled in a satisfactory way, and if there were no significant limitations. If the study fulfilled at least 5 criteria, it was considered to provide at least moderately good information on the economic indications of the telecardiology application.

Results

From the 527 publications identified in the literature search, 46 papers describing 44 studies met the selection criteria and were included in the review. The numbers of studies reviewed by area of application and study design are shown in Table 1.

Table 1. Summary of selected studies

Study design	Type of application			
	Home care	Emergency care	Neonatal, paediatric	Adult, hospital and clinic
Large RCT	3			
Small RCT	3			
Prospective comparative	4	3		2
Retrospective comparative	2	2	6	1
Case series	1		10	7
<i>Total</i>	<i>11</i>	<i>5</i>	<i>16</i>	<i>10</i>

The quality scores for the four types of telecardiology application are shown in Table 2, with our judgments of the implications for decision-making, ranging from high confidence in the findings to unacceptable uncertainty.

Table 2. Overall quality scores for selected studies

Overall quality score	Implications for decision making	Type of application			
		Home care	Emergency care	Neonatal, paediatric	Adult, hospital and clinic
11.5-15	High quality; high degree of confidence in study findings	6	0	0	0
9.5-11.0	Good quality; some uncertainty regarding the study findings	1	2	0	0
7.5-9.0	Fair to good quality; some limitations that should be considered in any implementation of study findings	1	1	3	2
5.5-7.0	Poor to fair quality; substantial limitations in the study, findings should be used cautiously	4	1	6	5
1-5	Poor quality; unacceptable uncertainty for study findings	1	1	7	3

Studies of home care applications, particularly management of congestive heart failure, were of highest quality. They included six RCTs for which there was a high degree of confidence in the findings. Good and fair-to-good quality studies were located for all applications and provided more limited evidence of benefit. Most of the studies on paediatric and non-emergency adult applications were of poorer quality, mostly case series with relatively little detail provided.

Thirteen of the studies included an economic analysis, of which one used cost-effectiveness analysis and the others used cost analysis. Economic quality scores are given in Table 3. One good-to-fair quality economic analysis was found in a study of home monitoring of heart failure patients. The quality of the other studies was low, with insufficient high quality information for decision-making.

Table 3. Classification of quality of economic studies scores

Score	Quality	Number
10-8	Good	0
7-5	Good to fair	1
4-3	Low	7
2-1	Very low	5

Discussion

Telecardiology has been widely applied in the last 10-20 years and would be regarded by many as obviously successful. However, there is remarkably little good-quality published evidence on its costs and benefits to justify such an opinion. Over half of the small number of studies we identified did no more than establish the feasibility of telecardiology in particular settings. Of the 44 studies we reviewed, 36 (82%) concluded that telemedicine showed advantages over the alternative approach. However, 11 of these reports of "successes" were judged to be of unacceptable quality for decision-making and a further 13 had substantial limitations. In six studies (three of poor quality) it was unclear whether telecardiology provided an advantage and in the remaining two (one of poor quality) telecardiology was less effective than the comparator. It was notable that studies of paediatric applications were based only on retrospective comparisons or case series. Overall, the economic analyses were of low quality and weaker than those considered in general reviews of telemedicine applications [2,3].

This level of assessment of an important area of telemedicine does not inspire confidence, though there is some encouragement to be obtained from the publication of good quality studies of telecardiology in home care. Decision makers should note the need for follow up of preliminary studies in order to obtain reliable outcomes data for telecardiology applications.

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Using telemedicine to manage vascular surgical referrals

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Summary

We have performed a feasibility study of telemedicine used instead of conventional outpatient appointments to make diagnostic and management decisions in vascular surgery patients. 22 sequential patients referred by a single general practice to a vascular centre were offered a telemedicine clinic appointment as an alternative to conventional hospital outpatient appointment. A referral proforma and digital photograph (where appropriate) was transmitted in advance of the videoconference. The videoconference involved patient, practice nurse and vascular consultant. All patients opted for the teleconsultation. The majority had leg ulceration or leg pain. Six patients required only the initial teleconsultation and were managed thereafter in the community. 12 patients were referred to the vascular laboratory for investigation. Three patients proceeded to angiography or angioplasty and three to surgery. Two patients had a conventional outpatient appointment for follow up but all others were followed up via telemedicine. Overall 27 conventional outpatient appointments were replaced by a teleconsultation.

Introduction

Patients with vascular symptoms are often elderly and socially isolated. They find travelling difficult and hospital attendance daunting. The majority of patients referred for conventional vascular surgery outpatient clinics have leg symptoms due to arterial or venous disease. Standard assessment of these patients entails taking a detailed history; observation of the limb for varicose veins, discoloration and other skin changes, including ulcers; palpation to assess temperature; compression to assess capillary refill; and elevation followed by dependency of the legs to search for colour changes (Buerger's test). Pulses are assessed at different levels in the leg and the blood pressure

at ankle level is measured using a Doppler probe and compared to arm pressure (ankle/brachial pressure index, ABPI).

Much of the history can be encompassed in a standard proforma. Digital photographs transmitted by email can provide high definition pictures of specific lesions or a whole leg. Many of the conventional examination tools can be used in a teleconference, particularly with the help of a nurse accompanying the patient who can perform manoeuvres under the direction of the vascular consultant.

We have performed a feasibility study of telemedicine instead of conventional outpatient appointments.

Methods

Starting in March 2001, all patients referred from a single general practice with peripheral vascular symptoms were offered a telemedicine clinic appointment instead of a conventional hospital outpatient appointment for both initial referral and any follow up. A conventional outpatient appointment was available at any stage if the patient or consultant wished it. A standard proforma for leg ulceration was completed by the practice nurse where appropriate and sent with a digital photograph electronically to the vascular consultant. A standard referral letter was also sent electronically by the GP and this included details of palpable pulses and ABPIs, often taken by the nurse during home visits to dress the wound.

A videoconference was set up with the patient and nurse at the general practice, and the vascular consultant at the hospital. Two cameras were employed at the patient end. A "head and shoulders" camera was used for discussion between patient and nurse with the vascular consultant. A mobile digital video camera was available to provide a real-time video image of the area of the body under inspection, Fig 1. It could also be used to capture a high-resolution still image for the record or for transmission to the consultant [1]. This is a flexible design able to support a variety of specialties, Fig 2. A desktop videoconferencing system using ISDN at 128 kbit/s (Proshare 500) provided videoconferencing, supported sharing of data during the conference and, being PC based, allowed access to the local electronic patient record.

Ethics approval was obtained from the appropriate committee.

Results

22 patients entered the study, aged 30-93 years (median 73). The first patient had already had a conventional initial appointment, but all the others had their first consultant appointment via telemedicine. The presenting symptoms are given in Table 1. The most common symptom was leg ulceration.

Table 1. Patients' symptoms

Symptoms	Number
Leg ulcer	8
Calf pain (possible claudication)	5
Leg skin changes associated with varicose veins	3
Phlebitis	1
Foot pain (possible ischaemic rest pain)	1
Swollen legs	1
Toe discoloration	1
Discrepancy in arm blood pressures	1
Visual disturbance (possible amaurosis fugax)	1

An almost complete vascular examination of the legs proved possible using telemedicine. Foot pulses and ABPIs were assessed by the practice nurse prior to the videoconference. Colour and skin abnormalities could be evaluated by the consultant during the videoconference or by viewing the digital photograph. The practice nurse proved invaluable during the conference. She worked at the direction of the consultant and was able to: report temperature differences between the limbs; apply pressure to the skin so that the consultant could see capillary refill; and elevate and lower the limb for Buerger's test. Using this information the consultant felt confident about recommending a course of action in every case, and the option to see the patient at the hospital was always available.

Six patients did not require further investigation and were reassured that their symptoms were unlikely to progress or could be managed through the practice. Thirteen patients were referred to the vascular laboratory for investigation and three went on to angioplasty while four other patients had surgery.

Six follow up clinics for three patients were held: one of these was to discuss the possibility of surgery whilst the others were to evaluate the effects of intervention. Two conventional outpatient appointments occurred during the study, one at the patient's request, and the other due to administrative error. No appointments were required at the consultant's behest. Overall 27 conventional outpatient appointments were replaced by a teleconsultation.

Discussion

Previous studies have shown that decisions regarding follow up management of patients with leg ulcers and other vascular problems can be made using telemedicine, using either photographs or videoconferencing [2,3]. Few previous studies have concentrated on the initial management of vascular problems by telemedicine.[4-7] Although much of the required information could be transmitted beforehand by photographs and proformas, the videoconference provided an important means of transmitting additional information. It also allowed patient and consultant to be introduced and to discuss possible alternatives in management.

There was an important educational aspect to the videoconference. The nurses involved developed their skills in assessing vascular problems under the guidance of the vascular

consultant. They assumed responsibility for recognising and referring many of the patients needing vascular consultation. In addition, the vascular consultant was able to derive feedback from the nurses regarding response to variations in management. Many of the patients attended the vascular clinic for investigation, for example by ultrasound, but did not go onto intervention. In future it may be possible to use portable equipment in the community to perform these investigations, so that only those patients who are likely to be suitable for intervention need to attend hospital.

The present study suggests that patients with vascular symptoms can be satisfactorily assessed at a distance by using previously-transmitted digital photographs and proformas, followed by videoconferencing supported by a practice nurse. This has the potential to make consultation easier for the patient, to reduce the pressure on outpatient departments, to provide education and to develop stronger links between hospital and community staff.

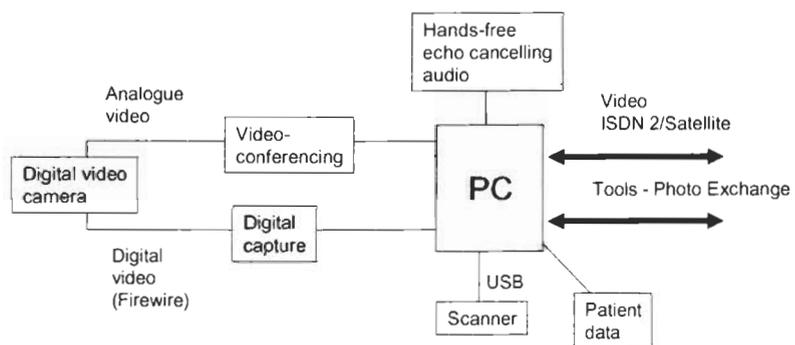
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Fig 1. Virtual consultation workstation (mobile camera at the left)



Fig 2. Telemedicine system architecture



Successes and challenges in a field-based, multi-method study of home telehealth

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Summary

We are conducting a three-year study of telehealth in 11 home care offices that serve rural clients in Alberta. Three hundred and twenty palliative home care clients are being recruited to participate in a randomized controlled trial (RCT) to answer three questions about the use of videophones and their effect on symptom management, quality of life and cost, as well as readiness to use the technology. Both successes and challenges have been identified in three main areas: technology, people/organizational issues and study design. Maintaining study integrity has been the key factor in decision-making, as adjustments from the original proposal are made. It is already clear that field-based RCTs are feasible, but require commitment and flexibility on the part of researchers and community partners to work through the study implementation.

Introduction

Advances in telehealth technology and reduced equipment costs have renewed interest in the possibilities of home telehealth to extend resources, improve access to services and minimize costs[1-4]. More timely visits may also result in earlier interventions, reduce unnecessary use of health services and assist clients to manage symptoms at home[2,5,6]. However, in spite of its potential, adoption of home telehealth has not matched expectations in part due to the limited evidence of its effectiveness beyond small pilot studies.

Project funders are often reluctant to invest in the large applied studies required to develop evidence because they are risky. Conducting a multi-method study in the field requires flexibility to adapt the original proposal to local conditions, while maintaining

the study rigour. While the study findings are important, demonstrating the success of a pragmatic RCT will also make an important contribution to e-health research and practice.

Methods

The present 36-month multi-method study compares traditional palliative homecare visits and a combination of traditional and telecare visits. The study is being conducted in four Health Regions (HR) that serve rural areas in Alberta. There are three research questions, see Table 1. Equally important are the issues about change management and understanding users' responses to adopting the technology[7-10]. The third question aims to better understand how users perceive use of telehealth technology in their care.

Table 1. Summary of research questions and methods

Research question	Methodology	Data collection
1. Do "video-visits," in combination with a reduced number of traditional homecare visits, alter symptom management achieved through traditional palliative homecare visits?	Randomized controlled trial	Symptoms (ESAS; Palliative Performance Score) Quality of Life (McGill)
2. Do "video-visits," in combination with a reduced number of traditional homecare visits, alter the cost-effectiveness of health care services in traditional palliative homecare?	Economic analysis	Client preferences for home/video visits Utilization of health services Costs (travel, equipment, supplies)
3. What issues influence the use of video-visits in this population?	Interviews, focus groups	Perceptions of care received via videophone Effect on ability to manage care

Four palliative homecare nurses from each Health Region were selected to participate in the study with paid release time to attend training. The videophone chosen for the study (Care Station 125, Motion Media) operates over ordinary telephone lines and is easy to use. Twelve videophones were allocated to each HR. A sample of 320 adult home care clients referred to palliative services are being recruited and randomly assigned to the control group (routine homecare) or the treatment group (a combination of home and video-visits). After 8 weeks, clients in both groups are re-assessed, and discharged or returned to routine care.

Results

Both successes and challenges have been identified in technology, people/organizational issues and study design in the first half of the 3-year study (Table 2). However, maintaining study integrity has been a key factor in deciding what changes are needed in the original proposal. The match between expectations arising from the proposal and the realities of care delivery partly determine how successes or challenges are defined.

Table 2. Summary of successes and challenges

Successes	Challenges
<i>Technology factors</i>	
Clients love the videophone	Installation of analogue telephone lines required
Nurses find the videophone easy to use	Programming the laptop to use peripherals
	Videophone distribution
	Privacy to use videophone required by nurse
<i>People and organizational issues</i>	
Project manager initiates and maintains frequent communication with each region	Project manager position budgeted at 0.5 FTE – could have been 0.8 FTE for the first year
Nurse participants enthusiastic and willing to learn the technology	More nurses required training than planned for
Manager support	Ethics approval processes
Internal/external communication	Cost of printing study documents
Regionally based research assistants	Need for car business insurance
Advisory committee	Integrating research into practice and daily workload
<i>Maintaining study integrity</i>	
Team members' expertise contributes to problem-solving	Eligibility criteria – changed from more than 2 visits/week to more than 1 contact/week

Technology factors

Because the study population lives in rural areas, videophones were selected because they operate on ordinary telephone lines (PSTN). It came as a surprise to find that most of the home care offices had been re-located to hospitals. These have digital telephone lines, so initially a digital converter was considered, but this did not support satisfactory videophone performance. These offices ultimately required analogue lines to be installed for the project.

The challenges in programming the home care nurse's laptop computer for peripheral use were not anticipated (e.g. client's responses on a Likert scale produce a solid bar, making it difficult for them to tell what number from 1-5 they had selected).

People and organizational issues

Regional project support The tremendous support of home care and palliative care leaders in each region is critically important to the success of the project. For the most part nurses have been enthusiastic about training, although there has been some anxiety about conducting the initial eligibility visit. Specific attention has been paid to the importance of positive feedback to recognize efforts at each site. Photographs taken during training sessions were assembled and sent with thank you letters to each region. Managers have been asked to track contributions of time in order to recognize these at the end of the project.

Research assistant in each health region Having a research assistant in each health region has been a resounding success. Four people were selected locally and hired centrally by the project manager. They are located in each region, which creates some challenges in providing support from a project perspective, but enhances the support they are able to provide study nurses. Research assistant roles are primarily to deliver and pick up videophones from the clients' homes, prepare data collection forms for nurses and ensure they are completed. The research assistant's backgrounds are not in healthcare and one of the palliative care consultants suggested that their orientation should prepare them for what they might see in the homes. This was accomplished by them accompanying a nurse on a home visit as well as including a verbal description of what to expect for those clients receiving videophones.

Distribution of videophones The original plan was to implement one videophone in a nursing office within each region, with 11 videophones to be distributed to eligible clients (Table 3). Early in the implementation it was found that there were too few palliative clients for recruitment through one office. Consequently, this has expanded to 11 communities to accommodate nursing practice patterns as well as increase the potential number of clients. This increased complexity has had implications for the cost of additional analogue telephone lines, additional training, more driving for research assistants and communication.

Table 3. Distribution of videophones

Health regions	Communities (number of videophones)		
	Primary 1	Primary 2	Secondary
Calgary	Strathmore (6)	Airdrie (3)	Cochrane (3)
Capital	Sherwood Park (6)	Leduc (3)	Thorsby (3)
Chinook	Taber (6)	Raymond (3)	McGrath (3)
David Thompson	Ponoka (6)	Stettler (6)	---

Training Fifty-one nurses attended training (versus 16 originally planned) due to work patterns, shared client loads and a majority of part-time positions. Travel to the eight primary communities to conduct training provided opportunities to meet the study nurses in each area. The 3-hour training sessions focused on study basics, data collection and videophone use. In the week following training, the local palliative nurse specialist or manager reviewed a few client charts to simulate an eligibility visit and data collection process. Given the much larger group of nurses participating and turnover during the study period, the need for a self-study guide as a refresher as well as

for new staff has become more urgent. The on-going training is under development and will probably combine a paper-based practice guide and on-line review. The project manager (0.5 FTE) has been instrumental in developing and delivering the training. However given the complexity, this position should have been closer to 1.0 FTE for the first year.

Communication The geographic and cultural diversity between sites has highlighted the need for better communication. This has been a success factor, in part due to the efforts of the project manager. Internal communication includes monthly meetings with site managers using voice over IP software (CentraSymposium) which allows meetings at 25% of the cost of conventional telephone conferences. Meetings with the research assistants every 6-8 weeks also provide opportunities to share successes and failures, offer support and engage in problem solving.

The development of media flyers with the assistance of the Faculty of Medicine communications department has been very successful. The media were invited to each of the training sessions, resulting in press coverage with a local emphasis. Quarterly bulletins highlighting project progress are distributed widely to participating health regions. Unplanned external communication has also extended to posters for Nurses' Week as well as nursing and palliative care journal articles. In many instances a more generic communication was written and then customized with local photographs taken during each training session.

Maintaining study integrity

Changes in regional boundaries and personnel since the proposal was funded have resulted in revisions to a number of study areas. The assistance of team members with expertise in biostatistics, health economics, health technology assessment and qualitative methods has been invaluable in resolving many of the unexpected challenges.

Eligibility criteria Eligibility for the study originally included adult clients referred to palliative home care who are expected to receive two or more visits a week. While initially thought appropriate, this criterion now applies to very few clients. A change to one or more contacts a week has been applied equally to both arms of the study. The overestimation of opportunity for use of telehealth technologies appears to be a common theme in other evaluations currently being completed (unpublished data).

Referral to palliative home care While the definition for "palliative" is similar in most regions (i.e. a terminal diagnosis plus requirements for assistance with respect to pain and symptom management), there are considerable variations in when clients are referred to palliative home care. Sometimes this is as early as when a terminal diagnosis is made and in other cases the referral is made only in the last few weeks of life. This potentially could skew results with the videophones apparently being used more often in regions where clients are eligible for the study earlier in their care. Although initially this was thought to be a potential source of bias, all clients are stratified into three groups based on an initial Palliative Performance score (PPS2) [11], which will be used to adjust for the expected differences.

Economic data collection Data collection for the economic analysis is also proving more difficult than anticipated. One of the key benefits expected from home telehealth is the reduction in travel. It is difficult to quantify the 'before and after' differences due to limited routine data collection. Some nurses use regional fleet vehicles funded through a global budget and no information is recorded on mileage or time spent travelling. For others using their own cars, it is not possible to attribute a specific amount of travel to any one client as multiple visits are made during one trip. In most cases the nurses work part-time and have caseloads that are a mixture of home care and palliative care. They also share these caseloads with other part-time staff. All of these factors contribute to the complexity of data collection and analysis, which has yet to be resolved.

Discussion

While the project is not unfolding exactly as planned, the project team is working hard to ensure that study integrity is maintained. The study represents a large RCT, which will not only provide rigorous results related to home telehealth, but can potentially demonstrate that these types of studies in e-health can be successful. Field-based RCTs are feasible, but require commitment and flexibility on the part of researchers and community partners to work through the study implementation.

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Evaluation of a pilot second opinion child telepsychiatry service

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Summary

A second opinion child psychiatry service was piloted for six months in the northernmost two thirds of Queensland to provide specialist expertise by telehealth to local multidisciplinary teams of mental health staff. During the study period, 28 teleconsultations were facilitated by the service, including nine videoconferences for administrative purposes, two videoconferences for educational purposes, and 17 videoconferences for direct and indirect clinical applications. The mean time between a referral being made and a consultation being performed was 4.7 days (range 1-13). The results of a barriers survey administered to referring and non-referring mental health workers showed that major barriers to service implementation included the limited allied health applications that were offered, a perceived lack of communication during the implementation phase of the service, and the creation of a new referral networks that did not conform to traditional referral patterns in the north of Queensland.

Introduction

It is widely recognised that establishing and maintaining telemedicine programmes within broader healthcare systems is difficult [1-5]. There are various barriers, including the managerial style employed by the co-ordinators, the amount of clinician involvement in, and perceived ownership of the telemedicine programmes, and the amount of support provided by senior healthcare management [3]. Smith et al. [6,7] have explored these issues in relation to the management of telepaediatric referrals. A number of barriers were identified; one of the most significant being that telehealth activity in Queensland was limited because it was more convenient for clinicians to refer patients to larger tertiary facilities via conventional means (involving patient travel), than it was for the clinician to set up a teleconsultation [7]. By establishing a full-time coordinator whose role was to provide a single point of contact for referring

clinicians, Smith et. al. [6,7] demonstrated that referrals to the telepaediatric service increased markedly, and admissions to the tertiary centre decreased. On the basis of these findings, a similar guaranteed-response service was trialled for child and youth telepsychiatry.

Pilot telepsychiatry service

A six-month pilot trial commenced in February 2003. The service was located at the Royal Children's Hospital (RCH) in Brisbane, and was offered to all Child and Youth Mental Health Service (CYMHS) workers in the northern and central administrative zones of Queensland. Teleconsultations were performed using standard commercial videoconferencing units (Sony) at a bandwidth of 128 kbit/s. To encourage utilisation of the service, referring facilities were not charged for its use, except for ISDN call charges and line costs.

On receiving a referral to the service, the medical director vetted it for appropriateness before a suitable time to hold a videoconference was negotiated with the remote CYMHS team.

Methods

To evaluate the service, the following information was collected: patient medical history, the date when a referral was received by the service and subsequent consultation performed, the duration of each videoconference, and sub-specialities attending the videoconference. To identify barriers to use of the service, a questionnaire was administered to referring and non-referring CYMHS teams. There were four main themes:

1. *Value of the service*

CYMHS workers were asked whether or not they considered the service to have been useful, and what they considered to be the level of interest in the service, with particular reference to sub-speciality (e.g. social work)

2. *Clinician ownership*

CYMHS workers were asked whether the service was consistent with the ideas, values and culture of the CYMHS, and whether the implementation of the service had been characterised by enough consultation, feedback or communication with regional CYMHS workers

3. *Management strategy*

CYMHS workers were asked what they believed was the degree to which the service fitted into the current organisation of the CYMHS, and whether they perceived any unresolved cross-jurisdictional issues associated with it

4. *Pilot status of the service and issues of sustainability*

Questions were included in the survey to explore issues such as the pilot status of the service and whether this inhibited referrals to it. Issues of sustainability were also explored, following the recent introduction of the telepsychiatry item numbers by the Australian Federal Government that could potentially be used to reimburse the service.

A preliminary analysis of referral data to the Child and Family Therapy Unit (CFTU) was performed to provide a baseline for comparison with the telehealth activity.

Results

The CFTU received a total of 512 referrals between 2001 and 2002, Table 1.

Table 1. Conventional referrals to the CFTU (financial year 2001-2002)

Health service district	No. of referrals
Bundaberg	5
Cairns	1
Central Highlands	1
Central West	1
Charleville	1
Gladstone	2
Gympie	1
Mackay	3
Mt Isa	1
Rockhampton	4
South Burnett	3
Southern Downs	1
Toowoomba	4
Sunshine Coast	10
Southeast corner	463
Outside Queensland	4
<i>Total</i>	<i>512</i>

Telehealth activity

During the six-month study, 28 teleconsultations were performed, which represented a total of 24 hours and 15 minutes of videoconferencing activity. Nine videoconferences were for administrative purposes, two videoconferences were for educational purposes and 17 videoconferences were conducted for direct and indirect clinical applications, see Table 2.

Table 2. Videoconferencing activity

Application	No. of conferences	Usage (h)
Clinical	17	16
Administrative	9	5
Educational	2	3
<i>Total</i>	<i>28</i>	<i>24</i>

Administrative videoconferences were performed to introduce RCH staff to the CYMHS teams located elsewhere in Queensland. These included seven point-to-point conferences, and two multipoint videoconferences involving eight rural and remote locations and the RCH. Two multipoint educational videoconferences were performed

to facilitate an Attention Deficit Disorder Advisory Group being run by the CFTU and RCH.

Direct and indirect clinical consultations

A total of 19 referrals for secondary input were received from mental health professionals based in Brisbane. For two referrals, it was decided that a telepsychiatry response would not be appropriate. Therefore, 17 clinical consultations were performed by the service, comprising 15 videoconferences and two conferences performed by telephone. There were seven direct clinical consultations where the patient was present during the conference and 10 indirect clinical consultations. Two patients were seen on multiple occasions to receive continued advice on the management. A total of 14 patients were referred to the service, Table 3.

Table 3. Locations of the clinical consultations performed

Health service district	Administrative zone	No. of conferences	No. of Patients	Usage (h)
Bundaberg	Central	4	3	4
Central West	Central	1	1	1
Innisfail	Northern	1	1	1
Mackay	Central	2	2	2
North Burnett	Central	3	1	2
South Burnett	Central	5	5	4
Tablelands	Northern	1	1	1
<i>Total</i>		<i>17</i>	<i>14</i>	<i>16</i>

The mean time between a referral being made and a consultation being performed was 4.7 days (range 1-13). The mean duration of clinical consultations was 50 min (range 30-80). Most patients referred to the pilot service continued treatment in their health district of origin. However, three videoconferences resulted in the patient being transferred to Brisbane for specialised treatment. A variety of mental health issues were referred to the service, Table 4.

Table 4. Clinical consultations by diagnosis.

Diagnosis	No. of patients
Attention-deficit hyperactivity disorder	1
Autistic spectrum disorder	1
Eating disorder	3
General behavioural problems	1
Suicidal ideation	1
Obsessive-compulsive disorder	1
Medication query	1
Munchausen by proxy syndrome	1
Unknown	4
<i>Total</i>	<i>14</i>

Barriers survey

A total of 17 CYMHS workers (3 males, 14 females; 8 psychologists, 6 team leaders, and 3 social workers) were surveyed. All participants stated that the service had been useful, that it had reduced the sense of isolation experienced in rural and remote areas, and that it was suited to the organisational structure values of the CYMHS.

Furthermore, respondents reported no cross-jurisdictional issues, and all the workers believed that the pilot status of the service did not deter them from using it. Finally, respondents stated that there had been a high degree of interest from CYMHS teams.

Several improvements to the service were recommended. Specifically, clarification was required about the variety of mental health sub-specialities that could be delivered to rural and remote areas via the service (i.e. the types of allied health input available). Respondents also stated that better communication concerning clients, rural issues, and the fostering of partnerships was also required to improve rapport, and that this requirement might be achieved through routine clinics. Finally, sites in Northern Queensland stated that the RCH was not a logical destination for them to transfer acute mental health patients. This was a major barrier to service delivery to Northern Queensland.

Discussion

The pilot service was designed to provide CYMHS staff in the Central and Northern Zones of Queensland with access to child and youth mental health expertise located in Brisbane (including appropriate medical, nursing and allied health services), and to evaluate the effectiveness of delivering child psychiatric services via communication technologies. The average time between a referral being made and the subsequent teleconsultation was 4.7 days. The majority of consultations were for teams located in the Central Zone. The telehealth referral rates were comparable to conventional referral rates to the CFTU (10 referrals over 6 months to the pilot service vs 8 over six months to the CFTU). This suggests that the service model was appropriate for the needs of the CYMHS teams who used it.

The Barriers Survey showed that there was considerable agreement between referring and non-referring CYMHS workers on certain aspects of the service. For example, most CYMHS workers agreed that the service had been useful, that the guiding

principles of the service were consistent with the culture of the CYMHS, and that the service model was consistent with the organisational structure of the CYMHS. No participants identified any unresolved cross-jurisdictional issues associated with the pilot service. A major barrier to the implementation of the new service at non-referring sites appears to have been a perceived lack of involvement by CYMHS workers in the development of the service. In addition, there was disagreement about the type of management strategy employed by the service. For instance, sites in Northern Queensland stated that the RCH was not a logical destination for patient referral. This coincided with the sentiment expressed by a number of participants that referral networks shared with the RCH were underdeveloped.

Participants made various suggestions about how to improve the service. The suggestion made most often was that more allied health services should be made available at the RCH. The rationale behind this statement was that several rural and remote CYMHS teams consisted of small groups of professionals who were specialised in specific areas (e.g. psychology). Participants also wished for better communication between themselves and the pilot service.

The results of the present study suggest that future research should limit the number of sites initially invited to access the service so that close professional ties can be established between referrers and service providers. Sustainable telehealth is not simply achieved by providing a statewide telepsychiatry service. Rather, considerable ground work is required to engender confidence about the utility of such a service in rural and remote areas.

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Trial of low-cost teledermatology in primary care

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Summary

We examined the feasibility of a low-cost, store-and-forward teledermatology for general practitioners in regional Queensland. Digital pictures and a brief case history were transmitted by email. A service coordinator carried out quality control checks and then forwarded these email messages to a consultant dermatologist. On receiving a clinical response from the dermatologist, the service coordinator returned the message to the referring GP. The aim was to provide advice to rural GPs within one working day of receiving a referral. Over a 6-month period, 63 referrals were processed by the teledermatology service, covering a wide range of dermatological conditions. The referring doctors were able to treat the condition on receiving email advice from the dermatologist in the majority of cases. In ten cases (16%) additional images or biopsy results were requested because image quality was inadequate. The average time between a referral being received and clinical advice being provided to the referring GPs was 46 hours. The number of referrals in the present study, 1.05 per month per site, was similar to that reported in other primary care studies. While the use of low-cost digital cameras and public email is feasible, there may be other issues, for example remuneration, which will militate against the widespread introduction of primary care teledermatology in Australia.

Introduction

Teledermatology is a well-researched telemedicine application[1]. A recent literature search on PubMed using the search term "teledermatology" yielded over 130 research articles reporting various aspects of real time and store and forward teledermatology. Teledermatology has been shown to be as clinically effective as conventional means of delivering dermatological services to remote areas [2,3]. However, in one UK study real-time teledermatology was not economic because the costs outweighed the savings made by reducing patient travel [2]. This has prompted the use of relatively simple and inexpensive technologies to provide teledermatology services. Store and forward

educational and diagnostic systems have proven popular, and research indicates that they are clinically effective when high quality digital images are used for diagnosis [4-6]. Furthermore, because of their low costs, there are often net savings in reduced patient travel and avoided hospital visits [7].

The present study was initiated in response to a request to improve access to dermatology services in the Mackay region. When the study began there were no dermatologists available in Mackay, and patients had to travel either to Brisbane (1100 km) or to Townsville (390 km) to be seen. The aim of the study was to examine the feasibility of public email and low-cost digital cameras for teledermatology in rural Queensland. Our hypothesis was that general practitioners (GPs) could capture suitable clinical images using low cost digital cameras and that an easy to use service would be attractive to them.

Methods

GPs located at 15 medical practices in Mackay were invited to participate in the study. The GPs were offered a digital camera and the necessary training, at no cost. They were offered a response to any teledermatology query from a Brisbane-based consultant dermatologist within 1 working day of submitting it by email.

GPs at ten practices agreed to take part. After four months, five of them withdrew from the study and were replaced by GPs at four surgeries in Brisbane and one in Biloela.

Equipment

GPs were provided with a digital camera (IXUS 400, Canon) and a colour-standardising Swinfen Ruler. The camera was chosen because it was relatively easy to operate, and had a macro setting of 5 cm. In addition, its design permitted the service coordinator to save the camera settings, thus ensuring that the GPs captured standardised digital images with a size of approximately 320 kbit each. Images were transferred from the camera to the GP's PC via a USB cable, and transmitted using a range of commonly available email programs.

Camera training

GPs were provided with training in the use of the digital camera, and transmission of referral messages by email. Camera training took 45 minutes to complete and was provided to GPs at their surgeries. GPs were also given a camera manual that described the basic functions of the digital camera, information about taking suitable clinical images, how to transfer images from the camera to the PC, and the types of clinical information to include in the email message.

Procedure

After the patient had been photographed, GPs attached the images and relevant clinical information to an email message, and sent it to the service coordinator, Fig 1. A requirement of the study was that all patient images and clinical information be de-identified before transmission. The coordinator checked the designated email account each day for new referrals. When a new referral was received, the service coordinator

checked the quality of the images and the accompanying clinical information. If they were satisfactory, the coordinator forwarded the email message to the dermatologist who provided a clinical response. On receiving the dermatologist's response, the coordinator forwarded the response to the referring GP. The service coordinator fulfilled a quality assurance role, checking the quality of the clinical images submitted by the GPs and providing advice where necessary. The coordinator also ensured that responses were provided for all GP referrals.

Ethics approval was granted by the appropriate committees.

Results

A total of 63 email referrals was received by the teledermatology service during the first six months of operation (10.5 referrals per month), i.e. an average of 1.05 referrals per month per site. The average time between a referral being received by the service and response provided to the GP was 46 hours (range 17-119, SD=24). Infections were the most commonly referred conditions (n=16), followed by a series of miscellaneous conditions (n=11). Few neoplastic conditions were referred to the service (n=6), Table 1.

Table 1. Diagnostic categories referred to the teledermatology service (n=63)

Category	n	Category	n
<i>Infections</i>		<i>Dermatitis</i>	
Folliculitis	1	Atopic eczema	3
Ecthyma	1	Endogeneous eczema	1
Tinea	3	Contact dermatitis	3
Scabies	2	Lichen simplex complex	2
Insect bites	2	Neurodermatitis	1
Warts	2		
Herpes simplex	1		
Herpes zoster	1		
Hand, foot and mouth disease	1		
Miscellaneous	2		
<i>Immunological</i>		<i>Neoplastic</i>	
Bullous pemphigoid	2	Basal cell carcinoma	2
Dermatitis herpetiformis	1	Squamous cell carcinoma	4
Lupus erythematosus	1		
Urticaria	1		
Rheumatoid arthritis	1		
<i>Psoriasis</i>		<i>Miscellaneous</i>	
Chronic plaque	1	Acne vulgaris	1
Pustular psoriasis	1	Acne rosacea	3
		Granuloma annulare	1
		Benign tumour	3
		Vascularitis	2
		Neurotic excoriation	1
Drug eruption	2	No diagnosis	10

In ten of the 63 cases (16%), no diagnosis could be provided by the dermatologist due to poor image quality, Fig 2. In these instances, biopsy results were requested to clarify the information contained in the email.

On average, each GP made 4.8 referrals to the service (range 1-15). Seven GPs sent referrals that could not be diagnosed. The average number of non-diagnosed cases per GP was 0.76. The longer that GPs were involved in the study, the more referrals they made, Fig 3.

Discussion

The teledermatology service was initially established to deliver diagnostic and treatment advice for skin conditions in the Mackay region of Queensland. At the start of the study there were no specialist dermatological services available in Mackay. The present study demonstrated that providing dermatological advice by email is feasible, although GP activity was rather variable during the six months of operation. One probable reason for this was that a full-time dermatologist began practising in Mackay halfway through the study. A number of GPs stated that they were more inclined to refer their patients locally, rather than send electronic referrals to Brisbane. Because of the limited need for the service at these Mackay surgeries, the digital cameras were re-located to other GP practices elsewhere, in Brisbane and Biloela.

63 referrals were received by the teledermatology service over a period of six months. This rate of referrals is similar to that reported in other primary care-based teledermatology studies (Table 2).

Table 2. Referral rates in similar primary care-based studies

Source	No of referrals	Duration (months)	No of sites	Mean referral rate (per month per site)
Moulin et al. [8]	117	12	18	0.54
van dan Akker et al. [9]	89	6	6	2.47
<i>Present study</i>	63	6	10	1.05

The mean time between a referral being received and a clinical response being sent to the referring GPs was 46 hours. This was slightly longer than our goal of providing a clinical response within one working day of receiving a referral, i.e. within 34 hours on average. During the study, there were major Internet problems, including the Swen Worm, that slowed email traffic throughout Telstra's (the major Australian telecommunications provider) IP network for several weeks. On one occasion it took nearly a week to provide clinical responses to the referring GPs.

A wide range of dermatology conditions was referred to the teledermatology service. However there were few neoplastic skin conditions. Skin cancer is very common in Queensland, and in recent years there has been increased education about the damaging effects of the sun. The small numbers of skin cancers referred for a teledermatology

opinion suggests that the participating GPs were proficient at diagnosing neoplastic conditions, and were confident about recommending treatment advice to their patients.

Finally, the GP uptake of the service was varied with four GPs making 65% of referrals, and five GPs who made only a single referral each. Active GPs reported that they felt confident in participating in the study once they had undergone camera training and had an opportunity to familiarize themselves with the camera in their own time. The longer the GPs participated in the study, the more referrals they made, and the fewer unsuitable images they forwarded to the teledermatology service for diagnosis.

While the use of low-cost digital cameras and public email is feasible, there may be other issues, for example remuneration, which will militate against the widespread introduction of primary care teledermatology in Australia.

Acknowledgements

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Fig 1. Procedure.

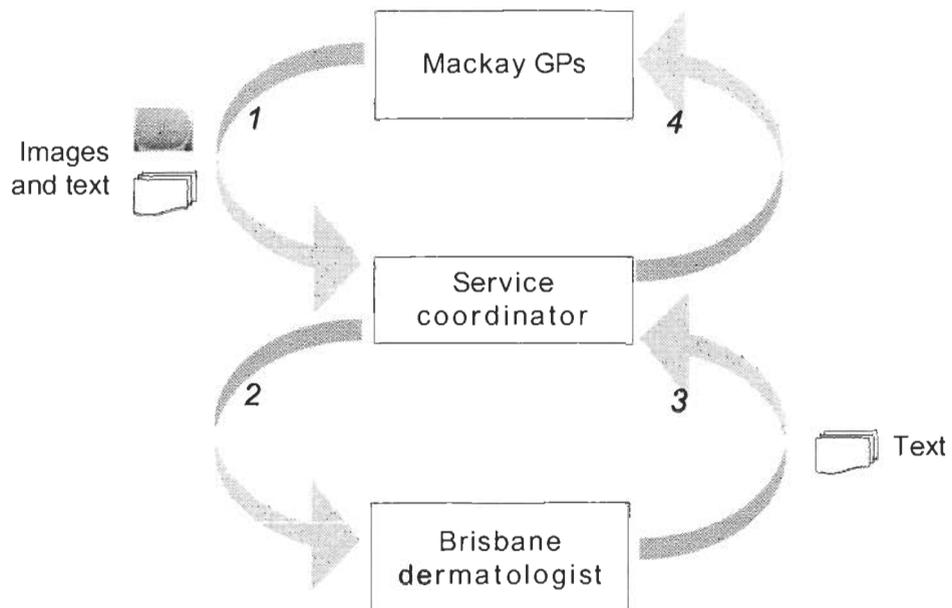


Fig 2. Referrals from participating GPs, including those in which a diagnosis was not possible

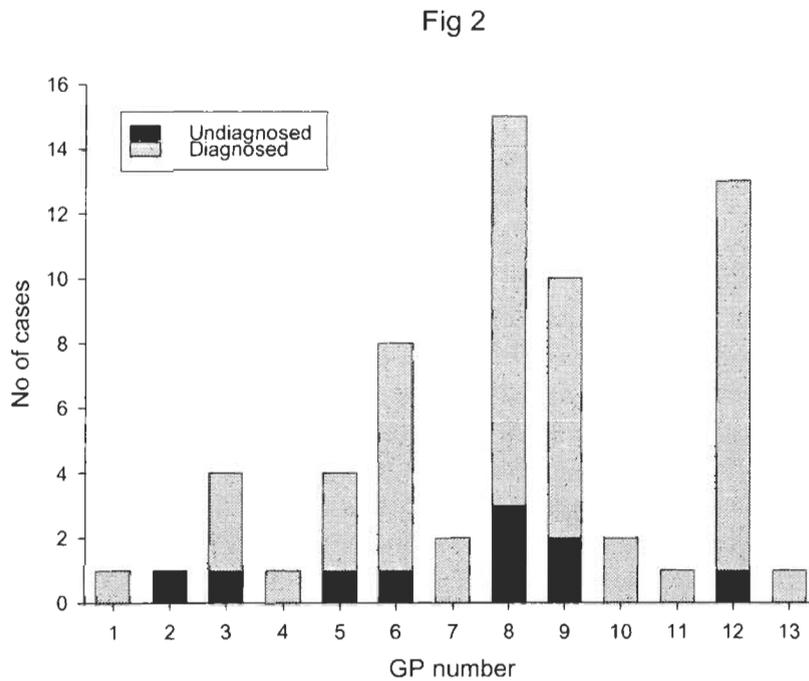
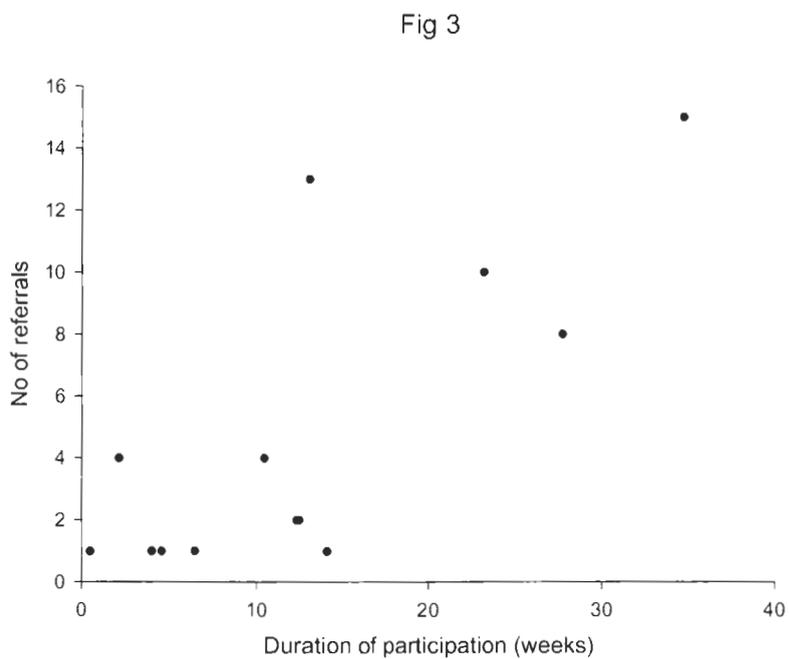


Fig 3. Numbers of GP referrals and their length of time in the study



Development of a telerehabilitation system for training physiotherapists in rural areas

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Summary

The purpose of this study was to assess the effectiveness of transmitting moving pictures through Internet using a three-dimensional motion analyzer. The movements of two patients were filmed by a video camera and transmitted to the university. After advanced analysis using a three-dimensional motion analyzer, physiotherapists prepared a therapy plan. The transmitted moving pictures were clear enough for satisfactory analysis. The physiotherapists in the hospital were satisfied with the results of the motion analysis, and found the guidance from an expert physiotherapist very valuable. In future, a large number of video pictures could be transmitted during night, stored at the university, then analyzed later by an expert physiotherapist.

Introduction

Home treatment of disabled elderly people is possible in Japan under a nursing care insurance system that started in April 2000. However, home visits for rehabilitation by physiotherapists rarely take place despite the needs. There are 33,415 qualified physiotherapists in Japan. Unfortunately, many young physiotherapists work single-handed and have no opportunity to learn from an experienced physiotherapist. Furthermore, in some rural hospitals and day service centres where few physical therapies are practised, there is not enough work to employ a full-time physiotherapist. In addition, health care professionals today no longer work in a stable, comprehensive health care system. They are faced with enormous changes, with a growing emphasis on the wider social responsibility. It is the role of professional health care practitioners to practice in a manner which demonstrates professional autonomy, competence and accountability, to engage in lifelong learning and to contribute to the development of the knowledge base of their discipline [1]. Therefore, clinical reasoning is a critical skill and is the foundation of professional clinical practice.

In all physiotherapy settings, motion analysis is carried out as part of the evaluation. Movement patterns are recorded under certain conditions by observation with the naked eye. Where three-dimensional motion analysis is used, it is expected to supplement clinical analysis. However, the equipment for three-dimensional motion analysis is expensive, and it is difficult to distribute among hospitals in general. A system to send back data for analysis by transmitting movement images of a disabled person would therefore contribute to regional medical treatment.

The purpose of this study was to assess the effectiveness of transmitting moving pictures through the Internet using a three-dimensional motion analyzer.

Methods

We explained the purpose of the study to the subjects and obtained their consent. Two physically disabled persons who were either outpatients or inpatients in the cooperative facilities outside the university agreed to participate. They stuck a marker on each joint region, such as shoulder joints, hip joints, with two-sided adhesive tape and then repeated the required movements several times in accordance with a sign by the measurer (Fig.1).

Each movement was filmed by a video camera and transmitted to our university as an attached file. The files were approximately 3 MByte in size. We used ISDN transmission at 128 kbit/s and file transfer took about two minutes. The data were analyzed by three-dimensional motion analysis equipment (Peak Motus 2000 System) at the university. After that, the physical therapists prepared therapy plans.

Results

The transmitted pictures were clear enough to give specialized guidance and to perform advanced motion analysis (Table 1).

Table 1. Results of motion analysis and physical exercise program in a case

Task	Results of motion analysis	Physical exercise programme
Sit-to-stand	<ul style="list-style-type: none"> • narrow base for feet • decreased buttock motion • stiffness in trunk motion 	<ul style="list-style-type: none"> • practice weight-bearing and weight-shifting on the affected leg while standing up
Gait	<ul style="list-style-type: none"> • stiffness in affected knee during swing phase • lateral contact of affected sole during standing phase 	<ul style="list-style-type: none"> • carry out gait training with a T-strap and a T-cane • practice reciprocal stair climbing and walking on rough ground

The physiotherapists in the hospital were satisfied with the quality of data from the motion analysis, and found the guidance from an expert physiotherapist very valuable.

Discussion

Compared to measurements made in a well-ordered environment like a laboratory, the accuracy of three-dimensional analysis in the field is naturally lower. The data we

obtained were therefore not of sufficient quality for research. However, they were satisfactory for movement analysis to guide therapy proposals. Other workers have reported the feasibility of low-bandwidth therapy at a distance. For example, Russell et al developed a software application to enable real time physical rehabilitation consultations via the Internet [2,3]. High-speed networks are usually necessary for real time movement analysis, but it is difficult to transmit large image datasets quickly with the technology readily available.

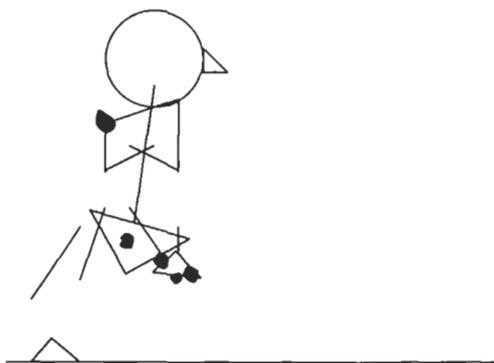
The therapy proposals prepared by the physiotherapists were improved by direct discussion with the personnel at the remote end or the disabled persons themselves. It is important to evaluate the satisfaction of subjects and their families. Enhancing the satisfaction level of subjects, together with improvements in their health, is the ultimate goal of medical treatment[4]. In addition, medical treatment is still being carried out experimentally under certain limited conditions[5]. The present research was also carried out under the limited condition that organizations involved were our university and the cooperative facilities outside our university. However, we confirmed the possibility that objective evaluation of exercise disability and physiotherapy services can be provided to regions where there are no physical therapists, if a network of hospitals and facilities outside a university is constructed via ISDN with facilities equipped with highly developed movement analysis equipment as its core.

In future a large number of video pictures could be transmitted overnight, stored at the university, and then analyzed by an expert physiotherapist. The results of motion analysis can then be sent back when time permits.

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Fig 1. Schematic drawing of the experimental set-up. A light reflective marker was placed on five anatomical landmarks.



A feasibility study of email communication between the patient's family and the specialist burns team

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Summary

We investigated whether the parents of burns patients could capture suitable clinical images with a digital camera and add the necessary text information to enable the burns team to provide follow-up care via email. Four families were involved in the study, each sending regular email consultations over a six-month period. The results were very encouraging. In 30 of 32 e-consultations (94%), the burns team felt confident that the clinical information that they received was accurate. In 11 of the 30 cases (37%) the burns team stated there was room for improvement, although the quality was adequate for clinical decision-making. The study also showed that low resolution images (average size 37 kByte) were satisfactory for diagnosis. Families were able to participate in the service without intensive training and support. The user survey showed that all the families found it easy and convenient to take photos and to participate in the study. The results suggest that the technique has potential as a low cost telemedicine service in burns follow-up, requiring only modest investment in equipment, training and support.

Introduction

Queensland is large state, with an area of over 1.7 million km². The paediatric burns unit at the Royal Children's Hospital (RCH) in Brisbane, services the paediatric population in Queensland and in areas north of New South Wales. About 300 patients are admitted to the unit annually and about 1200 outpatient consultations conducted each year. The outpatient management of a burns patient may take a long time, up to 10 years or more, after the initial injury. Videoconferences have been used for the post-

acute burns care of children in Queensland for several years [1,2] and there has been some experience in the use of digital photographs to complement videoconference appointments [3]. Telemedicine consultations involving transmission of clinical images by email between health care professional have proven valuable in many fields [4-7]. Other applications have shown the benefits of an email service which links patients directly to the specialist [8,9].

We have conducted a feasibility study to assess whether the parents of burns patients could use email and digital cameras in their follow-up care. Additional goals were to establish the imaging requirements and to find out how much training and support parents would need.

Methods

The study was conducted at the RCH in Brisbane. Ethics approval was granted by the appropriate committees. Four families were invited to participate in the study and all agreed. Families were chosen in which at least one of the child's parents had some experience with computers. The families were told that the specialist burns team would contact them immediately if they found any changes in the child's condition that warranted urgent attention.

Equipment

Families 1 and 2 had their own digital cameras and preferred to use them. Families 3 and 4 did not own a digital camera and had no experience in using digital cameras. These families were provided with a new camera (Coolpix 2100, Nikon). Different cameras were assessed in accordance to functional user requirements specified by the Volere method [10]. The requirements included ease of use, satisfactory lens quality, a resolution of at least 2 million pixels, a macro of less than 10 cm for close up images, automatic focusing, rechargeable batteries, image reproduction in JPEG format, the possibility of downloading images from the camera to the PC without installing any software, and a reasonable price (not exceeding AUS\$400). 8 MByte of flash memory was deemed acceptable for the purposes of the study.

Procedure

Communication was by email, see Fig 1. The families were asked to send a message to the specialist burns team each week for the first two months, and then every second or fourth week. The messages were sent to an email account at the Centre for Online Health (COH). Research staff forwarded the email consultations collectively in a single message to the specialist burns-team. This combined email also contained a checklist for the burns-team to evaluate the quality of the images and the textual information presented in the patient email, and whether the information was adequate for diagnosis and clinical decision-making. A chief physician and a registered nurse from the burns unit perused the email consultations and arrived at a joint decision regarding the quality, and returned the checklist to the COH email account. Staff at the COH forwarded the individual replies from the specialist burns-team back to the respective families.

Participants were asked to include written information to explain their child's condition (see Appendix A). All the families were provided with an instruction manual that described the project procedure in detail. Patient confidentiality was maintained.

User survey

Five weeks after starting to use the email consultation system all the parents were asked to give some feedback via email on their needs, expectations and experience so far, and to make suggestions on how the telemedicine service could be improved.

Results

Between November 2003 and May 2004 a total of 32 email consultations was carried out using three types of cameras, Table 1.

Quality of the consultations

30 consultations (94%) were deemed by the specialist burns-team to be adequate for diagnosis and clinical decision-making, Fig 2. In 19 of these 30 cases (63%) the quality was very satisfactory and there were no need for improvement. In 11 of these 30 cases (37%) the burns team stated that there was room for improvement, although the quality was sufficient for clinical decision-making. The quality would have been improved if: more pictures had been taken with dressings down (one consultation), some pictures had not been so blue (an error in patient 2's private camera, four consultations), and the focus had been improved for one or more of the pictures (six consultations).

Two of the consultations (6%) were not of satisfactory quality. In the first consultation from patient 1 the pictures were taken too far away and dressings covered up the areas that were most important. Patient 2 had a problem with their private camera that grew worse and worse: more and more photographs appeared blue, and on the sixth consultation the burns team were unable to determine the colour of the scar. In all cases the text was judged between good or excellent.

Image size

The sizes of the images that the families took are shown in Table 2. All the cameras used compression. For the Nikon Coolpix cameras the initial image quality used was set to "PC screen" (1024x768 pixels, Compression 1: 8) for family 4, and for family 3 it was set to the lowest quality called "TV screen" (640x480 pixels, Compression 1: 8). All the images taken by families 3 and 4 were taken inside with use of flash.

Table 2. Details of the images taken by the families

Family	Total number of images received	Average number of images per consultation	Range (pictures per consultation)	Average (kByte)	Range (kByte)
1	15	3.8	3-4	267	100-524
2	30	5.0	5-6	174	144-290
3	48	6.0	4-8	37	19-65
4	151	10.8	5-16	147	54-179

Family 4 sent many more images per consultations than the others. This child had serious burns all over the body, while the other children had more limited injuries.

Training and support

The families did not need a great deal of training and support. For family 3 and 4 the training included how to capture images and download them to a PC. Since we spent so little time training them we expected that they would need some intermittent support during the project. But in practice, there was little demand for technical support or questions regarding the procedure, see Table 3.

Table 3. Time spent on training and support

Time	Start up meeting and training (min)	Support by email (min)	Support by telephone (min)
Patient 1	40	20 + 20 + 20	0
Patient 2	Information over the Internet and by telephone, 10	35	10
Patient 3	90	10	10
Patient 4	120 (child present)	20 + 20	20

User survey

All the families reported that they were very happy to participate in the study, and that taking photographs was easy and convenient. The telemedicine service gave them the chance to show the specialists what happened with the burns, which helped in concerns they had. Sometimes they thought that there had been changes and wondered if they should make an appointment or if they just worried about nothing. In circumstances like this the telemedicine service gave them the opportunity to "*show them in pictures when telling is hard to explain sometimes*". One parent said that the trial was "*a pleasurable experience as it gives the opportunity to be more involved with your child's progress and makes you take more notice of the healing and how well your child is doing*". Another parent said that "*it has saved a lot of time by not having to travel to the hospital as much. It has also saved my child a lot of upset as he/she becomes very stressed at going to the hospital*" and that they "*hope it continues as it will benefit a lot of people*".

One of the families found it to be a little disappointing that they twice did not receive a response to questions they asked, and said that "*it was quite frustrating not getting a response when a concern was raised*". The burns team could not remember that they had seen these questions, so they may have been overlooked.

The families also suggested how the telemedicine service could be improved. One suggestion was to regulate the sending frequency depending on the clinical needs. They found one consultation per week to be more often than necessary since there usually were very few changes during a single week. If they had major concern or a query that could not wait then they suggested having the opportunity to send in an additional email – directly to the burns team – to get their concern answered. If the quality of the images was adequate for diagnosis they would also appreciate some feedback from the team about the prognosis for their child.

Discussion

The results of the present study show that parents are able to combine suitable clinical images and textual information to enable the burns team to provide follow-up care. In almost all of the cases, the burns team felt confident that the clinical information that they received was accurate. The study also showed that low resolution images can be used for this purpose; even images that were only 37 kByte in size were satisfactory for diagnosis. As expected, the number of pictures included in a consultation depended on the area that was burned and the healing progress, and could not be predetermined. The study also showed that families did not need much introduction, training or support to participate in the telemedicine service. The user survey showed that all the families found it easy and convenient to take photos and to participate in the study. The study suggests that the technique has potential as a low cost telemedicine service, requiring only modest investment in equipment, training and support.

The present work represents a small feasibility study that, despite its success, cannot be generalised to the entire population without further research. The aim of future research should be to determine if it is possible to provide paediatric burns patients with individually adapted treatment in their own homes without necessarily needing to see the patient in the outpatient clinic all the time. An expected outcome of this approach will be a significant reduction in travel costs and inconvenience to the patient and family.

Acknowledgements

We thank the patients and their parents for their contribution and involvement in the research.

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Appendix A. Clinical information contained in the body of email communications

Item	For example
The patient number we have given you	002
Please tell us about any changes since last week's pictures: <ul style="list-style-type: none"> • scars (pale/pink/red) • thickening of scars • areas where the skin is tight • movement • activity level • open sores • treatment 	Pink scars – image 1 No thickening Tight around thumb – image 1 Cannot move thumb completely Good, except for using the thumb No open sores Pressure garment and cream daily
Any concerns you have	A bit worried about movement of thumb
The picture number, where on your child's body each picture is from, if the picture was taken with or without the flash, inside or outside	Image 1 - Right hand - With flash, inside Image 2 – Right hand – Without flash, inside

Table 1. Details of the families and the number of email consultations carried out

Family	Age of patient (11.2003)	Distance from Brisbane (km)	Estimated travel time car	Images emailed from	Internet connection	Camera	Number of consultations		
							Nov-Dec 2003	Jan-May 2004	Total
1	17 months	21	43 min	Home	Broadband	Canon Power Shot A 70	4		4
2	16 months	2384	36 h	Work	Broadband	Sony DSC-S75	4	2	6
3	19 months	43	56 min	Grandparents 50%, own home 50%	Modem on both places	Nikon Coolpix 2100	4	4	8
4	6 year	94	2 h	Home	Modem	Nikon Coolpix 2100	7	7	14

Fig 1. The email procedure

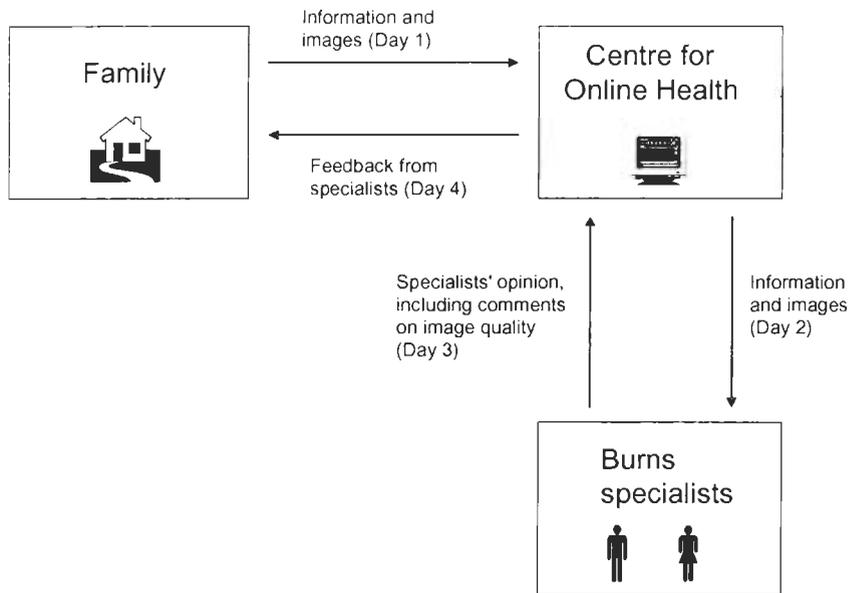
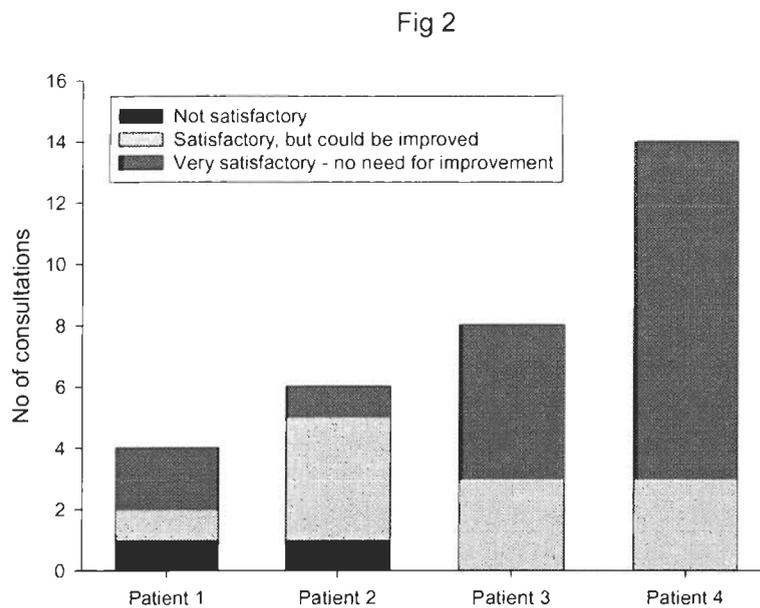


Fig 2. Consultations adequate for diagnosis and clinical decision-making



Paediatric telecardiology services in Queensland: a review of three years experience

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Summary

Videoconferencing at 384 kbit/s for the transmission of echocardiograms has proven useful for the assessment of children with suspected cardiac disease, in regional areas of Queensland. A retrospective review of patient and management outcomes was conducted on cardiac teleconsultations performed at two regional hospitals during the period November 2000 to February 2004 inclusive. In the first three years, there were 106 echo studies. A subset of 72 cardiac teleconsultations performed between May 2001 and February 2004 was reviewed in detail. The median age of patients at the time of consultation was 3 months (range 1 day–17 years). 16% of teleconsultations were classified as urgent and conducted on the same day as referral. Following the videoconference, 90% of patients could be managed locally and reviewed by the paediatrician or visiting paediatric cardiologist during an outreach clinic. Six children (8%) had significant cardiac lesions which were initially managed locally, with subsequent elective transfer at the appropriate time for treatment. Only one child (1.4%) required urgent transfer to the tertiary centre for specialist care and surgery. Telecardiology was effective in accurately identifying congenital heart disease. Paediatric telecardiology is an evolving modality of assessment and communication, and is likely to result in continued improvements in patient care, patient outcomes and parental satisfaction, in provincial centres removed from the tertiary cardiac centre.

Introduction

Before the advent of telemedicine, children born with congenital heart disease were managed by urgent transfer to tertiary paediatric cardiology centres or at infrequent

outreach clinics for less urgent cases. One of the first services to employ real-time transmission of paediatric cardiac echocardiographic images was established in 1987, allowing accurate diagnosis of congenital heart disease in remote centres [1]. This service, in Nova Scotia, used broadband video transmission. Since then a number of paediatric cardiology units have developed telecardiology services using a variety of transmission modalities for compressed digital images, which range in bandwidth from 128 kbit/s to 45 Mbit/s [1-3]. Studies suggest that a bandwidth of 384 kbit/s is the lowest desirable band width for reliable diagnosis of cardiac defects [4,5].

As Queensland is a large state with a population of 3.5 million people, telemedicine has the potential to improve the delivery of health care in the state. A large number of telemedicine units exist in hospitals in the state, most connected by ISDN at 128 kbit/s. As part of a research project established in 2000, the ISDN lines between the Centre for Online Health in Brisbane and two regional centres in Queensland were upgraded to a bandwidth of 384 kbit/s, permitting transmission of paediatric cardiac echocardiograms in real-time.

Paediatric telecardiology

The two regional hospitals were located 300 km (Hervey Bay) and 1100 km (Mackay) from the tertiary paediatric cardiac service. Only one centre was serviced by paediatric outreach clinics when the project commenced, with outreach clinics commencing at the second centre in 2003. Thus, the indication for telecardiology service utilisation varied between centres, with one centre using the service for elective consultations and the second using it for urgent and semi-urgent indications.

All consultations were conducted in real-time using commercial videoconferencing equipment (Sony), see Fig 1. Simultaneous audio and video transmission required ISDN lines at a bandwidth of 384 kbit/s. The advantages of this mode of transmission were that direct communication could occur between the ultrasonographer, paediatrician and family at the peripheral site, and the paediatric cardiologist at the tertiary referral centre. At a bandwidth of 384 kbit/s the quality of the echocardiographic images did show some degradation but the image quality was, in general, adequate for accurate diagnosis.

The cardiac scanning was performed at both peripheral centres with an ultrasound machine (ATL HDI Sonis 5000) using standard 3, 5 and 7 MHz probes. The local sonographer, with the guidance of a paediatric cardiologist at the tertiary centre, was able to obtain standard paediatric cardiac diagnostic images. Direct real-time communication between the cardiologist and sonographers allows ongoing education of sonographers and medical staff at the peripheral centre. Direct communication between the paediatric cardiologist and family facilitates improved understanding of the implications of the cardiac diagnosis.

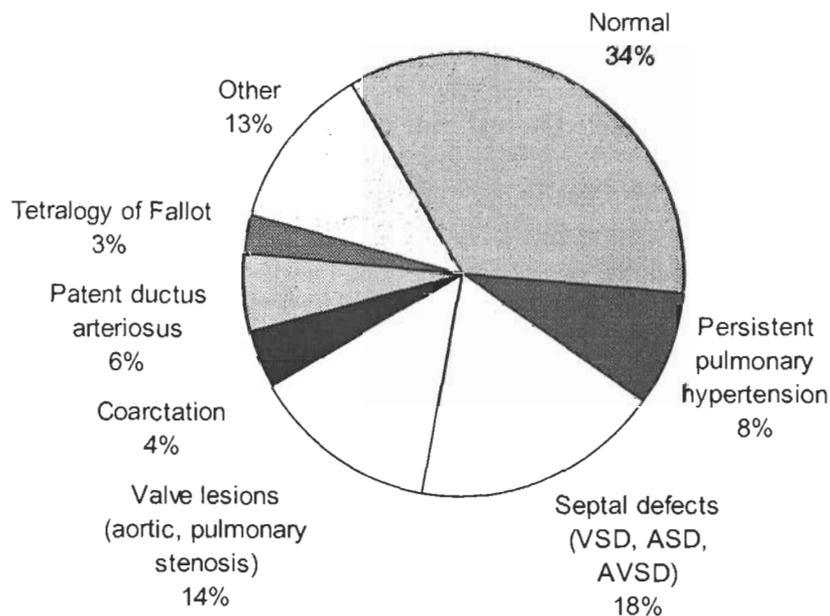
Methods

A retrospective review of patient and management outcomes was conducted on cardiac teleconsultations performed during the period November 2000 to February 2004 inclusive. The data collected included patient demographics, cardiac diagnoses and the influence of the diagnostic modality on patient care.

Results

During the 40 months of the study period a total of 106 paediatric cardiac teleconsultations was performed. Hospital records for 72 (68%) of all cases were located and clinical notes were reviewed. This subset of 72 cardiac teleconsultations performed between May 2001 and February 2004 was reviewed in detail. The median age of patients at time of consultation was 3 months (range 1 day–17 years). Of the children assessed 11 (15%) had had previous cardiac assessments and 5 (7%) had had more than one teleconsultation. The diagnoses made at the time of the teleconference are shown in Fig 2.

Fig 2. Cardiac diagnoses made during videoconference (n=72)



16% of the teleconsultations requested were classified as urgent and performed on the same day. All infants in this group were less than one month of age. 40% of teleconsultations were semi-urgent, with assessment of the child occurring within 24 hours of the request being received. The remaining 44% were planned elective consultations. At the time of teleconsultation, 7% of the cardiac echocardiographic assessments were felt to be of poor quality, either because of poor image transmission quality or the uncooperativeness of the patient. It was suggested that these patients

should have a further review by a paediatric cardiologist when he visited the peripheral centre.

The majority of patients assessed in this manner could be managed in the peripheral centre. 65 (90%) of patients continued local follow-up with the paediatrician or visiting paediatric cardiologist in the peripheral centre and did not require transfer to the tertiary centre. One patient (1.4%) required urgent transfer to the tertiary cardiac centre. This infant was diagnosed with severe coarctation of the aorta and a large ventricular septal defect. He was transferred to the tertiary centre on a prostaglandin infusion and subsequent careful echocardiographic examination demonstrated that he had an interrupted aortic arch. This was repaired surgically with success [6]. The remaining six children (9%) had significant cardiac lesions which were initially managed locally, with subsequent elective transfer at the appropriate time for either surgical or interventional treatment.

19 (26%) of the 72 patients had subsequent echocardiography by a paediatric cardiologist, either locally or at the tertiary centre (some reviews were checked during a scheduled outreach clinic). No major discrepancies were detected in the original diagnoses. The only medically different diagnosis was in the infant transferred to the tertiary centre where the diagnosis was changed from coarctation of the aorta to interruption of the aortic arch. This change in diagnosis did not significantly affect the patient's management and care.

Discussion

Utilisation of telemedicine for performing detailed paediatric cardiac assessments has proved very effective in improving patient care in peripheral centres. Transmission at a bandwidth of 384 kbit/s resulted in cardiac imaging which was of sufficient quality to allow accurate diagnoses to be made. This experience is consistent with previously reported studies [4,5]. While not all patients assessed in this trial had their teleconsultation findings checked at later clinical review, no significant errors which would adversely affect patient management were identified in those who had subsequent follow-up (26%).

The greatest benefit was in managing more acute cardiac presentations in distant centres where a diagnosis was required prior to the next routine clinic. The majority of patients (99%) in whom an accurate diagnosis was made by telecardiology could be managed by the local paediatrician without urgent transfer to the tertiary paediatric cardiac centre. Most patients with a serious cardiac abnormality could then be transferred electively at the time appropriate for the required intervention. The ability to manage patients in this manner has been shown to result in significant cost savings to the health system by minimizing the necessity of transporting sick neonates to a tertiary centre for cardiac assessment [7]. The inherent risk of these transfers and social dislocation of families is also minimized by this modality of assessment and treatment.

Telecardiology can be utilised as a service for routine clinical review, but a high level of confidence is required in the quality of images obtained and transmitted, to label a study as normal, allowing discharge of a patient without clinical assessment by a paediatric cardiologist. As the transmitted image quality is not that of an on-site

echocardiographic assessment, it was not felt to be appropriate for a telecardiology service to replace peripheral clinics attended by a paediatric cardiologist.

Additional benefits from the telecardiology transmission service have included improved communication among paediatric care providers, with a resulting greater sense of community, and educational benefits. The rapid provision of accurate diagnostic information directly to the paediatrician in a regional hospital can provide very useful reinforcement of their clinical assessment. For the sonographers producing the images at remote sites, each transmission provides a tutorial with constant commentary by the cardiologist supervising the study. Finally, the availability of telemedicine for follow-up studies ensures safe cardiac follow-up without the need to travel.

As telecardiology evolves from pilot study to standard practice and treatment, it will be essential that manpower, funding and medicolegal issues are addressed. It is possible that telecardiology services will serve as a new benchmark, raising the standard of paediatric cardiac services normally available in regional and remote areas of the state. In the near future, areas that do not have access to these services, may be considered substandard [8]. Whilst we are confident that telecardiology is a more efficient way of assessing paediatric cardiac patients, further work is required to quantify the health outcomes, costs and potential savings of telecardiology in Queensland.

When dialogue with a patient is established using telecardiology, a physician-patient relationship is formed, replete with duties and responsibilities. While telemedicine has not yet generated significant case law relating to the liability of a virtual consultation, the seamless nature of the care involving multiple physicians and forwarded information, would suggest that liability is likely to be shared by all involved, with the major liability likely to be with the responsible health organization [8]. When ruling on cases the courts determine a proper standard of care, and thus in developing the technology it is essential that it complements and adds to existing practice, rather than replaces current clinical consultations in regional centres. As telecardiology becomes integral to clinical management of children with congenital heart disease, health organizations will be required to develop strategies to deal with these issues.

Conclusion

Telecardiology has proved effective in accurately identifying congenital heart disease. Thus the long-term plan should be to increase the number of centres in Queensland at which this service can be provided. This form of telemedicine is also ideal for providing more general consultative services to patients and medical staff. Telecardiology is ideally suited to counselling patients prior to transfer to a tertiary centre for major cardiac procedures. It may also play a significant role in nurse education in regional centres, particularly when patients with complex congenital heart disease return to these regions. Paediatric telecardiology is an evolving modality of assessment and communication, and is likely to result in continued improvements in patient care, patient outcomes and parental satisfaction, in provincial centres removed from the tertiary cardiac centre.

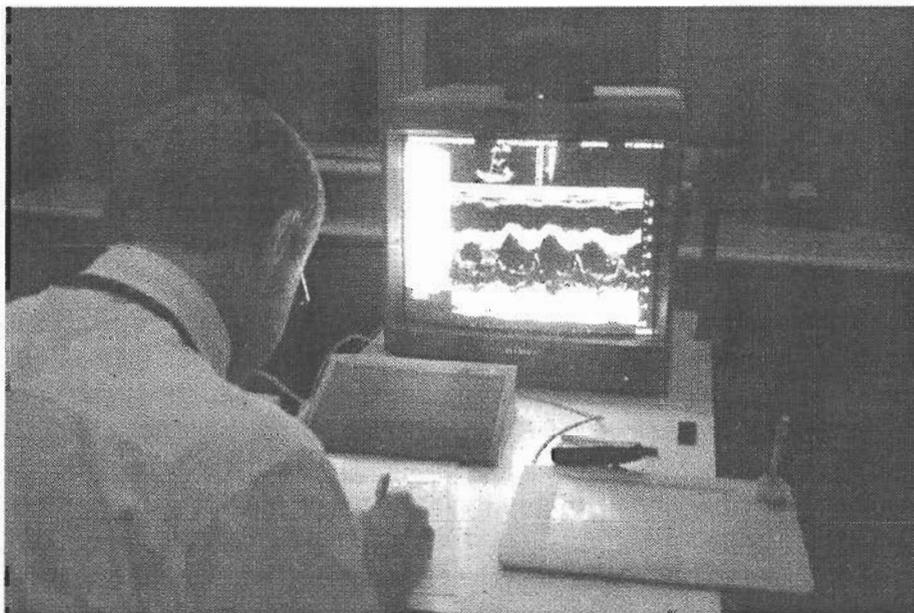
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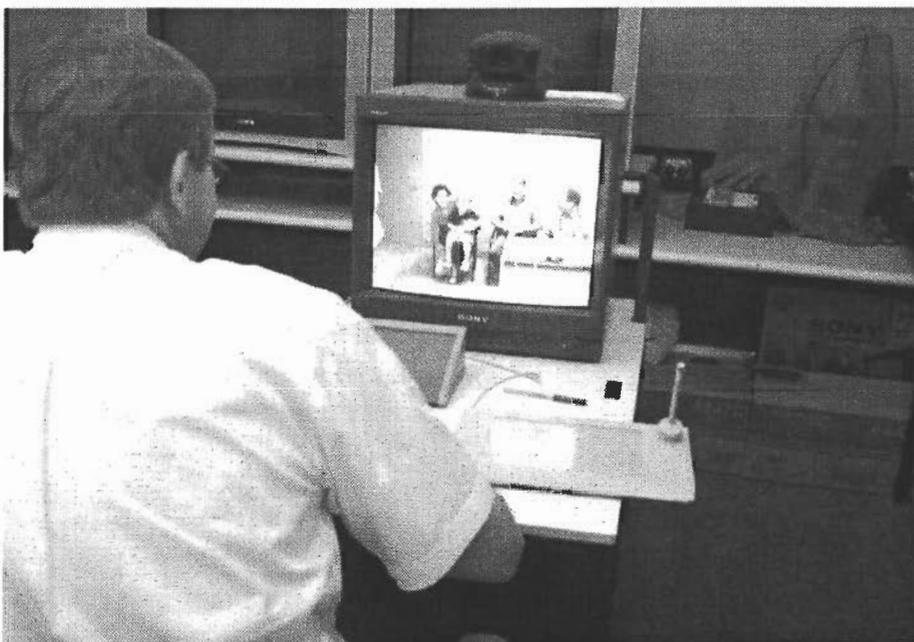
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Fig 1. Telepaediatric consultation. (a) Review of echocardiogram via videoconference and (b) Discussion with the local paediatrician, child and family.



(a)



(b)

Telehealth in New Zealand: current practice and future prospects

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Summary

We have surveyed the current state of telehealth in New Zealand. The survey found 22 telehealth projects active in 2003 compared with 12 identified in a previous survey in 2000. Many projects were small, localised and led by enthusiasts. Sustainability was a problem and many projects had failed to enter routine operation. Teleradiology and telepsychiatry services focused on acute hospitals were the most frequent clinical applications. The majority of projects (9 of 22) were concentrated in the North Island around Auckland. Telehealth appears to have special potential for rural communities and for the remote treatment (telecare) of chronic disease. However, the provision of telehealth in New Zealand is patchy and exhibits the same barriers to success as have been identified elsewhere, which make it difficult to move telehealth into routine operation. The obstacles constitute not so much a failure of individual projects as a lack of a driving force to take advantage of the opportunities. It is to be hoped that a suggested strategic framework can help to harness the opportunities.

Introduction

Many changes have taken place in health delivery in New Zealand brought about by almost continual reforms over the last 15 years. The latest reforms have shifted the emphasis of care, for the first time in many years, to the primary sector. Previous reforms significantly reduced the number of specialist service centres to three. The effect of these changes mean that patients often travel considerable distances to access specialist services at substantial cost in time and money. It is possible that telehealth can assist the delivery of high-quality specialist services to all New Zealanders, including those in remote areas.

Healthcare in New Zealand

New Zealand is a country of four million people with roughly the same land area as the British mainland (60 million people). The majority of the population (85%) live in cities, with the remainder living in well-dispersed rural areas. The main ethnic groups are European (72%), Maori (15%), Pacific (5%) and Asian (5%). Non-European groups are situated largely in or near towns, whilst the city of Auckland attracts many immigrant, especially Asian (19%), communities. As with many industrialized countries, the life expectancy of New Zealanders has risen over the last half century and the proportion of elderly people in the population is increasing.

New Zealand has a publicly-funded health system, with a smaller private sector (34%), mainly providing elective surgery. Expenditure on health and disability services has risen consistently in real terms over the last decade. In 1999/2000 the proportion of the GDP spent on health was 8.5% (6.8% public funding), similar to that of other OECD countries. Health spending amounted to NZ\$8.95 billion (US\$5.09 billion), or NZ\$2342 (US\$1330) per capita [2]. There are approximately 80 public hospitals ranging from secondary to tertiary level. Funding for services is distributed via 21 District Health Boards responsible for the health of their local populations.

The Minister of Health published the New Zealand Health Strategy [3] in December 2000. This placed particular emphasis on improving population health outcomes and reducing disparities between all New Zealanders, including Maori and Pacific peoples. The subsequent Primary Healthcare Strategy [4] indicated the need to develop a coherent approach to providing rural health services, including the difficult issues of attracting and retaining an appropriate workforce. Rural areas have comparatively small populations, and there are fewer healthcare providers, so that some patients need to travel considerable distances for health and disability support. Telehealth offers opportunities to support rural staff via continuing education and to improve services using specialist consultation to local areas.

Telecommunications in New Zealand

The New Zealand Health Network intranet became operational in November 1999. It offers a secure communications infrastructure permitting rapid transfer of data between health professionals. ISDN is available in most of the larger towns in New Zealand, and therefore to major hospitals, but not to all the outlying clinics or rural areas. However, the government has instigated a project [5] to ensure a broadband infrastructure across the country for the equitable implementation of education and economic development. The project also provides the underlying infrastructure for healthcare delivery that can be organised around the patient rather than the provider.

The 2000 study

A study of telehealth in New Zealand in 2000 found that most public hospitals had videoconferencing capabilities but these systems were used mainly for administrative rather than telemedicine purposes [1]. Uses ranged from management meetings, to interviewing overseas job applicants, to keeping in contact with satellite sites. However, some videoconferencing was beginning to move into more clinical areas, e.g. for continuing medical education, peer support and postgraduate training. The 12

clinically related projects revealed by this study involved nine centres. Most projects were realtime applications based on ISDN, mainly at 384 kbit/s for better video quality. Teleradiology was the most widespread (four examples), with telepsychiatry (three projects) a close second. There were a few telemedical services based on a patient being 'seen' by a distant health provider in real-time; examples included teledermatology (Waikato), telepsychiatry (North Auckland) and telepaediatrics (West Coast-Canterbury and Auckland). All projects had some public hospital funding and four also had direct government funding.

In spite of this modest activity it appeared that a number of these projects were moving from trial mode to mainstream delivery mode, and were on the point of developing extensive telehealth networks.

Present study

A new survey of the state of telehealth (telemedicine and telecare) in New Zealand in 2003 has been carried out. It updates and extends an earlier review undertaken by the Australian New Zealand Telehealth Committee in 2000 [1]. The aims of the work were to:

- discover the current position of telehealth;
- determine progress made since the last review;
- identify the potential for telehealth in New Zealand;
- establish a position for further successful development of telehealth.

Methods

Healthcare providers known to be involved in national and overseas telehealth projects (including those identified in the 2000 survey) in both private and public health sectors were invited to participate in the study. Contacts were solicited through advertisements and articles in relevant journals and conferences. Ministry of Health staff were also canvassed for contacts and for information about telehealth in the Ministry itself. Email messages were sent to more than 200 general practices.

An information sheet was sent by email with a questionnaire to all those who responded to the call for further information. The questionnaire, which took less than 30 min to complete, focused on issues related to the operation of services developed or identified by the participants and to questions concerning future directions for telehealth.

Whilst every effort was made to reach all telehealth service providers, there is no register of telemedicine providers in New Zealand and it is possible that not all were found.

Results

The survey identified 22 different telehealth projects in 2003 compared with 12 in 2000. About half of the projects from the 2000 survey continued to be active. As elsewhere in the world, radiology and psychiatry were the most common applications. Teleradiology continues to grow in popularity in both the private and public sectors

reflecting a lack of qualified and experienced radiologists outside the main centres. Telepsychiatry remains active, possibly less utilised in 2003 due to lack of maintenance of videoconferencing units, lack of administrative support for clinic bookings and lack of clinician champions in some locations. Clinical champions move on and the workers who are left do not always maintain the same level of interest in telehealth.

There were examples of primary care, teletriage and administrative usage as well as single representations from a small number of other clinical specialties such as paediatrics and support for clinicians in the Cook Islands. Telehealth offers opportunities for the provision of cost-effective care to Samoa and to Pacific Island communities that have difficulty in recruiting and retaining suitably qualified staff.

The projects surveyed made use of a range of telecommunication technologies, including mobile telephones, ISDN and broadband. Few projects used store-and-forward procedures. The Auckland region had the highest concentration (9 of 22) of services and activity was greatest in the North Island. This reflects the focus on secondary care where major hospitals in major population centres act as hubs to provide services to outlying areas.

The survey revealed a predominance of clinical, as opposed to administrative, telehealth applications. However, there had been no broad movement of projects from pilot to mainstream delivery, as predicted by the 2000 survey. What was also surprising was the absence in either the 2000 or 2003 surveys of tele-obstetrics care, particularly for pregnancies arising in remote areas such as those in the South Island. There were sporadic examples of ICT use for tele-education, but no evidence of systematic, embedded practice.

Discussion

Implications for future developments in telehealth

The WAVE report [6] published in 2001 is the Ministry of Health's strategy for exploiting the opportunities presented by information management and technology. It contains few explicit references to telehealth but does refer to the benefits attending the remote monitoring of home-care patients, the development of remote virtual reality surgery, and distance diagnosis using visual imagery. The present survey shows that several of these forms of telehealth are already practised in isolated pockets but their potential and extension across New Zealand will only be realised with better co-ordination.

The Primary Health Care strategy [4] outlines changes to the delivery of primary care in New Zealand. It is now the District Health Boards' responsibility to fund and ensure the delivery of primary care. This change encourages an integrated model of care, and also highlights the requirement to develop the primary workforce. Telehealth can help achieve these goals through the dissemination of patient information across sectors and the provision of teleconsultation services to support primary care providers.

The Primary Health Care strategy notes that primary health organisations must be able to identify disadvantaged groups within their populations. Meeting their needs may

mean a variety of approaches for hard-to-reach groups, including the need to deliver services and providers to people who cannot get to them. The strategy also recognises the need for access to information so that individuals are enabled to manage their own problems, wherever possible. Electronic referral guidelines are also identified as a means of improving the co-ordination between primary and secondary care. Telehealth via broadband, combined with messaging standards such as HL7, would go some way to providing these types of services through teleconsultation with specialists and information and interactive advice via the Internet.

The move towards seamless care can also be facilitated through the delivery of electronic discharge summaries from hospitals to GPs, as acknowledged in the WAVE strategy. Electronic access to hospital laboratory results from tests requested by the GP further enhances seamless care.

Implications for the future

Whilst exposing these opportunities and their strategic context, the survey also directed attention to the barriers to telehealth that seem to arise wherever it has been applied [7,8], i.e. funding, uncertain cost-effectiveness, compatibility of equipment and standards, clinician and patient acceptance, privacy, security, ethical, legal and reimbursement issues.

Notwithstanding these issues, the survey reveals several factors in the current New Zealand environment that suggest that telehealth may have much to offer patients, providers and policy makers. These factors include the ageing population and the increased incidence of chronic disease, the consequent shift to care in the community, the shortage of skilled, specialist clinicians and allied health professionals (particularly in rural areas), the ongoing development and improvement of the health network, and the increased expectations by the public and professional bodies for ongoing education of the health workforce. These factors, together with the increase in activity since the 2000 survey, produce a clear recommendation for further study leading to the development of a national framework to co-ordinate and encourage these activities and realise their benefits.

Directions for telehealth in New Zealand

The following recommendations seek to define the essential features for future telehealth policy. The framework should:

- be continuously informed about the current state of telehealth in New Zealand
- find mechanisms to disseminate good practice in telehealth
- promote telehealth as an information source for patients, addressing in particular the needs of those who want greater control and choice in the own care
- promote telehealth as a means of broadcasting information on public health and lifestyle issues
- investigate how telehealth services can assist providers and patients in rural communities
- compare the needs and benefits of telehealth policies for urban and rural communities

- explore the role of telehealth in chronic care and disease management
- support innovation and find ways to move successful pilot studies into mainstream healthcare
- address the issues of standards including clinical and technical guidelines and protocols for the conduct, documenting, and auditing of telehealth consultations
- use education and training to produce a high level of awareness and competence in telehealth amongst healthcare practitioners
- determine international best practice in telehealth and its relevance to New Zealand
- investigate opportunities for commercialising New Zealand's expertise in telehealth by offering clinical and other services to overseas clients.

The provision of telehealth in New Zealand is currently patchy and exhibits the same barriers to success as have been identified elsewhere, which make it difficult to move telehealth into routine operation. The obstacles constitute not so much a failure of individual projects as a lack of a driving force to take advantage of the opportunities. It is to be hoped that the suggested strategic framework can help to harness the opportunities.

Acknowledgements

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Evaluation of compressed video images for emergency telemedicine work with trauma patients

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Summary

Video encoders in telemedicine systems need to adjust their coding methods for operation on heterogeneous networks where bandwidth fluctuates. We evaluated MPEG-4 compressed video pictures of three trauma patients. We compared the difference between original video frames and compressed video frames, using the PSNR (peak signal to noise ratio). In a qualitative evaluation, three emergency specialists scored the quality of the video images blind, on a five-point scale (1=bad to 5=excellent). The PSNR increased as the bit rate increased from 0.2 to 6 Mbit/s. When the bit rate was fixed, in other words at a given network bandwidth, a higher PSNR was obtained at the expense of spatial resolution and frame rate. The video quality was highly affected by the amount of camera shake. Emergency telemedicine systems require a high bit rate, high spatial resolution and a high frame rate to achieve optimum video quality. However, if the bandwidth is limited (i.e. the bit rate is fixed), spatial resolution becomes more important than temporal resolution.

Introduction

In some applications telemedicine systems must operate via the Internet, which is composed of many heterogeneous networks, so that transmission bandwidths may vary. Thus, a scalable video encoder should be incorporated into the design of such telemedicine systems to counter the effects of the varying bandwidths. Such a device should adjust coding parameters like the compression and frame rates [1,2]. Coding parameters can highly influence transmitted image quality.

In order for telemedicine systems to operate in a variable bandwidth environment, patient video decompressed at the receiver should retain the minimum quality required for remote patient inspection. In the case of emergency telemedicine systems, the transmitted video quality is important to allow adequate inspection of trauma patients. Some research has been performed on the evaluation of image quality in terms of compression ratio and frame rate [3,4]. However, the effects of video acquisition conditions, including camera shake and tilt, and the ambient illumination, have not been comprehensively examined. We have therefore evaluated these effects on compressed video pictures of trauma patients.

Methods

Three emergency trauma patients (forehead laceration, scalp laceration and lower leg laceration) were involved in the experiments. Patients gave informed consent before participation and permitted us to record video images for the purposes of the study. The original video recordings were approximately 1 minute in length. MPEG-4 compression using a DivX software library (Digital Digest Co.) was used to produce the compressed video files for quantitative and qualitative evaluation by changing: (a) bit rates (200, 400, 600 and 800 kbit/s, and 1.0, 2.0, 4.0 and 6.0 Mbit/s), (b) spatial resolutions (640x480 and 320x240 pixels), and (c) frame rates (30, 15 and 5 frames/s).

Video capture

The effects of different video capture conditions (camera shake, camera tilt and environmental lighting conditions) were evaluated at a fixed bit rate of 1 Mbit/s. Camera shake was examined using a fixed (without shake) and portable camera (with shake). Camera tilt was examined by directing the camera 60 degrees from the horizontal. The normal light intensity in an emergency room is approximately 300 lx (without light illumination), while a lamp with two 130 W light bulbs (Hanalux blue80 Mobile, Hanau-Med, Germany) can achieve an intensity of 20,000 lx.

Evaluation of video images

Quantitative and qualitative evaluations were performed to examine video quality [5]. First, we compared the difference between original video frames and compressed video frames, using the PSNR (peak signal to noise ratio):

$$PSNR = 20 \log_{10} \left(255 / \sqrt{\frac{1}{MN} \sum_{y=1}^M \sum_{x=1}^N [I(x,y) - J(x,y)]^2} \right)$$

where $I(x,y)$ is the original image, $J(x,y)$ is the decompressed image, and M and N are the dimensions of the image. In the case of reduced spatial resolution (320x240), the original image was down-sampled by the factor of 2 to compose reference images for mean PSNR calculations. In the case of a reduced frame rates (15 frames/s and 5 frames/s), frames were excluded, and the remained frames were used to calculate the mean PSNR.

In the qualitative evaluation, three emergency specialists scored the video images blindly from 1 to 5 (from bad to excellent). The mean score difference was the average difference between the observers' scores for the uncompressed video and for compressed video.

Results

Video coding

The PSNR increased with increases in bit rate, Fig 1. When the bit rate was fixed, in other words at a given network bandwidth, a higher PSNR was obtained at the expense of spatial resolution and frame rate. Image quality was found to be proportional to the PSNR, i.e. a better image quality was obtained after decompression as the bit rate increased, and spatial and temporal resolutions decreased. However, according to the qualitative evaluation (Fig 2), video quality increased as bit rate, spatial resolution and frame rate increased. Higher resolutions (640x480), and higher frame rates (30frames/s), at a fixed bit rate, could maintain a better quality. Hence, to maintain subjective clinical video quality, reduced spatial resolution and reduced frame rate should be avoided, even though they can be compromised in terms of PSNR performance.

Video capture

Effects due to different video capture conditions were evaluated in terms of PSNR and mean score differences, as shown in Table 1. PSNR differences were only slightly affected by changes in spatial and temporal resolution. On the other hand, the mean score differences showed the importance of the video capture conditions. Camera shake had the most detrimental effect on image quality. The illumination of the area of interest was the next most important variable. Camera tilt had the least effect on video quality. Spatial resolution was found to be more important than the frame rate for maintaining image quality.

Table 1. Mean PSNR differences and mean score differences in different video capture and video coding conditions

Video quality		Mean PSNR difference			Mean score difference		
Resolution (pixels)	Frame rate (frames/s)	Shake (dB)	Tilt (dB)	Light (dB)	Shake	Tilt	Light
640x480	30	0.31	0.37	0.49	3.1	1.0	1.6
640x480	15	0.27	0.38	0.1	2.2	0.8	1.8
640x480	5	0.35	0.62	0.46	1.8	0.5	1.5
320x240	30	0.27	0.51	0.58	2.4	0.8	1.5
320x240	15	0.21	0.37	0.19	2.2	0.7	1.7
320x240	5	0.12	0.54	0.22	1.2	0.6	1.45

Discussion

Although PSNR measurements can be used as a quantitative index of video quality, we found that subjective scoring was a more practical means for inspecting quality remotely in clinical practice. Emergency telemedicine systems require a high bit rate, high spatial resolution and a high frame rate to achieve optimum video quality. However, if the bandwidth is limited (i.e. the bit rate is fixed), spatial resolution becomes more important than temporal resolution. Because camera shake can markedly affect video quality, a portable emergency telemedicine system should be managed to minimized camera movement. If a camera is fixed to telemedicine equipment, the tilt angle of the camera should be within some pre-defined range, so as not to reduce video quality. Proper illumination of the wound is important for both movable and fixed cameras.

We evaluated the effect of coding and video capture conditions both quantitatively (PSNR) and qualitatively (mean scoring method), particularly with respect to MPEG-4 compressed video images of trauma patients. Video quality was markedly affected by camera shake and illumination. In terms of the coding, spatial resolution affected video quality more than frame rate. These results are important when designing telemedicine equipment for emergency trauma consultations via heterogeneous networks.

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Fig 1. Quantitative evaluation: PSNRs in different video conditions

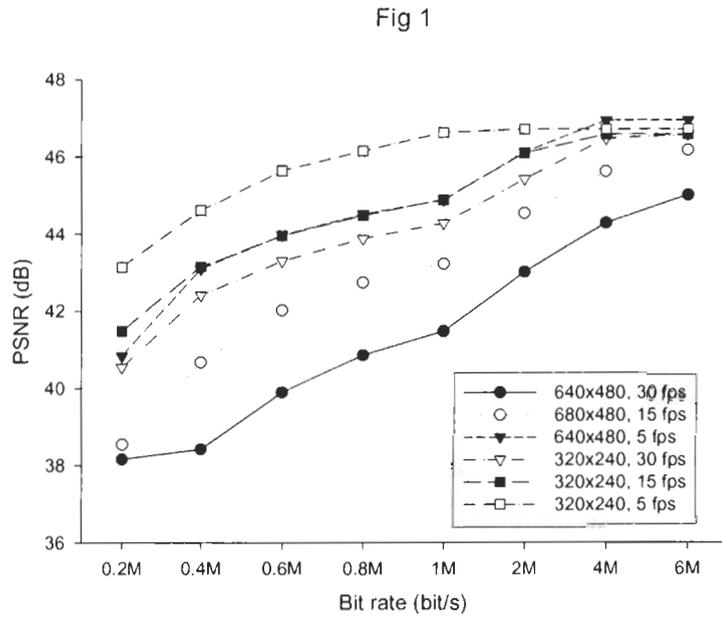
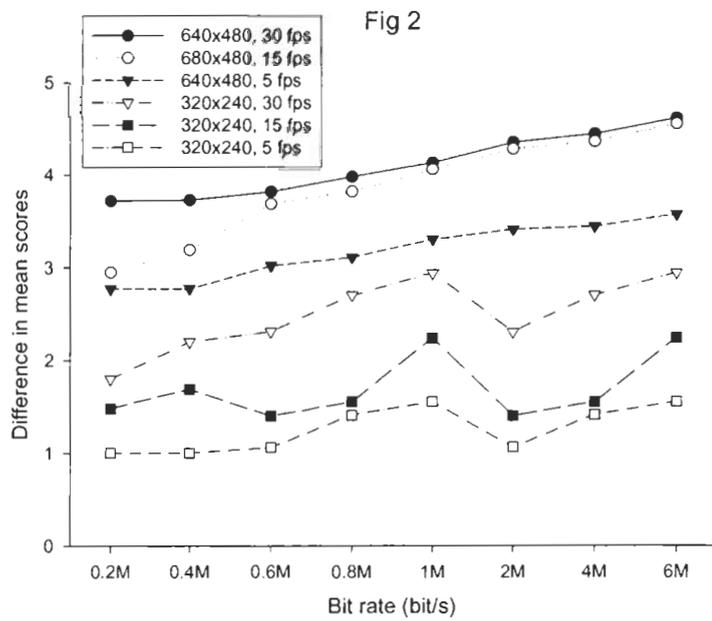


Fig 2. Qualitative evaluation: differences in mean scores in different video conditions



Telemedicine consultations: failed cases and floundering specialties

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Summary

The Arizona Telemedicine Program began as a multi-service provider with teleconsultations in over 53 sub-specialties. Although new sites often use numerous sub-specialties at first, this is typically followed by a longer period where only a few sub-specialties are used. A retrospective analysis of the referral rates from the sites showed wide variations, some exhibiting extreme fluctuations. There was a high correlation (0.84) between personnel turnover rates at each site (i.e. the number of personnel changing) and the degree to which the fluctuations were "out of control". Over a period of six years 402 teleconsultations were scheduled but did not occur. 82% were closed with no further contact. 63% were managed eventually via telemedicine, all in telepsychiatry. The reasons for these appointments not taking place were that the patient did not show up (45%), the patient cancelled (32%), the telepsychiatrist cancelled (22%) or bad weather prevented travel (1%). 84% of unsuccessful teleconsultations were real-time and 16% were store-forward. The average cost to the provider of a missed real-time teleconsultation was US\$228 for a one-hour session.

Introduction

The Arizona Telemedicine Program (ATP) has provided teleconsultations since 1997 [1]. It began as a multi-service provider with teleconsultations in over 53 sub-specialties. As each site was connected to the network there was initial use of numerous sub-specialties, typically followed by a longer period where only a few sub-specialties were used. Sustained periods have been interspersed with other sub-specialties, but not to the same degree. Some sites have focused primarily on teleradiology or telepathology, with few teleconsultations involving the patient

directly [2]. Other sites have focused on one or two sub-specialties, mostly telepsychiatry and teledermatology. Analysis of these characteristics may be helpful in planning future developments.

Methods

As part of the ATP quality control programme, records are kept of all patient encounters, recording information about demographics, encounter types and general network usage for each site. For the present study, a retrospective analysis of these records was conducted to determine changes in referral patterns, types of cases being referred and the reasons for failed telemedicine consultations. Failed cases were those that were scheduled, but did not occur at the scheduled time for some reason.

Results

Since its inception, the ATP has provided teleradiology services to 21 sites (see Fig 1). Four of these sites (19%) also refer telemedicine cases to the ATP hub site. Two of these four sites (50%) started out using mainly teleradiology services, then progressed to referring other specialties for telemedicine. In this sense teleradiology was the driver for telemedicine in general. Seven sites (in Arizona, Mexico, China and Panama) have used our telepathology services for several years. The two primary sites in Arizona use telepathology exclusively, without referring cases in any other specialty.

When the referral rates from each of the seven main telemedicine sites are examined, it is clear that they vary from month to month. Statistical process control (SPC) methods [3] can be used to determine if the observed fluctuations are normal or out of control. SPC looks at the SD of number of cases received each quarter from a given site, rather than looking at the individual frequencies of cases from sites. This represents fluctuation better than the raw numbers or some summary statistic such as the mean (see Fig 2). Overall, the site fluctuations were considered to be within normal ranges of variation, but when individual sites were examined, some were out of control (i.e. fluctuations were more extreme). There was a high correlation (0.84) between personnel turnover rates at each site (i.e. the number of personnel changing) and the degree to which the fluctuations were "out of control" (i.e. 1, 2 or 3 sigma). That is, sites with higher turnover rates in personnel tended to be more out of control than those with lower personnel turnover rates.

Failed teleconsultation rates have also been examined [4]. Over a 6-year period there were 402 teleconsultations that were scheduled but did not take place, out of a total of 4317 scheduled teleconsultations. 82% of failed consultations in 28 subspecialties were closed with no further patient contact. 63% of patients who missed an appointment, however, were managed eventually via telemedicine. All were in telepsychiatry. The reasons for these appointments not taking place were that the patient did not show up (45%), the patient cancelled (32%), the telepsychiatrist cancelled (22%) or bad weather prevented travel (1%). These reasons were similar to those for failed appointments in our traditional psychiatry clinic. There were no significant changes in the proportion of unsuccessful to successful cases from year to year. 84% of unsuccessful teleconsultations were real-time and 16% were store-forward. The difference between real-time and store-forward is significant. The

average cost to the provider of a missed real-time teleconsultation was US\$228 for a one-hour session.

Discussion

Success and failure in telemedicine can be analysed in various ways and will differ depending on the definitions and criteria chosen to define these concepts [5]. If one defines success as providing more services to more sites over time, then the ATP is clearly a success. New sites have been added to the network every year, enabling not only connection to the ATP hub site, but also interconnections between various sites that enable them to carry out teleconsultations without involving the hub. Currently there are over 120 sites connected to the network. However, growth in numbers of sites and range of services may not be the best index of "success".

Teleradiology was the first application at many of the sites, but has led to other telemedicine specialties in only a few cases. This is not necessarily a failure, but simply reflects the particular needs of certain sites. It is possible that in future they may extend to other sub-specialties or carry out other consultations with other sites than the hub (to maintain their regular referral patterns). Equally, it is possible that they may remain focused on teleradiology.

In terms of failed teleconsultations, there were fewer than 4% of scheduled teleconsultations that never took place, i.e. many were re-scheduled successfully. The failed teleconsultations were all in telepsychiatry which may simply reflect the characteristics of this type of patient, rather than indicating a more basic problem with telemedicine itself. The failure rate might be reduced with better patient education, improved patient contact and follow-up, and perhaps better screening of these patients to try and pre-judge their compliance to scheduled consultations. Missed consultations obviously result in a loss of income to the provider, but the relatively low proportion of cases that are complete failures is not regarded as a significant problem.

The ATP continues to expand the network and services to more sites in Arizona. Overall, we judge that the telemedicine programme is quite successful.

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Fig 1. Map of the Arizona Telemedicine Program network.

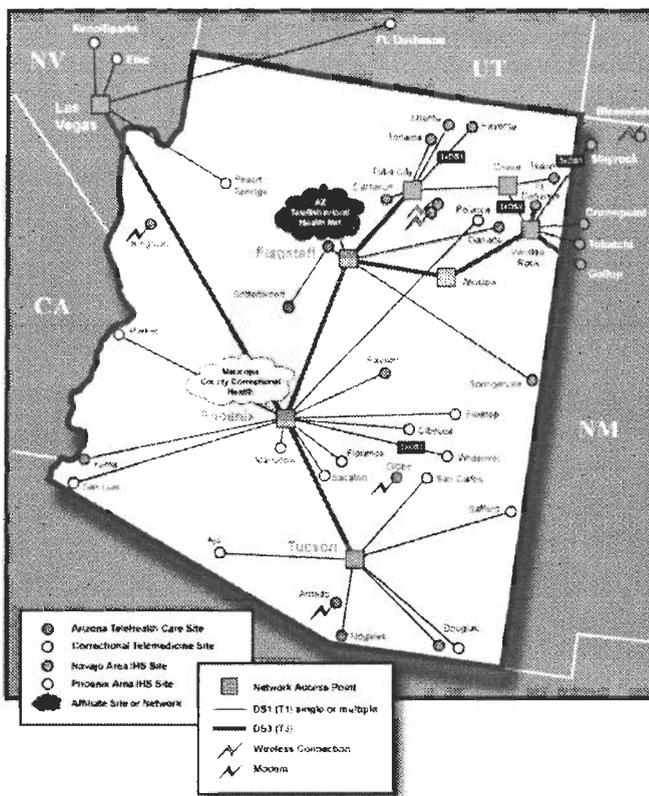
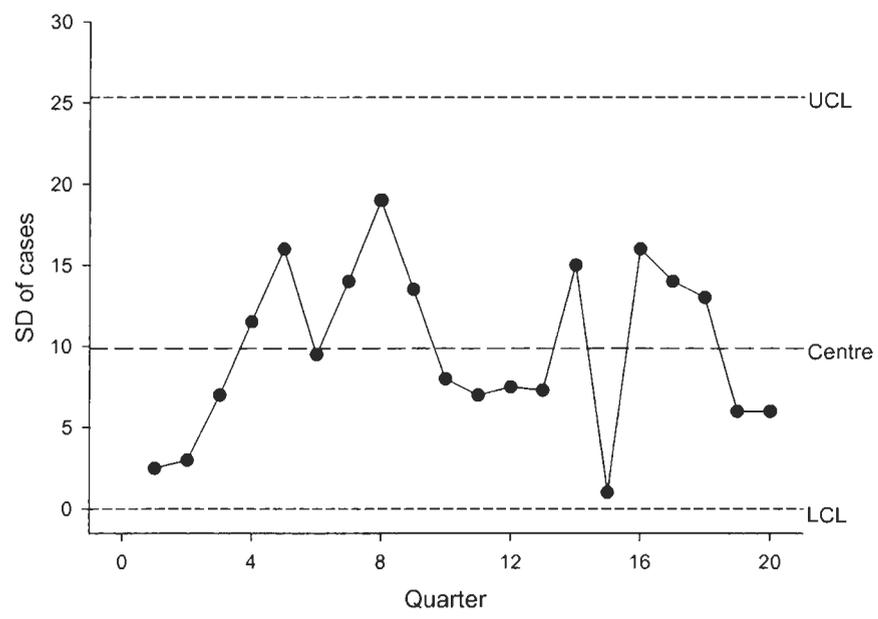


Fig 2. S chart for all the site data combined over a 5 year period (20 quarters) analyzed using 3-sigma limits. UCL = upper control limit. LCL = lower control limit.

Fig 2



The successes and challenges of developing a prison telepsychiatry service

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Summary

Recent reforms in prison health care in the UK have significant implications for the future organisation and quality of health care delivered to prisoners. Prisoners are not typical of the general population with regard to their health needs, having a disproportionately higher incidence of mental health and drug misuse than the general population. Health care delivery in prison faces a significant number of challenges not experienced by other health care organisations. Telepsychiatry is one strategy to improve the accessibility and quality of mental health care in the prison setting. Despite some initial challenges a telepsychiatry service was successfully established between a medium secure unit located in Fareham, Hampshire and a Category B training prison located on the Isle of Wight. Low cost, PC-based video conferencing system was used, connected by ISDN lines at 128 kbit/s. A valuable lesson that was learnt was the importance of having the support of key individuals in a prison setting.

Introduction

At present the vast majority of prisoners with mental health needs receive a standard of health care far below that afforded to patients in the community or hospital [1]. Prisoner's lifestyles are more likely to put them at risk of ill health. Many prisoners have had little or no regular contact with health services before entering prison [2,3]. Mental illness, drug dependency and communicable disease are the predominant health problems among prisoners[4]. The prevalence of severe and enduring mental illness in prisoners is higher than equivalent community rates [5]. As many as 90% of prisoners have a diagnosable mental illness, substance misuse problem or, frequently both [6].

A period of imprisonment could offer opportunities to improve the health of prisoners. Access to the prison health service may be the first opportunity for an individual to receive care and treatment in an otherwise disordered and sometimes chaotic life. However, opportunities to engage with prisoners are often missed due to the restrictive nature of the prison environment and the emphasis upon security and containment. Health services are isolated in prisons and are poorly resourced and under funded [7]. Health care for prisoners will always come second to other requirements in prison, such as security.

The prison service has been subject to criticism for many years for not providing suitable standards of health care to prisoners [8]. However, in recent years things have begun to change. A formal partnership between the NHS and the Prison service was formed in 1999[9]. The express purpose of this partnership is to improve health care standards for prisoners.

In adopting a collaborative approach to health care delivery in prisons it is clear that there are barriers which will need to be overcome. Prisons have highly restrictive regimes and staff are often faced with time constraints [9]. The present period of prison health reform offers increasing challenges to an already overburdened and poorly resourced National Health Service. In recent years the NHS has been looking at new ways of delivering health services to those that require them. The increasing adoption and use of information and communication technology has been instrumental in forming new kinds of services. This is evident in the development of recent services such as NHS Direct. In other countries such as Australia and the US, the adoption and use of technology to support health care delivery has been much more extensive. This has partly been prompted by the large distances that separate patients from health services.

In the US, telehealth has been used within the correctional system to deliver equitable health care to prisoners.[10] Many US prison systems have well developed prison telehealth services which are well established and operate regular clinics. Telehealth may provide the only regular access to specialist health care.

Establishing a UK prison telepsychiatry service

In June 2001 a telepsychiatry link was established between a medium secure unit located in Fareham, Hampshire and a Category B training prison located on the Isle of Wight. Initially it was anticipated that this system could be used to provide additional health care alongside an already established visiting service. However, no evaluation of this service had been conducted and there was limited empirical evidence to support its introduction. This led to the design of an evaluative study which commenced in December 2001 with three main aims:

1. to establish the validity and reliability of the telepsychiatry interview as an instrument for eliciting and rating psychiatric signs and symptoms
2. to determine the level of satisfaction with the telepsychiatry service from the perspective of the patient, psychiatrist and prison staff
3. to determine the cost of the telepsychiatry service compared to the existing visiting service.

Establishing the service

The introduction of any new service in a prison will need the support of the prison governor to succeed. Without the endorsements of this key individual any new venture is likely to fail. Initial discussions and an outline of the proposed service were discussed with the Governor. Once he had granted permission for the study to go ahead it was possible to begin installing the equipment and organising the installation of ISDN lines.

A low cost, PC-based video conferencing system was installed (Cruiser 75, VCON). Discussions were held with the prison staff about suitable storage and supervision of the equipment. There was initially anxiety about connecting the system to what was perceived to be an Internet link. This needed clarification in order to allay these concerns.

One of the notable features of prison work is the often slow pace at which things happen. Due to complex contractual agreements with telecommunication companies, it took several weeks of negotiation and a four month wait to get the ISDN line installed. This was further hampered by a decision to refurbish the health care centre, which consequently involved moving telepsychiatry equipment to another office. The service finally became operational in March 2002.

Once the system was operational this led to a period of testing the equipment. Initially problems were encountered with the sound, and unfortunately there was very limited technical support available. The local NHS Trust provided some guidance, but in hindsight it would have been better to have purchased additional IT support. It took a number of weeks to resolve the sound problems but by April 2002 the system appeared to be working well. A number of trial sessions were used to ensure that the equipment was functioning correctly. This also allowed staff at each site to familiarise themselves with the operation of the system.

Evaluation

Once the system was fully operational, the evaluation of the service was able to start. Recruitment of participants to the study was facilitated by a community psychiatric nurse based at the prison. Between July 2002 and April 2003 a random sample of 81 prisoners in contact with the prison mental health service were assessed by a psychiatrist and a face-to-face health care professional simultaneously. The psychiatrist sat in an office in the medium secure hospital in front of the videoconferencing equipment and conducted an assessment of the prisoner's psychopathology using the Comprehensive Psychopathology Rating Scale [11]. The prisoner and a health professional sat together at the prison health care centre. Both rated the prisoner's responses to the rating scale items. Following the initial assessment interview, 20 prisoners also took part in a semi-structured interview which aimed to elicit their views about acceptability and satisfaction with the service.

The period of main data collection ran fairly smoothly. Additional burden was placed upon both prison officers and the community psychiatric nurse who had to escort prisoners between the wings and the health care centre, although good will and support of the study facilitated this. On some occasions there were difficulties

escorting prisoners to the centre due to staff shortages and staff being moved to other areas of the prison to deal with an incident. This emphasised the importance of being flexible and accepting that certain issues took priority over the research study. Ultimately this emphasised how security and containment took priority over everything else.

Discussion

Despite some initial challenges the telepsychiatry service was successfully established and underpinned by a research study which has produced favourable outcomes. The results of the service evaluation suggest that videoconferencing can provide a reliable assessment of a wide range of psychiatric signs and symptoms, and that this method of health care delivery is both feasible and acceptable in a prison setting. Following the successful completion of the service evaluation, this now leads to perhaps the greatest challenge: moving from a service which was driven by a research agenda to a fully operational service.

A valuable lesson from this study was the importance of having the support of key individuals in a prison setting. Forging a working relationship with staff allows support for a study to build and raises the chance of a new service becoming accepted. Ensuring that prison staff are involved in establishing a new service also reduces anxiety and avoids possible sabotage of a new service.

Acknowledgements

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Is there a contradiction between telemedicine and business?

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Summary

Is there a contradiction between telemedicine and business? The driving forces in the telemedicine market are: competition within the health care industry, newly developed cheap IT solutions and especially the Internet, and 21st century health care consumers, with their expectations of free choice and a high level of healthcare. The market has four segments (citizens, patients, professionals and employees) and the boundaries between these segments are blurred. The telemedicine market is obviously growing, but it is still unstructured, fractured and disorganized. The telemedicine market needs a meeting place where the status of telemedicine and telecare can be reviewed, a place to explore new ways to improve the efficiency of health care services and a forum to define a roadmap for future developments. One such place is the International Trade Event and Conference for eHealth, Telemedicine and Health ICT, Med-e-Tel. At the 2004 event, there were 32 exhibitors from 23 countries and over 400 industry and medical participants. A survey of participants showed that the event was judged to be a success. There is no conflict between telemedicine and business. On the contrary, telemedicine is a promising business development area.

Introduction

Is there a contradiction between telemedicine and business? At first glance their objectives differ. Telemedicine aims to increase the quality and efficiency of healthcare in order to achieve the best service for everyone, at any time, from anywhere. It also aims to reduce the pressure of healthcare on national budgets and to create new working environments for health care staff. The strategic goal for business

is profitability. That is why telemedicine is more often considered as a tool to fulfil social tasks, not as a tool for making successful business. Many potential players are still struggling to grasp the broad picture in which their field of activity performs. So, it is not surprising that many questions are raised: Where is the telemedicine market? What is its structure? How big is it? Has this emerging market a specialized meeting place where suppliers of telemedicine/e-health equipment and service can meet together with buyers, healthcare professionals, institutional decision makers and policy makers from all over the globe?

Turning back to the question: is there a contradiction between telemedicine and business? The answer is a clear "No". Telemedicine is a recently emerging part of the healthcare market, which has been business driven for decades. There is equality between telemedicine and business. But compared to the traditional healthcare market, the telemedicine market has some specific characteristics.

Some of the problems have their roots in the historic development of telemedicine. Due to the high cost of information technology, most projects were initially funded under national or international programmes. This is often the case, even now. For the first e-health call under the 6 Framework Programme of the EU, the budget for telemedicine was € 70M. Some observers have used the size of this funding as an economic measure of the size of the telemedicine market, but this is not correct.

In the late 1990s, telemedicine began to expand in many directions. The development of digital diagnostic peripherals, the worldwide distribution of low cost mobile phones and the Internet, led to major growth in the number of ways that patients and physicians could interact. Many surveys were performed to understand the market but telemedicine grew faster than our ability to measure it as a business sector. Most surveys have been based on relatively small samples in one or two countries [1]. They are to be welcomed, although they are obviously restricted in scope. One solution might be to develop an all-inclusive measurement system for telemedicine, but this is not realistic. Thus, we have to accept that at present it is not possible to have a precise picture of the telemedicine market. We have to concentrate on what is already known.

The telemedicine market

To understand the market it is essential to identify its main driving forces. These are: competition within the health care industry, newly developed cheap IT solutions and especially the Internet [2] and 21st century health care consumers, i.e. the three "C-consumers" (cash, college and computers) and their expectations of free choice and a high level of healthcare [3]. These driving forces are not restricted by national boundaries, continents, religion, culture or social status and are closely connected with the segmentation of the telemedicine market. The market has four segments: citizens, patients, professionals and employees. Boundaries between these segments are blurred as members of society participate in different segments during different periods of their lives [4]. Each segment has its own needs and expectations which very often overlap.

The next step in understanding the market is to put together a list of current telemedicine activities. In general they are: (1) health-related commercial activities,

i.e. medical equipment and supplies, health insurance, medications, clinical services; and (2) telemedicine web sites that have enjoyed a faster growth than the general use of the web. The sites are either non-interactive (e.g. distributing health-related information) or interactive (e.g. specialized online support groups offering after treatment care).

Forecasts

Several analyses have been published with estimates of the market value of telemedicine and make predictions for its development. An example is the CHIC market forecast [5] (Table 1).

Table 1. Market forecast based on Compound Annual Growth Rate (CAGR) [5]

Region	Forecast growth rate (% per annum)
Asia Pacific (excluding Japan)	17
Australia	15
Canada	14
Europe	8
Japan	12
USA	10

Irrespective of forecasts, one has to remember [6] that “the true measure of telemedicine should also include the value of expenditures on telecommunications, human capital and other resources consumed in the process of delivering health care over time and distance. Almost any estimate of the size of telemedicine business should be interpreted with a big grain of salt.”

Last but not least, it is necessary to recognise that at the moment telemedicine market is facing serious barriers, such as:

- funding
- staffing, i.e. staff with IT skills and experience in health environment [7]
- the pace of technological change
- reimbursement. This is one of the greatest barriers, as online health providers cannot compete with healthcare that is paid for by insurance companies
- legal issues and the need for globally-recognized safety standards
- lack of regulations concerning more global development and distribution of telemedicine that are extremely important in the time of globalization. The first steps were taken by the EU policy in setting up specific action plans (eEurope2002 and eEurope2005) to contribute to the development of e-health across EU, because only telemedicine can help to meet the challenges faced by European healthcare systems [7].

To sum up, the telemedicine market is obviously growing. We are witnessing a growth in the search for e-health services. There is a discrepancy between demand and supply, with demand surpassing supply. Some proxy measures of market growth

include: the increasing number of trade show exhibitors every year, the accelerating number of published telemedicine applications, a rapid increase in the number of websites offering telecare, reimbursement for telemedicine is becoming common although it is not a government policy and people have to pay out of their pocket for it. These are signs of growth, not of stagnation.

At the same time, we have to admit that the telemedicine market is still unstructured, fractured and disorganized. The path from research activities to practical application is far too long and takes too much time. Judged by international developments, the situation in various countries is ambivalent. And most important, when analysing this market one has to consider managing for long-term value — something very different to managing for short-term capital gains and stock options that are a characteristic of the IT market.

The Med-e-Tel event

As mentioned above, nothing is possible without a global strategy as the extensive use of telemedicine requires specific general conditions and infrastructure. The telemedicine market needs a meeting place where the status of telemedicine and telecare can be reviewed, a place to explore new ways to improve the efficiency of health care services and a forum to define a roadmap for future developments. One such place is the International Trade Event and Conference for eHealth, Telemedicine and Health ICT, Med-e-Tel (see <http://www.medetel.lu>. Last checked 13 July 2004).

The role of Med-e-Tel is to organize a specialized e-health and telemedicine exhibition, enhanced by a high-quality scientific programme, and to bring together suppliers of equipment and services with buyers, healthcare professionals, decision makers and policy makers from many countries. This is an annual event, organized in Luxembourg, in cooperation with the International Society for Telemedicine (ISfT).

The goal of the ISfT is to promote e-health and telemedicine around the world, to facilitate international dissemination of knowledge and experience in telemedicine and e-health, and to provide access to recognized experts. The ISfT is a non-governmental, not-for-profit organization of individuals, institutions and corporations, established and governed under Swiss law. It is an international representative body of national and international telemedicine and e-health organizations, and fulfils its mission in close collaboration with the World Health Organization, International Telecommunication Organization (ITU) and other international and national bodies (see <http://www.isft.net>. Last checked 13 July 2004).

The centrepiece of the Med-e-Tel event held in April 2004 was the exhibition where suppliers and users of telemedicine equipment and services exchanged information, established new business relationships or reinforced existing ones, found solutions to problems, looked for partners and new markets, and viewed the telemedicine applications available. There were 32 exhibitors from 23 countries and over 400 industry and medical participants coming from 50 countries around the world (Table 2).

Table 2. Organizations attending Med-e-Tel

Organization	No
Companies	143
Universities and research centres	39
Hospitals	27
National decision makers	14
International bodies	9
<i>Total</i>	232

In a survey of 70 participants from Africa, Asia, Europe and North America, the event was judged to be very successful (Table 3).

Table 3. Results from the evaluation questionnaire (n=70). 41% of responders were from the private sector, 24% from research institutions, 20% from government or public organizations, 7% from international organizations and 6% from non-government organizations.

Topic	Proportion responding positively (%)
Will recommend Med-e-Tel to colleagues	84
Plan to follow up in the future	85
Satisfied with the content of Med-e-Tel	87

Education

Simultaneously with the exhibition, there was an extensive educational programme. A total of 77 presentations from 29 countries from Africa, Asia, Europe and North America allowed participants to obtain information about newly developed telemedicine technologies and applications. The exhibitors' presentations covered commercial products, while presentations from research units offered knowledge about future developments in telemedicine, and presentations from health centres described telemedicine applications for patient monitoring and their cost efficiency.

The Telemedicine and eHealth Directory 2004, was presented at Med-e-Tel.(see <http://www.medetel.lu/teldir/teldir.html>. Last checked 13 July 2004). This is a project initiated by the ITU in cooperation with Med-e-Tel and the ISfT.

Conclusion

From the above it can be seen that there is no conflict between telemedicine and business. On the contrary, telemedicine is a promising business development area. The market exists and is steadily growing.

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A pilot study of physiotherapy education using videoconferencing

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Summary

We investigated the possibility of instructing assistants about activities of daily living via videoconferencing. A videoconference system was installed in two rooms to simulate a connection between a home and an institution. The subjects were five first-year university students with no experience. First, they saw a videotape of several general assistance procedures on sitting-up, standing-up and walking with a cane. Then they actually assisted with a simulated patient, suffering from right hemiplegia due to a stroke. They received instructions from a physiotherapist in another room using the videoconference system. We used five grades to evaluate each technique. The results showed that it was most difficult to get precise assistance on activities of standing up from sitting with legs stretched in a Tatami room. The average of the first assistance was 34.5 points out of 45. The average of the second assistance was 38.5 points out of 45. The present study shows that the delivery of rehabilitation services is feasible in remote places.

Introduction

Since 1999, we have investigated how we could provide a rehabilitation service to remote places using videophones. We have considered both the economic and technical aspects. The aims of these studies[1-4] were to investigate how to provide healthcare for people living in remote places, where there was heavy snowfall. We hoped the results would show the benefits of using videophones to give instruction in rehabilitation exercises to patients at home. However, the performance of the equipment was rather limited. Therefore, we used videoconferencing systems with a better cameras and higher quality video transmission.

The purpose of the present pilot study was to investigate the possibility of instructing novices about activities of daily living using a videoconference system. This may be useful for patients' family members at home.

Methods

We assumed that the people using the systems were novices, with no experience as assistants. We selected subjects from first year students because they had no prior knowledge of assistance techniques. The students were from the department of physiotherapy at Aomori University of Health and Welfare. There was one man and four women (n=5).

A videoconference system (PCS-1600, Sony) was installed in two rooms at the university to simulate a connection between a home and an institution. The subjects first saw a videotape of several general procedures about sitting-up, standing-up from a bed, standing up from sitting with legs stretched and walking with a cane. Then they assisted a simulated patient, suffering from right hemiplegia due to a stroke, by receiving instructions from a physiotherapist in another room via the videoconference system.

After the first assistance, we conducted a question and answer session with them. After they solved some problems, we began the second assistance. The subjects filled in questionnaires after each round of assistance. We recorded the subjects with a video recorder to monitor each assistance activity. From the videotapes, we evaluated each student in all experiments. There were five grades:

1. difficult to accomplish the performance as directed
2. performance almost completed as directed, but additional explanation was required (more than twice)
3. performance almost completed as directed but additional explanation was required (once)
4. performance completed as directed
5. good performance as directed.

We also divided each assistant technique to grade according to five ranks, as follows:

- "sitting-up" in 7 situations. The perfect score was 45
- "standing-up from bed" in 11 situations. The perfect score was 55
- "standing up from sitting with legs stretched in a Tatami room" in 8 situations. The perfect score was 35
- "walking with a cane" into 4 situations. The perfect score was 20.

The score of each assistant situation was added up. The first subtotal score was compared to the second one. In addition, the questionnaires that each subject completed at the end of each assistance were analyzed.

Results

The most difficulty was experienced with the activity of "standing from sitting with legs stretched in a Tatami room". The average of the first assistance was 34.5 points out of 45. The average of the second assistance was 38.5 points out of 45. The next worst averages were "standing-up from a bed", where the average of the first assistance was 45.6 points out of 55. However, the average of the second assistance was 52.2 points out of 55. This performance score improved the most after the question and answer session. The average score of "sitting-up" was 29.4 points out of 35. The average of the second assistance; 38.5 points out of 45. There were two students who got a perfect score after having a question and answer session. The average score of "walking with a cane" was the highest. The average of the first assistance was 17.2 points out of 20. This performance score, however, improved by the fewest points. The average of the second assistance was 17.6 points out of 20.

Discussion

The "standing from sitting with legs stretched in a Tatami room" was the most difficult performance for the students. According to questionnaires, they felt most anxious about whether they could carry this out or not. This activity requires more applied movement than others. In addition, the movement of "standing from sitting with legs stretched in a Tatami room" is one of the most perpendicular and unstable of all movements and requires the highest level of assistance. The students were also puzzled about how they could support a simulated patient's activity and where they should support the patient's low back. It was obvious that a more thorough explanation would be required when guiding members of a patient's family.

The most important observation was that all of the students stated that they felt more anxious and thought that assistance was more difficult with the more perpendicular movements. They were also unsure about how much force they needed to exert on the simulated patient. The activity "standing from sitting with legs stretched in a Tatami room" is one of most popular movements in Japan because of Japanese custom and culture and it therefore needs to be experimented with.

We have to explain not only by video-recorded assistant techniques but also by making appropriate verbal guidance to the freshmen. As a result, the level of assistance could be improved. The present study shows that the delivery of rehabilitation services is feasible in remote places.

Acknowledgements

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The ups and downs of the International Society for Telemedicine

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Summary

The International Society for Telemedicine (ISfT) was originally established in 1997 as an organisation of individuals. It suffered from years of difficult consensus and, despite the efforts of about a dozen of individual members, the Society did not flourish. In 2002 it was decided that the ISfT in its then form was no longer effective and unable to achieve its original goals, and it therefore needed to be reformed. The re-founding of the Society was carried out in 2003. One of the essential changes was the transformation of the ISfT from an organisation of individuals into an umbrella association for national telemedicine and e-health organisations. The Society's website now includes a regularly updated newsletter and a great deal of information about common efforts to prepare the ground for e-health and telemedicine. The new ISfT has more than 500 members from 18 countries and is receiving membership applications from all over the world. The ISfT appears to be moving in the right direction to serve as an international association for national telemedicine and e-health organisations, with a politically neutral and democratic attitude.

Introduction

In 1993, a meeting was held which represented a sort of precursor to the International Society for Telemedicine (ISfT). The meeting was the *First International Conference on the Medical Aspects of Telemedicine*, and it was held in Tromsø, Norway. This conference was held under the chairmanship of Dr Steinar Pedersen, now head of the Norwegian Centre for Telemedicine, who realized that such a society was necessary to harmonise much of the telemedicine work done on different continents. During the conference a business meeting was planned to discuss whether there was a consensus for the creation of a society or association.

Just prior to the meeting and also during the conference, a document was circulated which stated that “the society has already been founded, so please fill in the paper and you will then be a member”. However, this approach was offensive to many of the conference participants. Therefore, the business meeting concluded that “the already founded society” was not accepted and thus was turned down. Furthermore, the meeting was not able to reach a consensus about any alternative.

On the occasion of the *Second International Conference on the Medical Aspects of Telemedicine* in Rochester, USA, in 1995, a new initiative was launched for the creation of an international society. Again, this initiative was turned down with no further steps to be taken.

Founding of the ISfT

As part of the preparation for the *Third International Conference on the Medical Aspects of Telemedicine* held in Kobe, Japan, in 1997 the groundwork to put together a founding board and to prepare suggestions for a constitution and bylaws was carried out. Finally, during the Kobe meeting, the ISfT was founded and Dr Pedersen was elected president. From this date, annual ISfT scientific conferences were organised and supported by the ISfT. Due in part to the efforts of Dr Pedersen, the society has been kept alive.

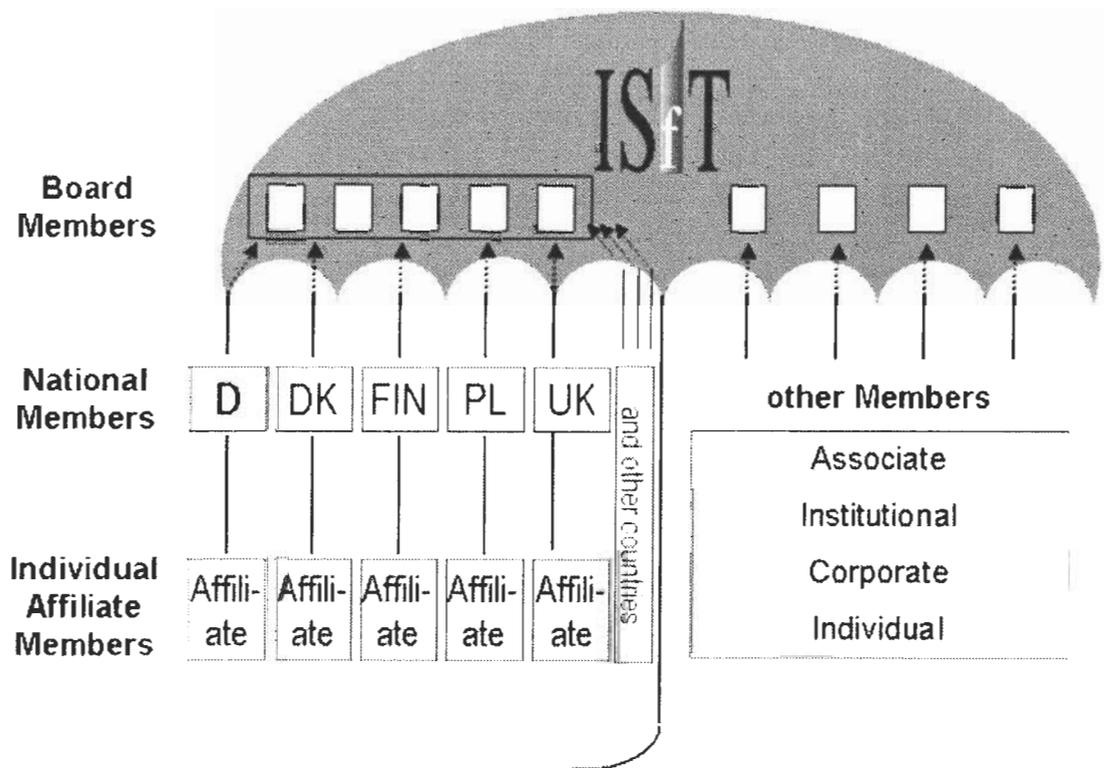
Unfortunately, growing and strengthening the ISfT turned out to be very hard work. Despite the efforts of about a dozen of individual members, the ISfT did not flourish.

Re-formation of the ISfT

During the *Seventh International Conference on Telemedicine* held in Regensburg, Germany, in 2002 it was decided that the ISfT in its then form was no longer effective and unable to achieve its original goals, and it therefore needed to be reformed. One of the long-standing problems with the original constitution of the society was its relationship with the existing and national telemedicine societies, which were fast increasing in number. It was never wholly clear whether the ISfT was intended to be a traditional society, to which individuals could belong as members, or whether it was intended to act as a federation of the national societies. In the former case, obviously, it would be competing for members in countries which already had a national telemedicine society.

The re-founding of the Society was carried out at the *Eighth International Conference on Telemedicine*, again held in Tromsø, in 2003. One of the essential changes was the transformation of the ISfT from an organisation of individuals into an umbrella association for national telemedicine and e-health organisations. The new ISfT combines representation of national organisations and their members (as affiliate members) with individual membership in countries where national organisations are not yet formed. Furthermore, other membership categories exist, including associated, institutional, corporate and individual. Even students can become members. These membership categories are explained on the website (<http://www.isft.net>).

Fig 1. The new ISfT serves as an umbrella for national telemedicine and e-health organisations.



Starting from there, the mission of the ISfT is to facilitate the international dissemination of knowledge and experience in telemedicine and e-health, and to provide access to recognized experts in the field worldwide (Box 1).

Box 1. Philosophy of the ISfT

The ISfT is a non-government and not-for-profit society with close ties to the WHO and the ITU.

It serves primarily as an umbrella association for national telemedicine and e-health organisations.

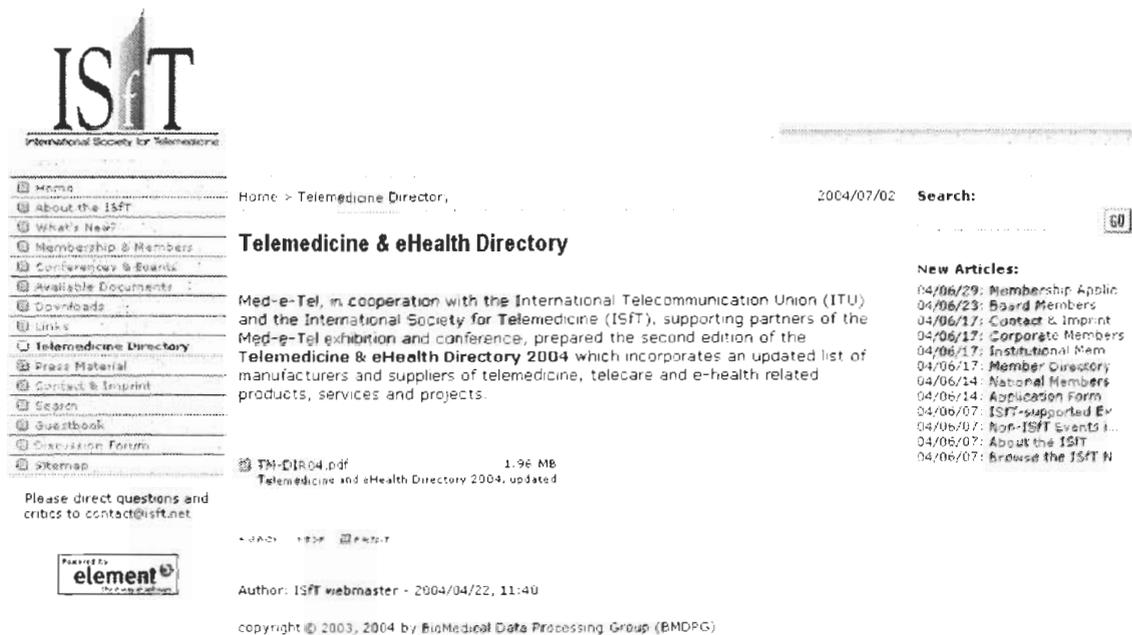
The ISfT is geopolitically neutral and democratic. It is established under Swiss law.

Further activities of the ISfT include:

- promotion and support of telemedicine and e-health activities worldwide
- assisting the start-up of new national organisations
- supporting developing countries in the fields of telemedicine and e-health.

From then on, the ISfT grew a completely new shape. The website includes a regularly updated newsletter and a great deal of information about common efforts to prepare the ground for e-health and telemedicine.

Fig 2. Telemedicine and e-health directory on the ISfT website



At the time of writing the new ISfT has more than 500 members from 18 countries and is receiving membership applications from all over the world. The number of members is growing daily. The added values of the society are probably an important reason for this interest. The ISfT provides advice and support to new national organisations and societies, networking within the international telemedicine and e-health communities, and participates in working groups on telemedicine and e-health standards and regulations. There is still a lot to do, but the ISfT appears to be moving in the right direction to serve as an umbrella association for national telemedicine and e-health organisations, with a politically neutral and democratic attitude.

The ISfT's registered office is located in Zurich, Switzerland. The coordinating office, to which all questions and applications should be sent, is located in Regensburg, Germany (see Box 2).

Box 2. ISfT coordinating office

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Conclusion

The effort to establish and especially keep alive a telemedicine society which combines national telemedicine and e-health organisations is tremendous. It has taken almost 10 years to move from a simple idea to the point of effective and harmonising work. Through conferences, regular newsletters and the website, the ISfT has a very good chance to integrate the heterogeneous tasks that the membership are busy with. The aim is to build a strong and dynamic international platform to foster the integration of telemedicine and e-health into routine medical work.

The role of telemedicine in the care of children in under-served communities

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Summary

Children living in rural and medically under-served areas are confronted with a shortage of paediatric specialists. Telemedicine has become increasingly popular as a means of providing health education and medical care to people living in rural areas in other countries as well as in the US. Some US hospitals have had experience with the use of telemedicine to provide subspecialty services to rural children with special health care needs and health education for immigrant parents. The Medical Missions for Children, a non-profit organization, aims to provide a 'virtual information bridge' between sponsoring hospitals in the US and hospitals located in developing nations. The organization serves children in hospitals in 58 countries throughout Latin America, eastern Europe, South Africa, Nigeria and India and delivers three to four videoconferences per month. Since its inception, the program has provided teleconsultations and services to approximately 18,000 children annually. In addition, there are an average of 50 educational videoconferences per month, during which physicians at the mentoring hospitals exchange ideas with physicians in the developing countries. About 600 educational videoconferences are conducted annually.

Introduction

The World Health Organization (WHO) has emphasized 'the importance of reducing social and economic inequities in improving the health of the whole population' to ensure high-quality health care for all [1]. This vision is particularly relevant to many developing countries and medically underserved populations living in rural communities in the US, who face growing health disparities. Moreover, children are disproportionately affected by these inequalities. Of the 57 million deaths in 2002,

10.5 million were among children of less than five years of age, and more than 98% of these were in developing countries [2].

Advances in information and communications technology have provided new ways of delivering health care [3]. Telemedicine has become increasingly popular in both industrialized as well as developing countries [3]. In addition, telemedicine has been successfully implemented to deliver health education and medical care to people in rural areas in other countries as well as in the US [4,5].

Telemedicine for children in under-served areas in the US

People living in rural areas, unlike those residing in urban and suburban areas, are faced with inequities in access to health care [6]. Children living in rural and medically under-served areas are also confronted with a shortage of paediatric specialists and subspecialists [6]. For children with special health care needs (CSHCN) who live in rural, medically under-served areas, obtaining a subspecialty consultation is even more of a challenge [5]. Marcin *et al* [5] reported the results of 130 telemedicine consultations for 55 CSHCN from a rural community in California. The authors concluded that paediatric subspecialty telemedicine consultations for CSHCN living in a rural community were feasible and they were considered highly satisfactory by both the parents and the rural health care providers.

Children living in the South Bronx, one of the medically under-served areas of New York City, have the highest rates of both asthma hospitalizations and death [7]. The prevalence of asthma amongst Bronx children is at least twice the US average [8]. Effective management of paediatric asthma should involve children, parents and physicians. We began videoconferencing sessions in March 2003 to deliver asthma health education to immigrant parents in the Bronx [9]. We found that videoconferencing improved asthma-related knowledge, led to knowledge retention and allayed many concerns of the audience. In our experience, interactive videoconferencing is a useful tool to deliver health education to a large immigrant population.

Telemedicine for children in developing nations

Telemedicine has an important effect on health systems in the developing world [10]. It has the potential to improve health care in many medically under-served populations by removing time and distance barriers, providing medical education and medical care and optimizing the use of limited health services available [11]. There have been many reports about the potential advantages and benefits of telemedicine as a useful technique for delivering health care in the developing world [12-14]. However, there are few reports describing actual clinical experience of using telemedicine in developing countries [15-18]. The reported use of telemedicine for children in developing countries is even more limited.

Lee *et al* [19] used low-bandwidth telemedicine to evaluate surgical patients from Kenya prior to the visit of the surgical team from the US. Fifty-one patients, including seven paediatric patients, were pre-screened. Sixty-five percent of patients were thought to be inappropriate for surgical intervention due to advanced disease or the absence of the local medical resources required. Overall, 60 patients including

nine paediatric patients underwent surgery. Paediatric cases included various laparoscopic, oncology and soft tissue reconstructions. The authors concluded that low-bandwidth, Internet-based telemedicine was a cost-effective technique that allowed efficient and effective pre-screening of surgical patients in developing countries.

Person *et al* [20] described two cases involving five and six-year old girls who accidentally suffered leg fractures and how they were helped with the use of telemedicine. This report documented a simple-store-and-forward telemedicine application that provided consultations, referrals and education in the developing world of the Pacific Rim.

Medical Missions for Children

Improving health care delivery for children in medically under-served communities by using telemedicine is the goal of the Medical Missions for Children (MMC), a US not-for-profit organization supported entirely by charitable donations [21]. The MMC global telemedicine and teaching network represents a “virtual information bridge”, comprising a network of major US hospitals that mentor participating hospitals in under-served countries [21]. The MMC provides the videoconferencing equipment (in turn donated by Polycom and other companies) for the hospital in the developing country, as well as satellite time for the communication. The videoconferencing equipment includes ViewStation EX, ViewStation FX and VS 4000 using 128 kbit/s – 2 Mbit/s bandwidth.

Physicians from the mentoring hospitals volunteer their time and expertise to participate via videoconference in remote examinations of patients, consultations about diagnosis and treatment, and education about new procedures, drugs and medical equipment. The MMC serves children in hospitals in 58 countries throughout Latin America, eastern Europe, South Africa, Nigeria and India and delivers three to four videoconferences per month. Since its inception, the program has provided teleconsultations and services to approximately 1500 children per month, adding up to 18,000 children annually. In addition, the mentoring hospitals conduct an average of 50 educational videoconferences per month, during which physicians at the mentoring hospitals exchange ideas with physicians in the developing countries. Hence, there are a total of approximately 600 educational videoconferences conducted annually.

Case report

The story of Yordano [22], a boy whose life was changed with the help of the MMC, is a living proof of what MMC is all about. Yordano is an 11-year-old boy from rural Panama who was born with a cranio-facial deformity resulting in the absence of one eye, difficulty in swallowing and mental retardation. He was the first child to use the MMC telemedicine and learning network in November 2000. With the help of telemedicine, a computer model of his head was created. Then physicians, with the use of a computer, designed implants to correct his problem. Yordano had two operations performed in the US to reconstruct his skull and jaw. After the operations were completed, an educational session was held by the surgeons from the US who used the MMC link to review the procedure with 50 physicians from Panama.

The Children's Hospital at Montefiore (CHAM) in the Bronx, New York is a mentoring hospital for the University College Hospital in Ibadan, Nigeria. Although, this programme is relatively new to our institution, we envisage many possibilities for its use in providing health education and improving access to medical care for children in Nigeria. Telemedicine is used to facilitate encounters between CHAM faculty members and Nigerian medical professionals, providing a forum for medical information exchange in the form of training sessions, seminar series, symposiums and consultations via videoconferencing.

In partnership with the MMC, CHAM is sponsoring the College of Medicine at the University College Hospital in Ibadan. Elements of the programme include the following: (1) MMC provides the telemedicine equipment for the hospital in Nigeria; (2) a curriculum of the Nigerian hospital's educational needs and interests is being developed by medical professionals in collaboration with CHAM faculty members; (3) an existing agreement between MMC and the World Bank allows CHAM to call the MMC site (via ISDN lines) and access the World Bank satellite to reach the College of Medicine at Ibadan's satellite dish; (4) the World Bank pays for the satellite time so the Nigerian hospital is not burdened with these connection costs. Our Nigerian partner has responsibility only for providing the following: (1) fixed, dedicated space for the telemedicine equipment; (2) administrative support to ensure the high quality, efficiency, and long term sustainability of the programme; and (3) an appropriate mechanism for assessing and discussing the medical and educational needs and interests in Nigeria, so as to ensure the programme contributes to the enhancement of paediatric health care.

Conclusion

The World Health Organization (WHO) in its Health-for-all policy for the twenty-first century emphasized the importance of reducing social and economic inequities in health to ensure high-quality health care for all [1]. Technological advances provide new hope for achieving this goal. Telemedicine has great potential for improving the healthcare of children living in rural and medically under-served communities in industrialised, as well as in developing countries. Telemedicine can serve as a means of providing access to subspecialty care that is lacking in rural and under-served areas. In addition, it can promote education of rural physicians as well as improve parental knowledge about childhood diseases.

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Extending a multimedia medical record to a regional service including experiences with electronic referral and discharge letters

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Summary

Oulu University Hospital has a Web-based multimedia medical record in production use. One key element in the creation of regional e-health network is an electronic referral letter and discharge letter service. In Oulu an XML messaging system is used, which is an integral part of the medical record. The service has now been extended to primary healthcare centres and hospitals at the Oulu region. Using a secure Web link, primary care physicians have direct access to the original hospital's electronic patient record (EPR) remotely, including medical images and other results. According to the users, e-referral saves time and improves the quality of documentation. On the other hand, workflow development is still immature. Our experience suggests that the implementation of e-referrals is a process which requires careful handling of various aspects, from technology to organizational changes and human communication.

Introduction

A regional health services network between primary and secondary care has been one major strategic target for Oulu University Hospital. This has included development of various e-consultation tools like teleradiology, videoconsultation services, e-learning opportunities for professionals, and electronic communication between primary and secondary care. Electronic referrals and discharge letters are key tools in sharing multidisciplinary patient information between primary and secondary care. They are

especially valuable in treating patients with chronic disease, but they can also generally improve access to care and help to avoid unnecessary repeat examinations, e.g. in radiology. In order to be effective in a major health care service network, e-referrals should be connected to local electronic patient record systems and patient databases. The roll-out process is also demanding, because different organisations have to learn how to collaborate with the new tools. We report our initial experience in order to highlight the critical factors.

Networking environment

The Oulu region primary care referral and consultation network was implemented within the public health-care system. It started in 1991 as a teleradiology consultation network and was extended with mobile teleradiology tools and also with videoconsultation services in psychiatry and surgery[1,2,3]. In 1999 the first e-referral services between electronic patient record (EPR) systems at the university hospital and primary care centres in the region were started[4].

Oulu University Hospital started a Web-based multimedia medical record project in 1995. One purpose of this development was the creation of regional health care services. The ESKO electronic patient record system now includes narrative texts of more than 250,000 patients, about one quarter of the population in the university hospital's catchment area. The ESKO EPR has a Web interface within the secure hospital network and uses middleware technology in order to provide easy access to patient information in various databases. This modular structure has made it possible to combine the digital radiology image archive and the laboratory results database into one user-friendly multimedia interface.

Based on a recent study, all the primary health care centres in northern Finland are using electronic patient records in order to store patient narratives. There are three different commercial systems in use. Those systems also include a local laboratory database. Medical imaging in primary health care is currently moving into digital radiography and archiving.

Technical features

There are two different ways to use e-referral and discharge letter services: either a standardized XML language message between the EPRs or a secure Web link. The current XML message for e-referrals, e-consultations and discharge letters has been adopted by all the major EPR suppliers in Finland. The primary care physician can use his own EPR to type in the e-referral and patient consent, and can also attach any additional information such as ECGs in the form of PDF files. After the message is sent, the physicians at the university hospital can read the information using their own Web-browser EPR. An e-referral can be turned into an e-consultation, sent further to another department, or returned to the sender. After the treatment, the referring physician receives an electronic discharge letter into his or her own system, provided the patient has allowed that.

The alternative Web link interface gives the primary care physician extended access to the patient information in the hospital information system. If the patient has given permission, the physician can read all the multimedia information relating to a

particular hospital visit. All narratives, laboratory results and full resolution radiological images are available on-line. The Web-link also makes it possible to follow the referral work flow and waiting time. All the connections are protected from intruders. The primary health care centres are connected into the university hospital over a virtual local-area network (VLAN) or a virtual private network (VPN).

Roll-out process

The service started as a pilot with one remote health care centre and has now been extended to various GP offices and other hospitals at the Oulu region. At present there are 12 out of the 17 different university clinics providing e-referral services (emergency department, internal medicine, paediatrics, radiology, ophthalmology, neurology, gynaecology, radiation therapy, anaesthetics, medical genetics, physical medicine/rehabilitation (physiatry) and dermatology). The target is to include all the clinics as service providers before the end of 2004. There are currently 13 municipalities using the services for their primary health care centres and more will be joining the team during the following months. There were less than 2000 e-referrals in the year 2003, but during the first four months of 2004 the rate increased by 40%. The roll-out has been successful because a special team consisting of a primary care physician, university hospital physicians and a nurse has been in charge of education and planning of e-services usage. They have worked from clinic to clinic giving customised advice for workflow changes.

Advantages and challenges

According to a user questionnaire, e-referrals have saved time in referral management. The department of internal medicine estimated that the process has been accelerated by nearly a week. The small extra time required at the referring physician's site is compensated by the total time saved. It is also possible to use innovative methods of distance work: a physician can answer a consultation from anywhere in the hospital network without visiting his office. E-referrals improve the quality of management: each referral is now registered electronically and its progress can be followed. The direct access to the hospital patient record provides an overview of each hospital visit and serves as a feedback mechanism to the primary care physician. The access to the imaging and laboratory databases helps to avoid unnecessary repeat examinations.

On the other hand, workflow development is still immature. A comprehensive regional database would be a better alternative for storing additional information than separate PDF-attachments. Because there is not yet an official electronic signature in Finland, patient consent forms have to be stored on paper at the originating site. Also, in the current situation, more harmonisation is needed between the guidelines from different clinics. With the help of a computer, a physician is now performing many tasks done earlier by an office clerk and thus cannot know all the hidden information in the organisation. When omitting the paper, more computer terminals than originally estimated were needed. During the roll-out process, the technological integration solutions have changed many times making user training a real challenge.

Discussion

The main target for e-referrals and Web link connections is to enhance seamless care between health centres and hospitals. According to our user experience many practical problems have been associated with over-complicated technology and a lack of standardization. The Finnish National Health Project has accepted a bold challenge: interoperability between the various electronic patient record systems before the end of 2007. One of the first steps is to agree on a common structured minimum patient dataset, which can be exchanged between the systems during e-referrals. Also there will be guidelines for national electronic signatures and patient privacy. Regional patient database development is strongly encouraged. If these targets can be achieved, e-referral usage will increase considerably.

In our environment, e-referrals and direct access to hospital databases have been beneficial, even in the middle of the roll-out process. Also in other studies it has been possible to prove that e-consultations are comparable to that of face-to-face outpatient visits and that there is a considerable increase in productivity.[5] Our experience shows however that pioneering work is demanding and commitment is needed from the task group. The implementation of e-referrals is a process which requires careful handling of various aspects, from technology to organizational changes and human communication.

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Asthma educational videoconferencing for parents: A case-control study.

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Summary

We used a case-control, pre-post study to determine the effectiveness of educational videoconferencing in delivering an asthma education programme. The cases were immigrant parents who participated in the videoconference. The controls attended scheduled classes on English as a second language but did not have the videoconferencing experience. Knowledge in both groups was assessed with 10 true/false statements. Ninety subjects participated (47 cases and 43 controls). Controls showed no significant post-test improvement in knowledge scores (6.6 for pre-test vs. 6.4 for post-test, $P=0.38$). In contrast, cases demonstrated significant knowledge gain post-videoconference (7.3 vs. 8.3, $P<0.0001$). Educational videoconferencing was an effective tool for delivering health education in asthma.

Introduction

Videoconferencing has been increasingly used for health education in rural areas [1-3]. Previous reports have described the role of videoconferencing in the delivery of health education to parents [4-7]. However, there have been few controlled studies to demonstrate the effectiveness of educational videoconferencing. The aim of the present study was to determine the effectiveness of educational videoconferencing using a case-control design.

Methods

We previously created an asthma curriculum based on information provided in the brochure for the New York City Childhood Asthma Initiative [8], the 'Open Airways for Schools' curriculum [9] and 'Protecting our children's environment: an

educational outreach guide on asthma'[10]. We conducted a case-control, pre-post study of immigrant parents attending a class on English as a second language in the Bronx, New York. A 60-minute videoconference was used to deliver an asthma education programme. Cases were parents who participated in the videoconference. Controls attended scheduled classes on 'American civics', where parents learned about the foundation and purpose of the American government, as well as the rights and duties of American citizens.

The videoconference was held in March 2004. An English-Spanish interpreter was present in the classrooms for both cases and controls and provided translation as needed. The videoconferencing units (PictureTel) were connected via three ISDN lines at a bandwidth of 384 kbit/s. The videoconference included a general overview of asthma, its triggers, prevention of asthma exacerbations and types of medications used to control asthma symptoms. Most of the videoconference time was dedicated to questions from the participants, see Fig 1.

To test knowledge gain, we employed a before-after study design. For cases, we administered a self-completion questionnaire at the beginning and end of the videoconference. For controls, we administered the same self-completion questionnaire at the beginning and end of their English-as-a-second-language class. The same 10-item true/false questionnaire was administered to both groups.

Each correct answer to a true/false statement scored one point, so the maximum total knowledge score was 10. We used a paired *t*-test to compare the mean scores in the two groups. McNemar's non-parametric test was used for differences in proportions. Ethics permission for the study was not required.

Results

A total of 90 subjects participated in the study (47 cases and 43 controls). Of the cases, 82% were female; the mean age was 35 years (SD 10) and median residence in the US was seven years. Of the controls, 86% were female; the mean age was 40 years (SD 8) and median residence in the US was ten years. The majority of the subjects were immigrants from the Dominican Republic, Mexico and Puerto Rico.

Controls showed no significant post-test improvement in knowledge scores (6.6 for pre-test vs. 6.4 for post-test, $P=0.38$). In contrast, cases demonstrated significant knowledge gain post-videoconference (7.3 vs. 8.3, $P<0.0001$). For example, cases were significantly more likely to answer the following items correctly at post-test: 'Children who take asthma medicine every day become addicted to it' (53% vs 73%, $P=0.035$); Coughing can be a sign of asthma' (75% vs. 89%, $P=0.039$), see Table 1.

Subjects asked many questions about asthma and medications used for asthma management. Examples of questions, included: Is asthma a hereditary condition? Why is asthma prevalence so high in the Bronx? Can an adult develop asthma? How do I manage an acute attack if there are no medications available? If one child in the family has asthma, does it mean that another child in the same family will develop asthma? Can emotions start an asthma attack? What are the side effects of asthma medications?

Discussion

Prior reports describe the use of videoconferencing in delivery of health education programmes to women in rural Australia [1-3]. However, videoconferencing has not been widely used for patient education in the US [4]. In our previous work we found that interactive videoconferencing improved knowledge of immigrant parents, elicited concerns from the audience and provided an opportunity to deliver health education to a large immigrant population [6,7].

As far as we are aware, there have been no previous case-control studies which have investigated the effectiveness of videoconferencing. In the present study, educational videoconferencing was an effective tool for delivering health education. Subjects who participated in videoconferencing showed significant gains in knowledge at post-test, in contrast to the controls.

The present study had some limitations. First, we did not randomly assign subjects to the two groups, which would have been impractical. Second, the participants were mainly Latino immigrants studying English and so the results may not be applicable to immigrants in general. Finally, the videoconference was held in English. Although, the session was translated into Spanish, some subjects may have misunderstood the material presented. However, as compared to controls, the asthma-related knowledge of inner-city parents improved after the videoconference. This is encouraging and we intend to extend the use of videoconferencing to different populations of immigrants and non-immigrants, in addition to children as well as parents.

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Table 1. Number (%) of correct responses at pre- and post-test for cases (n=47)^a

True/false statements	Pre-test	Post-test	P
Children with asthma will always miss a lot of school	17 (38)	33 (73)	<0.001
Children who take asthma medicine every day become addicted to it	24 (53)	33 (73)	0.04
Coughing can be a sign of asthma	35 (75)	42 (89)	0.04
Staying away from smoke is one way to prevent asthma	36 (77)	43 (92)	NS
Asthma is a condition that only appears in early childhood and then goes away	40 (89)	38 (84)	NS
Children with asthma can run and play like their friends who do not have asthma	34 (72)	34 (72)	NS
Children can catch asthma from a friend, just like a cold or flu	34 (76)	38 (84)	NS
Furry pets and cigarette smoke are two of the things which can make asthma worse	42 (89)	47 (100)	NS
Some children with asthma need to take a medicine every day to prevent their asthma attacks from starting	43 (92)	43 (92)	NS
Preventive medicines for asthma should be taken every day even if a child feels fine	32 (70)	38 (83)	NS

^aThere were a small number of missing responses for some statements: the percentage values exclude these.

NS: $P \geq 0.05$? Yes

Fig 1. Videoconference monitor showing participants interacting with Dr Reznik.



Total knee replacement rehabilitation via low-bandwidth telemedicine: the patient and therapist experience

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Summary

After a total knee replacement, inadequate rehabilitation is associated with poor physical outcomes and a reduced longevity of the knee prosthesis. We have developed a low-bandwidth telemedicine system to enable rehabilitation services to be delivered directly to the home of patients in rural and remote areas. We have examined the experience of clinical physiotherapists and of 31 participants who received treatment via the system. High levels of satisfaction were reported by participants (mean responses >7 on a 10 cm visual analogue scale). The service was found to be effective, safe, easy to use and it integrated well into current clinical practice. The study demonstrates the potential for delivering physiotherapy services via low-bandwidth Internet connections.

Introduction

Total knee replacement (TKR) is an orthopaedic procedure performed, usually in the elderly, to correct deformity, improve function, maintain motion and alleviate pain in the knee joint by replacing damaged bone and cartilage with an artificial prosthesis. TKR is a very predictable and stable procedure, yielding successful results in over 90% of patients at 10 years postoperatively[1,2]. Physical rehabilitation is essential to the successful outcome of TKR surgery and should ideally start pre-operatively and continue for a number of months after the operation. For the majority of TKR patients in Australia, rehabilitation is sought in a public outpatient facility[3]. However, due to a lack of health care professionals and health resources, this is often not possible for patients who live in rural and remote areas. As a result, many people

from these areas forego outpatient rehabilitation, resulting in sub-optimum physical outcomes and shortened lifetimes of the knee prosthesis[4-6].

To address this issue, we have developed a low-bandwidth (18 kbit/s) PC-based telerehabilitation system to enable rehabilitation services to be delivered directly to the home via an ordinary telephone (PSTN) line[7]. The present study reports the experience of both the patient and physiotherapist in using the telemedicine system for outpatient rehabilitation post TKR surgery.

Methods

The telerehabilitation treatment was administered in a simulated home environment between two separate rooms at the Queen Elizabeth II Jubilee Hospital in Brisbane. Each room was equipped with a notebook computer which was fitted with a web camera (Logitech Quick Cam). The computers were linked via a low-bandwidth (18 kbit/s) Internet connection. The telerehabilitation software produced a realtime videoconference (320 x 240 pixels) between the computer terminals and included tools to enable the therapist to acquire objective measurements of the patients across the link[8-10]. Communication between the therapist and patient was enabled by the microphones in the web camera attached to each computer. Standard headphones were worn by the therapist (Fig 1) while the patient used wireless headphones to enable them to mobilize freely around the treatment room during the consultation. The room used by the patient was arranged to resemble the home environment and contained only common household equipment.

Thirty-one patients who had undergone TKR surgery and who met the inclusion criteria were recruited. Ethics approval was granted by the appropriate committees. An information sheet was provided and informed consent was obtained from each participant. Participants received a six-week rehabilitation programme consisting of one 45 min treatment session per week. This corresponds to the typical rehabilitation programme available to TKR patients in Australia. The treatment delivered via the telerehabilitation system included self-applied techniques under the guidance of the therapist, e.g. passive stretching of the knee joint or self-applied patello-femoral mobilisations. A tailored exercise programme and education in the management of the TKR was also provided along with proprioceptive training and gait re-education. The latter was achieved through the provision of feedback by the therapist while the patient mobilized.

To assess the effect of the telerehabilitation treatment, all patients were asked to complete a number of functional questionnaires before and after the treatment was administered. A number of physical measurements, such as knee flexion range of motion, were also performed at these times. Participants also completed a computer literacy questionnaire and a satisfaction questionnaire to evaluate their experience with the system.

Results

A total of 181 telerehabilitation consultations were conducted over the course of the study took place from November 2002 to September 2003.

Patient experience

Receiving treatment via telerehabilitation was well received by the study participants. This was reflected in a high level of participant satisfaction (Fig 2) and the fact that only one participant (3% of the group) failed to complete the six-week treatment course. Consistently high ratings (>9/10) were recorded by participants on the satisfaction questionnaire relating to their perceived benefit of the treatment, their contentment with the treatment method and whether they would recommend this method to their friends or have it again if the opportunity arose. High ratings (>7/10) were also observed for the visual and auditory components of the videoconference. Participants also had the opportunity to provide written comments on the satisfaction form. Positive comments were received, such as "I found that I concentrated more and pushed myself more with the telerehabilitation treatment". A number of participants expressed a preference for the telerehabilitation method of rehabilitation over the traditional face-to-face model, as they thought that treatment was more "personalized" via the computer system.

Attempted telerehabilitation consultations between the physiotherapist and participants were successful in 100% of cases. This result was surprising considering that computer literacy questionnaires completed by participants in the study revealed that only 29% of them had ever used a computer. Of those 29%, the average self-rated confidence in being able to operate a computer was 0.8 (SD 2.1) out of 10. This success was probably due, at least in part, to the design of the PC-based videoconferencing system located at the patient end of the consultation. Software automation, with a simple-to-use interface, ensured that participants could operate the software with little training, regardless of their previous experience with a computer. It has been suggested that user-friendly technology is one of the seven core principles required for a successful telemedicine system[11].

The participants in the study were very enthusiastic and compliant with the exercise programme prescribed via the telerehabilitation system. On average, participants reported completing 2.2 (SD 0.5) exercise sessions per day outside of formal treatment. As 'hands on' techniques could not be provided by the physiotherapist in the telerehabilitation treatment, techniques such as patello-femoral accessory glide mobilisations were taught to the participants via the telemedicine link. Participants commented that this provided the opportunity for them to self-treat outside of the formal physiotherapy treatment sessions. Self-management, together with the large education component of the treatment programme, may have empowered the participants to take an active role in understanding and managing their condition, leading to the high compliance rates observed. This phenomenon has been observed in other studies involving electronic and Internet-based healthcare[12,13] leading to one author coining the term 'tele-empowerment'[14].

Therapist experience

The telerehabilitation system was also well received by the study physiotherapists who reported that they were able to deliver effective and timely treatment for subjects with this mode of delivery. The therapists reported no safety concerns while using the system and the service integrated well into current clinical practice. Easy integration of a telerehabilitation application into clinical practice has been identified as a key factor for a successful telemedicine application[15]. The therapists reported that the software interface was easy and intuitive to use, and they were confident in the objective measurements that were collected with the system. This is consistent with the finding of previous studies investigating the reliability of physical measures obtainable via the telerehabilitation system[8-10].

The therapists were also content with the rehabilitation that patients achieved via the system. The physical and functional measurement conducted on the participants before and after the telerehabilitation treatment provided evidence for the efficacy of the treatment. Statistically, and clinically, significant improvements were observed in all of the physical (all $P < 0.05$) and functional (all $P < 0.001$) measurements from the pre-treatment to post-treatment assessment periods. These improvements were consistent with those commonly achieved with traditional face-to-face treatment. These patient outcomes were achieved with a single 45 min treatment session per week for six weeks, as is common practice with traditional TKR rehabilitation.

Discussion

The telemedicine system designed to provide rehabilitation after TKR surgery was well received by both clinical physiotherapists and patients. The service was safe, easy to use and it integrated well into current clinical practice. Furthermore, the participants were found to achieve treatment outcomes that were comparable to those achieved with traditional face-to-face treatment. The present study demonstrates the potential for delivering physiotherapy services via low-bandwidth PSTN Internet connections. Further research in the form of large scale, randomized controlled trials are required to firmly establish the efficacy of such services.

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Fig 1. A physiotherapist using the telerehabilitation system to provide treatment for a TKR patient.

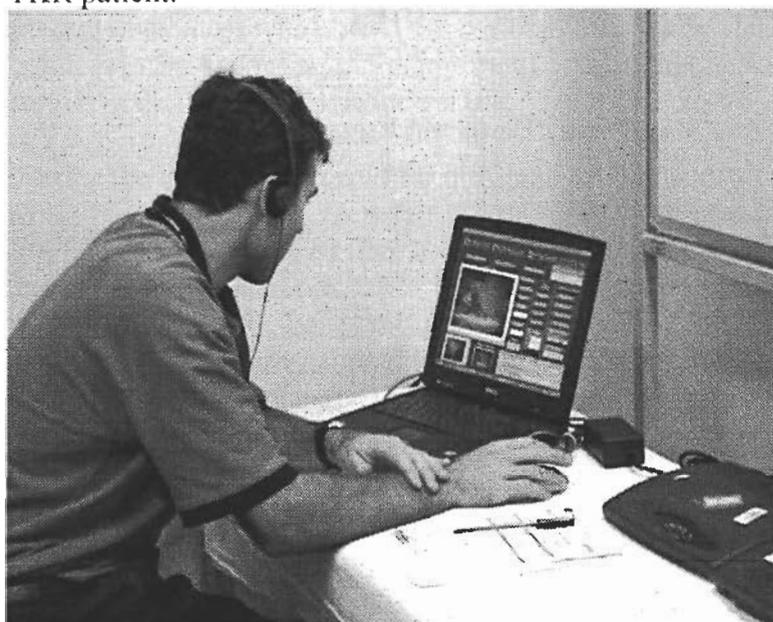
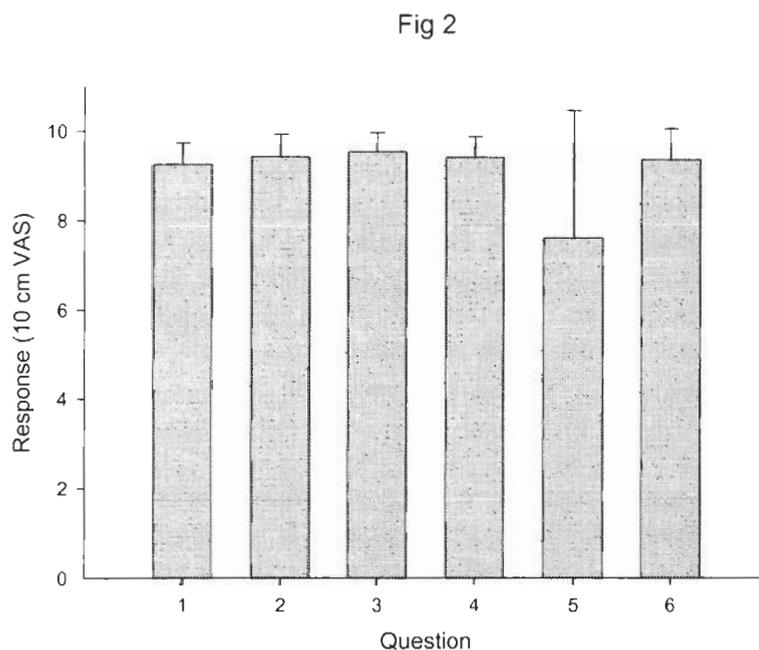


Fig 2. Mean participant responses to the satisfaction questionnaire (n=29). Error bars represent mean + 1 SD. The questions were about: (1) perceived benefit; (2) contentment with method; (3) recommend to friends; (4) have this treatment again; (5) visual clarity; (6) audio clarity.



A system for telephone and secure-email consultations, with automatic billing

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Summary

Doctors have traditionally provided medical advice during face-to-face consultations. A new remote consultation service has been developed based on an interactive voice response system and Internet-based technologies. If the doctor is unavailable a return call can be requested at a mutually convenient time. The patient's credit card is billed automatically. All that is required of the doctor and patient is access to any telephone. A dial-in dictation and transcription facility allows documentation. The service was launched in late 2003. After six months, there were approximately 55 doctors registered in five Australian states. Approximately 500 patients have registered. 250 consultations were selected randomly for analysis. Of these 84% were conducted by telephone and 16% by email. The mean fees charged were \$17.11 for telephone and \$12.93 for email consultations. The mean duration of telephone consultations was 4.3 min. Call duration ranged from a few seconds to 20.5 min.

Introduction

Medical practice has traditionally been focussed around the face-to-face consultation. However, most doctors have advised their patients at some time by telephone and a smaller proportion have used email. Patients' demands for non-face-to-face consultations with their doctors are increasing. The reasons for this include the availability of new methods of communication such as email, time pressures (the average Australian working week is one of the longest in the world) and social pressures, such as work and family. Also the use of non face-to-face delivery of services such as Internet banking and paying for services by telephone is increasing.

The types of health services provided by doctors have also changed. As well as face-to-face consultations doctors are carrying out more procedures and investigations, the results of which must be communicated. There are more treatments (and potential adverse outcomes) which need to be monitored. Behavioural therapy and preventive health care are becoming more important. Also, the population is ageing and the burden of chronic disease is increasing.

Despite the increased demand for non-face-to-face consultations, doctors are less willing to provide them. A recent study of GP work practices by the Australian Institute of Health and Welfare showed that the number of 'indirect consultations' (mainly by telephone) had fallen by more than 50% in four years [1]. Although most doctors do some telephone consulting, telephone consultations cannot be claimed through Medicare (the national health insurance scheme) or private health funds. There may also be concerns about privacy and difficulties in documenting a call if doctors are not at their desks.

We have therefore developed a system, TeleConsult, to allow easy communication between patients and their doctors using telephone and email.

Methods

Surveys

To assess patient and doctor attitudes to paid telephone and email consultations, a market research company (Newspoll, Sydney) was commissioned to survey 1200 respondents across Australia. A survey of doctors to determine their attitudes to a system with the features of TeleConsult was designed and conducted independently. This was posted to 1500 randomly selected doctors in NSW, Victoria and Queensland.

The service

A system allows patients to telephone their own doctor, and if he or she is available, to have a telephone consultation for a fee. If the doctor is not available the system allows the doctor to be notified of the patient's request so that the call can be returned at a suitable time. TeleConsult also enables billable, secure email consultations between patient and doctor.

TeleConsult uses an Interactive Voice Response (IVR) system to provide telephone communication, a web site (<http://www.teleconsult.com.au>) for secure email messages and administration (e.g. profile management and viewing statements) and Internet communication with third parties such as credit card companies and an SMS gateway, see Fig 1. The TeleConsult system uses the Oasis IVR platform developed in Australia by Pracom Limited running under the Linux operating system. Private information is protected during transmission over the Internet by 128 bit Secure Socket Layer (SSL) encryption.

Patients can register (Fig 2) by telephone (via the IVR system or an operator), via the website, or by mailing/faxing a form. Patients can then select their doctor. While the system telephones the doctor, patients are told about the fees, which are chosen by the doctor. If the doctor can accept the call the consultation begins and at the end the

patient's credit card is billed. If the doctor cannot take the call the patient has the option of requesting a return call using the telephone keys to choose a time range(s) and telephone number. This is sent by SMS to the doctor's mobile phone and stored on the system so that when he calls back through the IVR system he is connected to the patient who then enters their PIN number to ensure privacy. Again the call is timed and charged.

The doctor has the option of dictating an Availability Message which is stored on the IVR system. Whenever he is not available to take a call this is played to the patient allowing the doctor to advise preferred times for TeleConsults, periods of leave and cover by colleagues. At the conclusion of the telephone consultation the doctor can dictate a note or letter to document the consultation for transcription. This appears on the website for editing, sending electronically, printing and inclusion in the medical record.

Patients can request an email consultation or a telephone consultation using the website. When an email consultation is requested a notification via standard email is sent to the doctor with a link to the website. This applies in reverse when the doctor replies. The patient's information remains secure on the server. TeleConsult is unique in allowing billing to take place on a return telephone call and has applied for international patents which are pending.

Results

Surveys

In the Newpoll survey, 61% of respondents said that they were interested in a service that would allow them telephone access to their own doctor. Of these 71% were prepared to pay for such a service (42% of the total sample). Interest was higher amongst women, those with children and people outside capital cities.

There were 120 responses to the doctor survey – 66 GPs, 45 specialists and six others – a response rate of 8%. 90% of respondents felt that a service such as TeleConsult had some relevance to their practice (7% very relevant, 23% quite relevant and 60% somewhat relevant). Interest in telephone contact was higher than email - 80% of respondents indicated that they would use the telephone (3% very frequently, 14% frequently and 63% sometimes) while 40% of respondents indicated that they would use email (2% very frequently, 6% frequently and 32% sometimes).

System usage

The service was launched in late 2003. After six months, there were approximately 55 doctors registered in five Australian states. Approximately 500 patients have registered. Sometimes a relative of the patient registers and communicates with the doctor (with the patient's permission). The mean age of registered patients is 47 years (range 19-88 years). Some registrants have not yet requested a teleconsultation.

The main reason or outcome for 100 telephone consultations for one doctor are shown in Table 1.

Table 1. Main reason or outcome for telephone consultations for one doctor (n=100)

Reason	No
Follow up of a clinical condition (1 outside Australia, 5 about to travel abroad)	41
Test results	27
Discussion with relatives	19
Adverse events	6
Hospital presentations avoided	4
Number referred to hospital	2
Repeat prescription request	1
<i>Total</i>	<i>100</i>

250 consultations were selected randomly for analysis. Of these 84% were conducted by telephone and 16% by email. The mean fees charged were \$17.11 for telephone and \$12.93 for email consultations. The mean duration of telephone consultations was 4.3 min. Call duration ranged from a few seconds to 20.5 min.

The system has proved to be reliable with no significant interruption to the service.

Discussion

The TeleConsult system has been in use for six months. As far as we are aware, there is no similar system for telephone consultations that enables automatic billing both when doctors are able to accept the calls and when they return them.

The background research results were considered to be positive, showing that a core group of potential users exists who are likely to be early adopters. In addition, the majority of the remainder expressed some interest in remote consultations. These latter doctors are likely to wait for the service to become established and accepted before using it.

When a face-to-face consultation is not needed, the new service has several advantages. The benefits for patients include easier access to their doctor, ease of use, convenience (no need to travel, park or wait) and a reduction in time spent off work and away from other activities. Access to medical advice can occur earlier than if the patient has to wait for an appointment and can often accelerate the outcomes of the next face-to-face consultation. The use of TeleConsult is not reimbursed by Medicare or private health funds, but the average cost (\$17.11) for patients in Australia can be compared to the average 'gap payment' (a co-payment doctors can choose to charge their patients above the national health insurance scheme's Medicare fee) of \$14.92 for a standard GP consultation.

The benefits for doctors include automatic billing for teleconsultations. The doctors are able to provide an improved service for their patients, but privacy is preserved since telephone numbers and email addresses remain confidential. There is flexibility for the doctor who can take calls at any location and call back when convenient. Call management is also improved, since staff no longer have to pass on messages. By allowing earlier access for their patients and by allowing doctors to dictate and

document telephone consultations when they are away from their desk the potential for medicolegal problems is reduced.

Benefits for the health system include the potential for improved health outcomes (e.g. by earlier intervention), reduced hospital attendances at emergency departments, reduced hospital admissions and reduced length of stay for inpatients. Such improved outcomes from access to telephone advice for patients have been shown in previous studies [2-4]. These studies demonstrate the potential of significant cost savings to the health system.

Research on telephone consultations has been relatively sparse in the past. A recent review of telephone consultations reported that public satisfaction was high and that patients appreciated the speed, improved access, convenience and cost savings [5]. Doctors found telephone consultations useful for routine care and chronic disorders while some were concerned about possible medicolegal risks. The importance of telephone skills was noted.

Research has demonstrated that access to telephone consultations resulted in a decrease in the numbers of patients wanting same day face-to-face appointments [6]. Telephone consultations have proved useful in specific diseases including urinary tract infections, depression, smoking cessation counselling and chronic diseases including asthma, diabetes, heart failure, cystic fibrosis and rheumatological conditions. They have been used to manage therapy with drugs (e.g. warfarin and insulin doses) and with behavioural therapy.

The launch of the TeleConsult service has met with great interest from individual doctors and other health industry staff, although the conservative nature of many doctors means they are slow to adopt new systems. Their primary concern has been about patient acceptance, which has been good. Initial feedback indicates that patients are positive about the system, since it offers an additional means of obtaining medical advice to those currently available, and its use is an option for both patient and doctor. Some doctors have concerns about potential medicolegal implications which are the same whether or not the provision of a telephone or email consultation attracts a fee. The same standards of providing and documenting care apply. Finally some are concerned about the time required to introduce a new system. As with all new systems, implementation requires an initial investment of time, but results in improved patient and time management as well as remuneration.

It is anticipated that the use of telephone and email consultations will increase as both patients and doctors take advantage of a system that facilitates such consultations with the potential for improved health care delivery, as well as savings in both cost and time.

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Fig 1. Connections between patient and doctor

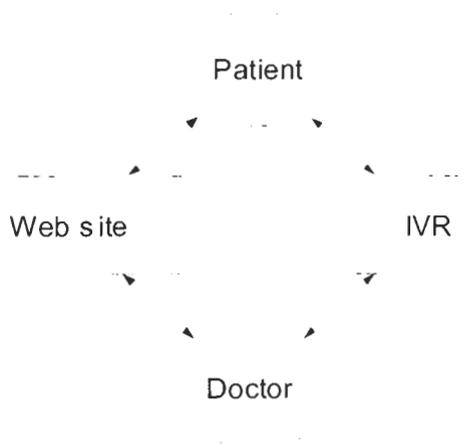
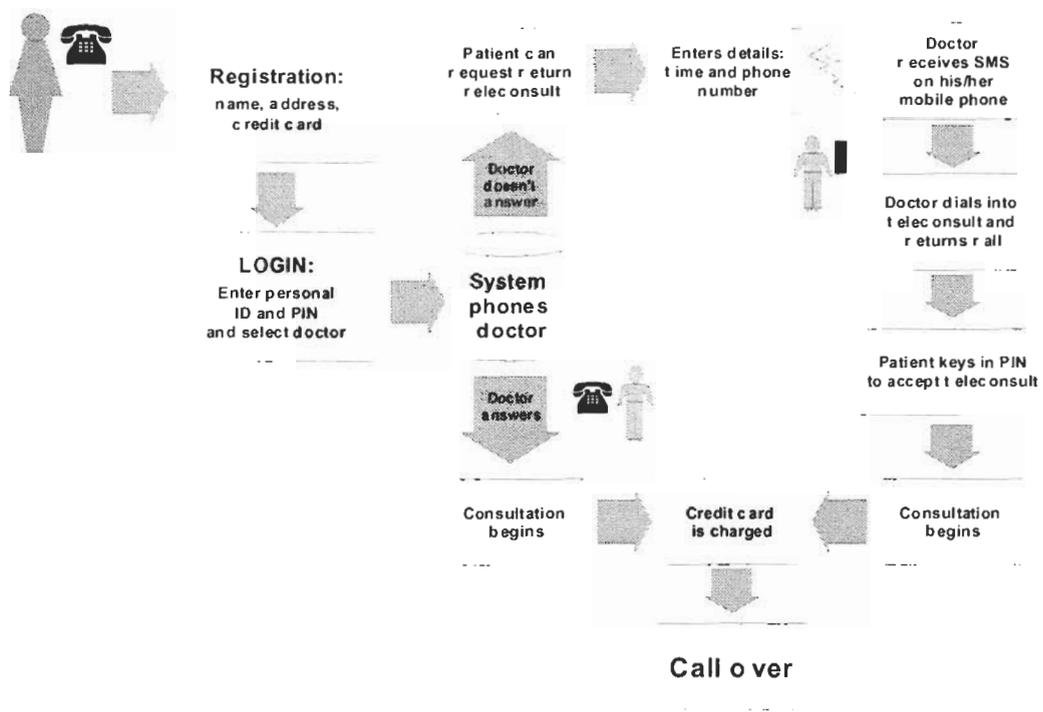


Fig 2. TeleConsult system – schematic representation



Telepaediatrics and diabetic retinopathy screening of young people with diabetes in Queensland

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Summary

We have examined the feasibility of a telemedicine-enabled diabetic screening service for children and adolescents with diabetes in Queensland. There are approximately 1400 young people with diabetes in Queensland and only about two-thirds of them are screened in accordance with international guidelines. A regional retinal screening service was established using a non-mydratic digital retinal camera. Seven centres volunteered to participate in the study. During a five-month pilot trial, a total of 83 (3.7%) of the young people with diabetes who attend these centres underwent digital retinal screening. Retinal images were sent via email to a paediatric ophthalmologist for review and results were returned via email. A copy of each participant's results was forwarded by mail to the referring diabetes doctor and the participant and their family. The majority of the image files (96%) were rated as excellent or good. Only one participant was identified as having an abnormal result. Participants and their families expressed satisfaction with the digital retinal screening process.

Introduction

All people with diabetes are at risk of developing diabetic retinopathy, a microvascular complication of diabetes. Diabetic retinopathy is a leading cause of vision loss in the population with diabetes even though retinopathy screening for detection, treatment and monitoring has been shown to be effective in the prevention of vision and is cost effective for society as a whole[1,2]. The Diabetes and Complications Trial [3] showed a direct relationship between the level of diabetes control measured by glycosylated haemoglobin (HbA_{1c}) and the risk of micro and macro vascular complications. Poor diabetes control in childhood and particularly adolescence increases the risk and rates of microvascular complications, especially diabetic retinopathy[4-6]. This risk is further increased by the duration of diabetes and the onset of diabetes before puberty but after five years of age[7,8].

In 1999, a survey was conducted of all children and adolescents with Type 1 and Type 2 diabetes in Queensland. There are approximately 1400 young people with diabetes in Queensland and results were obtained for 53% of them. Diabetic retinopathy screening was relatively low and only 61% of those eligible for screening had seen an ophthalmologist in the previous twelve months. Only 1.6% of those screened were reported to have background retinopathy[9]. The survey was repeated in 2002. The results showed that only 68% of those eligible for retinopathy screening had been examined. The reported prevalence for background retinopathy was 0.3%, even less than the 1999 study[10].

The two surveys show that adherence to current screening guidelines is far below the recommended standards. One-third of those eligible for retinal screening had not been referred for screening, or it was deemed not to be clinically indicated by the doctor. The prevalence of diabetic retinopathy was extremely low in comparison with reports in the literature. In two Australian studies using stereoscopic fundal photographs after dilation, the prevalence of diabetic retinopathy was 42% with a median diabetes duration of 8.2 years[4] and 52% with a median duration of 11.5 years[7]. Another Queensland Health survey[11] on accessibility and availability of services showed that public ophthalmology services were concentrated in certain areas, which limited access for young people with diabetes from rural and remote regions of the State.

Several studies using telemedicine and non-mydratic digital photography with adults in rural and remote communities have been undertaken[12]. The results have shown that this technique can be applied to retinal screening and assessment which in turn facilitates access for rural and remote patients with diabetes to appropriate eye care services. These studies have focused on adults with diabetes. The aim of the present study was to assess the feasibility of telemedicine in diabetic screening services for children and adolescents with diabetes and to increase the numbers screened in Queensland.

Methods

Letters of invitation to participate in the pilot study were sent to directors of medicine and paediatricians at twelve regional hospitals. Seven paediatricians and their associated hospitals agreed to participate in the study. All children and adolescents, particularly those who met the current State diabetes complication screening guidelines, attending the routine paediatric diabetes clinics at the seven hospitals were invited to participate. All patients in the study had a diagnosis of Type 1 or Type 2 diabetes mellitus. Ethics approval was granted by the appropriate committees. All patients and their parents signed a consent form and received information sheets about eye disease with diabetes and an outline of the pilot study.

A non-mydratic portable digital retinal camera (Handy NM-200, Nidek, Japan) which can capture 30 degree retinal fields was used to obtain the still images. The retinal images were stored on compact flash cards in a TIF format (3.5 MByte, 24-bit colour, resolution 72 pixels/inch). The images were assigned a coded identification number and compressed in JPEG format to a size of approximately 56 kByte. This level of compression produced approximately the same quality as the TIF image.

Best visual acuity was measured on both eyes using a Snellen eye chart. The visual acuity was measured prior to the retinal photography. Distance correction glasses were worn for the acuity testing if they were normally used. Using the digital retinal camera, four 30 degree retinal fields covering the optic disc and macula centred, lateral macula, nasal and centred optic disc were captured for each eye. The fields were chosen to encompass retinal areas where diabetic retinopathy occurs frequently of is visually significant.

The study participants were also asked to provide information on any previous eye assessments.

Screening visits were carried out by a qualified registered nurse and paediatric and adolescent endocrine specialist from February to June 2004. At each of the twelve clinics attended in five centres, digital photographs of the retina of both eyes were taken after using non-medical dilation. The coded identification number was attached to each set of the patient's retinal images. Each set of images along with a participant data sheet that contained visual acuity, diabetes duration and glycaemic control information and an area for recording results were sent electronically to the paediatric ophthalmologist for review. The coded patient data sheet with the results was returned via email. A letter containing the results was subsequently generated and sent to the referring diabetes doctor and the patient and their parents.

Results

During the five-month study, a total of 41 males and 42 females were screened. Their mean age was 12.9 years (SD 3.0, range 6.1-18.4). Eighty one (99%) participants had Type 1 diabetes mellitus. The mean diabetes duration was 5.2 years (SD 3.3, range 0.1-15) years. Only 40% of the patients reported that they had seen an ophthalmologist since diagnosis, 25% had seen an optometrist and 35% had not had any eye screening. Only 82 participants had an available HbA_{1c} result. The mean value was 9.1% (SD 1.7, range 5.3-14.5).

The majority of the photographs which were assessed (n=79) were rated as 'good' or 'excellent' by the paediatric ophthalmologist, Table 1.

Table 1. Image quality results (n=79)

Excellent	Good	Poor	Undiagnostic
31	32	6	10

Only one patient was identified as having an abnormal result. The individual was aged 13.3 years with an HbA_{1c} of 10.7% and diabetes duration of 11 months. This participant is to undergo re-screening prior to further ophthalmologic examination.

Discussion

Diabetic retinopathy screening using telemedicine can provide resources in communities where services are limited or do not exist. The provision of a service into the rural and remote areas is crucial to lower the risk of developing diabetic retinopathy in a young population and to ensure early access to ophthalmologists to prevent further eye damage.

In the present study a portable digital retinal camera was used, which could be transported by road or air to sites where patients attend their routine diabetes clinics. The study targeted children and adolescents with diabetes and was well-received by the young people and their parents since it avoided the need to travel for specialist eye services. Participants and their families expressed satisfaction with being able to view their own images on the digital camera screen. This gave the opportunity for further diabetes learning for young people and their family. In addition, the participant and their parents received the results of the retinal screen in a letter for their diabetes records at home.

The present study demonstrates the feasibility of a screening service for diabetic retinopathy using a portable digital retinal camera. It also met the objective of screening people who had not previously been examined.

Acknowledgements

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Prospective case review of a global e-health system for doctors in developing countries

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Summary

The Swinfen Charitable Trust has managed email consultations for doctors in developing countries since 1999. The process was handled manually for the first three years and then subsequently using an automatic message-handling system. We conducted a prospective review of email consultations between referring doctors and consulting specialists during a six month period of automatic operation (December 2003 – May 2004). During the study period 125 consultations took place. These concerned a wide range of specialties (e.g. orthopaedics 17%, dermatology 16%, obstetrics and gynaecology 11%, radiology 10%). 33% (41) of the referrals were for paediatric cases. Consulting specialists, who were based in five countries, were volunteers. Referring doctors were from 24 hospitals in 12 developing countries. The outcome measures were time from referral being received and a definitive reply being given; and the value of the consultation to the referring doctor. The median time from referral to definitive reply was 1.5 days (interquartile range 0.6-4.9). There was an 85% response rate (n=106) to the survey. All the referring doctors made positive comments about the service and half said that it improved their management of the case. The second opinion consultation system operated by the Swinfen Charitable Trust represents an example of a global e-health system operated for altruistic, rather than commercial, reasons.

Introduction

The Swinfen Charitable Trust (SCT) is one of several organisations using email to provide second opinions to doctors in developing countries. The charity, which has been growing steadily over the past five years, uses a panel of specialists who volunteer their time and expertise to assist colleagues in the developing world. Email

provides a practicable and reasonably reliable method of performing low-cost telemedicine.

In reviews conducted in 2000 and 2002, the service provided by the SCT was found to be valuable to the referring doctors [1,2]. In 2002, an automatic message-handling system was brought into operation due to the increasing caseload and the associated work of handling the email messages manually. The manual handling of messages also made undertaking reviews a very laborious task, and an added benefit of the automatic system was that message traffic is archived and readily available for subsequent analysis [3]. A retrospective review of the usefulness of the service was conducted in 2003 although there was a poor response rate from the doctors surveyed (38%) [4].

We have conducted a prospective review in order to obtain better survey data. There were two main objectives. First, we wished to determine if the management of patients in developing countries changes (improves) following the provision of email advice and whether the referring doctors find the service useful. Second, we examined the feasibility of a global email telemedicine system for developing countries, to answer such questions as how long does it take to resolve a query in practice?

Methods

User survey

We surveyed the doctors who had referred cases through the automatic message-handling system during the period December 2003-May 2004 inclusive. A short survey was sent by email, asking about each new case:

- did you use the advice given?
- did you find the advice helpful?
- did the advice received change the management of this patient?
- what are your opinions on the service?
- would you be happy to use the service again?

The survey message was sent approximately ten days after the response from the specialist(s), to allow time for the referring doctor to consider the advice provided by the specialist(s), and to implement it as appropriate.

System performance

Data were taken from the message database to quantify the system performance. Statistics were calculated on the time to resolution of cases, i.e. the interval between the original referral being received by the SCT and the first response from a specialist being sent to the referring doctor.

Results

User survey

There were 125 cases sent to the SCT during the six-month survey period. Thus 125 surveys were sent to referring doctors. There were 106 responses, a response rate of 85%. The results indicated that the advice provided was used by 94% (99) of the respondents. 79% (84) found it helpful, and for a further 8% (8) the advice was not helpful because the patient did not return for follow-up. In one case the patient died prior to the doctor receiving the advice. Over half (53%) of all respondents indicated that the advice provided changed the management of the patient with a further 12% indicating that the advice confirmed their diagnosis or management. All respondents had positive opinions about the service and said they would use the service again, see Table 1.

Paediatric cases accounted for 33% of the referrals received. The cases involved approximately 30 different specialty areas, the most common being orthopaedics (17%), dermatology (16%), obstetrics and gynaecology (11%), radiology (10%) and neurology (6%). The cases came from 24 different hospitals in 12 countries. The countries sending the most referrals were Nepal (34%), the Solomon Islands (18%), Bangladesh (16%) and Iraq (10%).

Performance

The 125 referrals generated 161 queries, an average of 1.3 queries per case. A *referral* refers to a second opinion being sought about a unique patient case. When a referral is sent to a specialist it represents a *query* and since one case may be sent to several specialists before a definitive reply is received, there may be multiple queries for each case. These cases involved 416 email messages being sent between referrer and specialist, an average of 3.3 per case. The median time between the SCT receiving an email referral and the referring doctor receiving a reply from a specialist was 1.5 days (IQR 0.6 – 4.9). 50% of cases were responded to within 2 days and 90% has been responded to within 12 days.

Discussion

The growth of the SCT over its five years of operation is encouraging. As the survey responses showed, the referring doctors found the service very useful and therefore were happy to use the service again in the future. The median time from the original referral being sent and a definitive reply being received is also excellent (less than 2 days) especially considering that all specialists provide their advice on a volunteer basis and are located all over the world.

The results of the user survey show that the advice provided through the SCT service is helpful and appreciated; it also changes the management of patients in a high proportion of cases. The response rate for the prospective review (85%) was substantially higher than that of the previous, retrospective review (38%). The results of both reviews, however, indicated that the users of the service found it helpful and appreciated the ability to access specialist advice. This was indicated by 50% of respondents who changed their management plan due to the advice provided.

The response rate for the prospective review was very good considering that hospitals in the developing world have high staff turnover – commonly overseas-trained doctors spend only short periods of time there and then return to their home country. Patient follow-up is also difficult as the patients may not return to the hospital after the initial treatment, and hospital record systems may be lacking.

The SCT is a charitable organization that depends on the willingness of consultant staff to respond to their colleagues, using spare moments during the working day, or often in the evenings. There is a parallel here with grid computing[5], where unused processing cycles on computers connected to a network are used for solving problems too intensive for any single machine – in the SCT operation, consultant resources around the world are brought to bear on specific questions via the Internet.

The SCT network represents an example of a sustainable global e-health system, which is operated for altruistic, rather than commercial, reasons.

Acknowledgements

The SCT is grateful to the volunteer consultants who have provided advice to their colleagues in developing countries.

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Table 1. Results of the prospective review (n=106)

	Responses	%
<i>Question 1 - What the advice provided helpful? Yes/No</i>		
No	7	7
Yes	99	93
<i>Question 2 - Did you use the advice given? Yes/No If No, why not?</i>		
No (patient died)	1	1
No (did not return)	8	8
No	13	12
Yes	84	79
<i>Question 3 - Did the advice received change the management of this patient?</i>		
Confirmed	13	12
No	37	35
Yes	56	53
<i>Question 4 - What are your opinions on this service?</i>		
Positive	106	100
<i>Question 5 - Would you be happy to use the service again?</i>		
Yes	106	100

POSTERS

The patient diary as tool for patient empowerment

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Summary

Control with medication is very important for people's health. 10% of Norwegian hospitalizations are assumed to be caused by non compliance or the adverse effects of medication. Some of the problems are caused by lack of control with medication, and/or reporting of lack of compliance with medication. For a patient, it is often hard to remember all the details concerning compliance, adverse effects and so on, during the few minutes that a visit to the doctor takes.

At the Norwegian Centre for Telemedicine, we have constructed a web-based patient diary, PanDa, that allows patients to monitor their own use of medication. The aim has been to provide the patient with a tool for registering the effect of medication, both through answering questions about the patient's illness as well as free-form, text-based input. The diary supports three patient groups: chronic pain, asthma and diabetes. Patients have to record their medication in advance from a list of relevant drugs for the specific illness. The diary produces graphs that present the development of the specific medication-related questions each month. Much emphasis is put on authentication and authorization. In addition, no personal identification data are stored on the server.

Providing remote patient monitoring services in residential care homes

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Summary

eVital, a European funded project, has investigated the provision of vital signs monitoring services in the community. In a UK pilot trial, services to monitor the vital signs of patients in residential care homes by remote health care workers have been established in three residential care homes around Watford, an area to the north west of London. The aim was to allow the resident's own general practitioner to observe the ECG, blood pressure, SpO₂, temperature and respiration whilst still in the health centre and be able to advise on the most appropriate action should a crisis occur.

Vital signs monitors were connected through a wireless network (802.11) to a central access point to allow the monitors to be used throughout the building. Residential homes were connected to the Internet by broadband (ADSL). Health care workers could access the secure data server from any location on the Internet.

The pilot project was designed to determine feasibility of the technology and assess channels of communication between key participants. Monitoring has been performed when a resident gives cause for concern, such as feeling dizzy or unwell, or having difficulty in breathing. The monitors have been used for 20 incidents. Residential home staff have commented on the extra level of security they feel in being able to "summon" medical support for residents for whom they may have concern. Patient's relatives have also commented on the reassurance they experience from knowing that the resident is being monitored. After an eight-month trial, the preliminary results appear promising.

Telemedicine in human space flight – expectations and reality

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Summary

Space missions with human crew have always been portrayed as a classical situation in which telemedicine would be required. The public knowledge about the health risks of space flight is limited. It is almost universally expected that any medical problems can be solved rapidly and efficiently, using the latest or even experimental technologies. However, there is a significant difference between expectation and reality.

Telemedicine in space programmes has been traditionally used for routine crew health management, for scientific investigations and for operational applications, especially in emergency situations. Telemedicine techniques have been developed in Russian manned space programmes over the years and have been tested during operation of different spacecraft and orbital stations. Failures would have important consequences.

Telecare: a reference telemedicine architecture

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Summary

We have developed a reference architecture for a telemedicine system to support a complete spectrum of telemedicine applications, including ambulatory, acute and chronic monitoring. Each of these application areas has its own characteristic functions, which may be limited by the communication system available. Acute monitoring is characterised by high levels of transmission of data, ambulatory monitoring by little transmission but monitoring for the occurrence of events and consequent transmission of alarms, and chronic by repetitive recording of data.

The telecare architecture and protocol are designed to support all areas, and have introduced several new concepts. In particular, controllable, intelligent sensors are supported. A hierarchical design has been developed for the sensors. The base device measures a signal, such as an ECG, and a family of sub-devices are defined to derive signals such as heart rate and arrhythmias. In this way, the device and each of its sub-devices can be controlled in a consistent manner.

Prototypes have been developed to prove the concept. The first practical implementation is for ambulatory monitoring and uses mobile phone technology (the General Packet Radio System) for wide area communication. The protocol is designed to work over low bandwidth links.

The architecture is a first step towards defining where and how telemedicine standards might exist, and where protocol conversion from manufacturer or de facto standards will be needed in future. Sensors are defined in an object-oriented way for families of devices that will be used as telemedicine devices rather than simple transmitters of data. To date the architecture has been a useful tool against which to compare other standards, such as POCT1 and VITAL, and determine their strengths and weaknesses in order to define a better telemedicine standard.

Validating tele-otology to diagnose and manage ear disease in remote communities

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Summary

Ear disease, especially otitis media, is common in rural and remote Australian Aborigine communities. Access to specialist medical services for people in rural and remote areas is limited, and may be improved by reliable telemedicine systems. Digitised video-otoscope images can form the basis of providing remote assessments of ear disease.

The aim of the present study was to determine if digitised images of the eardrum, with a clinical history, audiometry and tympanometry data, can provide sufficient information to an ear specialist to make an assessment of a patient. 127 ears of 66 children (aged 9 months to 16 years) from remote communities were assessed by an ear specialist by standard otoscopy, using a clinical history, audiometry and tympanometry. Up to 5 images of each ear were digitised. At a later date, the ear specialist made observations, diagnoses and recommendations for management from the images and clinical data.

There was a significant relation ($P < 0.01$) between image quality and the age of the subject. There were significant agreements for the clinically important observations of otorrhea, perforation, retracted tympanic membrane and atrophy of the tympanic membrane ($P < 0.05$). There were significant agreements for the diagnoses of acute otitis media, chronic suppurative otitis media, otitis media with effusion and Eustachian tube dysfunction. The rate of recommendations for review or referral after a tele-otology assessment were 4% to 16% higher than those made in the field. Agreement between the advice or recommendations made in the field and those made by tele-otology was significant ($P < 0.01$).

A tele-otology system that incorporates good quality digitised images of the tympanic membrane and patient data provides the ear specialist with sufficient information to make a confident diagnose of existing middle ear disease, and provide management advice to the patients' primary care provider.

Telehealth: successes and failures at the Ukwanda Centre for rural health

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Summary

The Government of South Africa is committed to providing basic health care to all South African citizens, not as a privilege, but as a fundamental right. In 2001, the Department of Health stated that "the challenge for us lies in reaching all our people, especially in the rural areas and being mindful of not increasing the developmental gap between the 'have' and 'have-nots' of this country." At the Ukwanda Centre for Rural Health, health science students from different departments – including, community health, physiotherapy, occupational health and speech therapy – have the opportunity to spend 3-6 weeks in rural areas as part of their undergraduate rural training. During this time certain aspects of the academic programme continue with the use of videoconferencing. The effect of this still needs to be evaluated, but it is essential that the failures and successes be understood.

The equipment that is currently being used for videoconferencing is expensive and not user friendly. Training programmes about videoconferencing installation and usage do not exist. These must all represent failures. Some of the successes would include a reduced need for travelling by students and lecturers, since the distance between tertiary institutions and rural sites usually exceeds 100 km. The rural community also benefits, indirectly, from these activities.

Telemedicine is not completely new in South Africa. Telephones have been used for simple communication for decades. More recently, telephones have been used extensively for clinical consultations between rural hospitals and tertiary institutions. To avoid already the overloaded tertiary hospitals it was suggested that telemedicine units be sited at rural hospitals and that consultations should be carried out with tertiary hospitals. Unfortunately, many failures have arisen with this, since most nurses are unable to use the equipment, no proper training programme exists and the equipment is not user friendly.

A pilot study of the use of videoconferencing for teaching assistance techniques in activities of daily living

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Summary

We have investigated the possibility of instructing assistance techniques in activities of daily living with videoconferencing. A videoconference system was installed in two places in our university to represent a connection between a home and an institution. The videoconference link used the local area network. Subjects were first year students of our university with no previous experience of acting as assistants. First they watched a videotape showing some general assistance procedures on sitting-up, standing-up and walking with a cane. Then they assisted a simulated patient (right hemiplegia following a stroke), receiving instructions from a physiotherapist in another room using the videoconference system.

The pictures on the television monitor were relatively clear and smooth. Because only one camera was used, there were some dead angles. Therefore, it was necessary to consider carefully in advance the position of the camera, the starting place of any motion and the direction of any movement.

The videotape showing assistance procedures was found to be very useful. The invisible elements such as the amount of assistance and the direction were a little difficult to understand. In future we will need to analyse the motion, arrange the order of procedures, and explain more briefly and clearly with simple words, emphasising important points using subtitles or signs like arrows.

The effect of culture on telemedicine

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Summary

AIDMAN, a European funded project, was designed to introduce telemedicine services between health clinics on Aegean islands and hospitals in Athens. A conventional telemedicine model of referral of the patient from the remote site to the hospital was proposed, together with shared care using a combination of store-and-forward and telemedicine clinics. Equipment to capture digital images, radiological images and ECG signals was installed. Videoconferencing (ProShare V5.2) was configured to use IP over a satellite link at 384 kbit/s. A programme of training and education was established.

The system was never used. We determined that culture was the problem. Referral was anathema; patients diagnosed at the clinics were simply advised to present themselves at the appropriate outpatient clinic of the hospital and to wait until seen. There was no referral process and no clinical information on the patient was sent by the clinic. At best the patient might be given their X-rays to take with them. Follow up and management of the condition remained the responsibility of the hospital and the clinics had no role. Hospital doctors had a poor opinion of the capabilities of the medical staff on the islands, as they were generally newly-qualified doctors fulfilling an obligation to spend a period in a remote clinic and there was rapid turnover of staff.

Our experience showed that, although the technology worked perfectly, the technological model of our telemedicine solution had not been designed to fit the underlying clinical model and to support existing pathways of care. Nor had we made sufficient effort to determine how to change the pathways of care in advance of introducing telemedicine. Instead we had tried to impose our technological model without regard for the culture and existing practice, and had expected the people to immediately embrace the technology and change their habits. In hindsight our approach seems naïve, but it must be realised that within the scope of a pilot project, time scales are short, and the emphasis of development is often placed on technology.

In our case, AIDMAN was a European project, which brought the additional problem of dealing with the cultures and languages of different countries (for example, the Greeks refer to the UK general practitioner as a pathologist). This compares with the success within the same project at Chorleywood, UK, where clear paths of referral and a culture of shared managed care existed.[1]

The lessons are clear. Design of the telemedicine solution must begin from consideration of the clinical model. Current pathways of care must be identified and the new pathways of care defined. From this, a policy for change management must be established that includes management structure, professional relationships and interactions, attitude and clinical procedures. There must be support from all levels of the organisation. Critical milestones of change should be identified. Only when the planned change in the organisational culture has occurred can the technology be introduced, and even then in a carefully managed way. Failure to do this will probably result in the equipment remaining unpacked, or being left in a corner and not switched on.

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Using videoconferencing to deliver clinical pain management services to nursing home residents

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Summary

Few telehealth projects have been developed for service delivery to nursing home residents [1,2]. We have tested the feasibility of using videoconferencing to improve access to specialist pain management services for nursing home residents with arthritis. Nineteen residents with an average age of 83 years from three aged care facilities in metropolitan Melbourne participated in the trial.

Three distinct videoconferencing systems were developed for bedside service delivery based on the available ICT infrastructure, physical layout and needs of the residents in the facilities. These were: (1) desktop PC, laptop PC and commercial videoconferencing units communicating over a LAN; (2) desktop PC, laptop PC and commercial videoconferencing units communication over a LAN and WAN; and (3) commercial analogue videophones for delivery communicating over the ordinary telephone network.

The systems were used to conduct all aspects of a standard clinical consultation with the exception of a physical examination. However, clear visual data and the presence of either a relative or registered nurse with an accurate knowledge of the resident contributed clinically useful information.

Nursing home residents, nursing staff and clinicians demonstrated high acceptance of the teleconsultations. The benefits of the trial included: cost savings from reduced transfers to the pain clinic; increased access to geriatric services and reduced pain from transfers to the pain clinic for residents; professional development benefits for nursing staff from participating in consultations; occupational health and safety

benefits from reduced transfers of residents to the pain clinic, quality of care benefits from access to resident medical data during consultations for discussion with the specialist; staff being able to act as an advocate for the resident both during and after the consultation. Benefits for the geriatrician included time and travel savings, and increased access to nursing home residents.

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Chronic disease surveillance and management in remote Aboriginal Australia: role of web-based applications

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Summary

Surveillance for chronic diseases in remote areas of Australia is sporadic and unsystematic. People living in these areas do not enjoy the same levels of access to health care and preventive services, primarily because of their location. A team from Kidney Disease Research and Prevention (KDRP) was involved in developing a systematic screening and treatment programme for chronic diseases in three communities in the Northern Territory (NT). The Accessibility/Remoteness Index of Australia (ARIA) scores for these communities ranged from 7.9 ('remote') to 12.0 ('very remote'). For considerable periods each year, these communities are inaccessible by road and air travel to these remote communities is expensive. We have used a web-based database for systematic screening and patient management in this setting.

One of the major advantages of online databases is that the staff members of KDRP can be located almost anywhere in the world and still retain the same levels of access to patient information through the Internet. Health workers, nurses, doctors and specialists can gain up-to-the-minute report on their patients, which makes possible 'just-in-time' medicine. Online case conferencing is possible and specialist staff practitioners can use their time more efficiently in these remote settings. Health workers based in these remote communities can interact with the nurse coordinators and doctors for efficient patient management, which is based on individual healthcare profiles. Obviously an Internet connection is a prerequisite for access to the database.

The use of a web-based database proved to be highly cost-efficient in these remote under-resourced communities. Other organisations which deliver health care and related services in such remote areas should consider adopting such systems to increase their efficiency and productivity.

Acknowledgements

We thank the following organisations for support: the Australian Kidney Foundation, Rio Tinto, OATSIH, Janssen-Cilag and the Colonial Foundation of Australia.

Asthma education: a comparison of interactive videoconferencing and written materials

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Summary

Clinicians often use written materials for patient education [1-3]. Our previous work showed that educational videoconferencing was effective in health education [4,5]. However, the relative efficacy of videoconferencing as compared to written educational materials in asthma health education has not been studied. We compared the effectiveness of these two methods using a case-comparison before-after study. One group (videoconference group) participated in an interactive videoconference on asthma while the other (written material group) received a written material transcribed from the videoconference presentation. Ten true/false statements tested knowledge. We calculated knowledge scores by assigning a point for each correct answer (maximum total score 10). Independent-sample *t*-tests were used to compare the mean pre- and post-intervention scores between the groups. Thirty-six subjects participated (22 in videoconference group, 14 in written material group). We found no significant difference in mean pre-test scores between the groups (7.3 vs. 6.4, $P=0.065$). Following the intervention, the videoconference group had a significantly higher mean post-test score (7.7 vs. 6.3, $P=0.001$) and was more likely to answer several statements correctly (Table 1). In this study, interactive videoconferencing was more effective than written material in delivering asthma education to inner-city immigrant parents.

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Table 1. Number (%) of correct responses at post-test for videoconference and written material groups.

True/false statements	Videoconference group (n=22)	Written material group (n=14)	P
Preventive medicines for asthma should be taken every day even if a child feels fine	18 (82)	3 (21)	<0.001
Children who take asthma medicine every day become addicted to it	12 (55)	0 (0)	0.001
Children with asthma will always miss a lot of school	13 (65)	1 (8)	0.001
Some children with asthma need to take a medicine every day to prevent their asthma attacks from starting	20 (91)	8 (57)	0.02
Asthma is a condition that only appears in early childhood and then goes away	16 (80)	13 (93)	NS
Children with asthma can run and play like their friends who do not have asthma	12 (55)	10 (71)	NS
Children can catch asthma from a friend, just like a cold or flu	15 (75)	12 (86)	NS
Furry pets and cigarette smoke are two of the things which can make asthma worse	22 (100)	14 (100)	NS
Staying away from smoke is one way to prevent asthma	21 (96)	14 (100)	NS
Coughing can be a sign of asthma	21 (96)	13 (93)	NS

NS: $P \geq 0.05$

Parental satisfaction with asthma education: videoconference versus written materials

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Summary

Asthma education can be provided through several methods, including written educational materials and videoconferencing. While written educational materials have been the standard for decades [1-3], videoconferencing is emerging as a new method of health education. Several studies have evaluated satisfaction with written educational materials [4,5], but few prior reports have examined satisfaction with videoconferencing [6,7]. The aim of this study was to assess parental satisfaction with these two methods of health education. We conducted a case-comparison study of two groups: the videoconference group attended an interactive videoconference on asthma overview. The written material group received a transcript of the videoconference presentation. Satisfaction was measured by a self-administered questionnaire using a 5-point Likert scale (1=strongly disagree to 5=strongly agree). Answers were dichotomized into disagree and agree categories. The differences between the categorical variables were compared using a Chi-square test. 39 subjects participated (25 in the videoconference group, 14 in the written material group). Parents were satisfied with most aspects of videoconferencing and written materials. However, most participants believed that written materials were not a good educational method. In contrast, nearly all videoconference participants believed that videoconferencing was a good method for health education (Table 1). In addition, parents in the videoconference group were less likely to have unanswered questions about asthma (Table 1).

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Table 1. Number (%) of participants in videoconference and written material groups who agreed with the following statements.

Statement	Videoconfer- ence group (n=25)	Written material group (n=14)	<i>P</i> value
I think videoconferences/written materials about health issues are NOT good ways to educate people	4 (17)	12 (92)	<0.001
I have more questions that I would like to ask a doctor about asthma	11 (65)	13 (93)	NS
I found this videoconference/written material about asthma to be helpful	24 (96)	14 (100)	NS
This videoconference/written material was held in a language that was easy to understand and follow	22 (96)	13 (100)	NS
This videoconference/written material answered all the questions I had about asthma	20 (87)	14 (100)	NS
I know more about asthma than I did before	21 (91)	14 (100)	NS
I would like to attend/receive another videoconference/written material about asthma	21 (96)	9 (82)	NS

NS: $P \geq 0.05$

Successes of Ukrainian telemedicine

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Summary

The first telemedical work appeared in the Ukraine in the 1970s. It mostly concerned telemetry of physiological parameters for miners. In January 2000 the Ukraine Informatics and Telemedicine Department was founded at the R&D Institute of Traumatology and Orthopedics in Donetsk. The same month we carried out our first teleconsultation: Professor Michael Nerlich from Regensburg (Germany) was consulted about a patient with serious pelvis trauma from Donetsk. Our telemedical workstations consist of PCs (connected to a local network), slide-scanners, digital cameras, printers, web-cameras, as well as a leased Internet line (128 kbit/s). We mainly use: email, professional mailing lists, Internet forums, off-line teleconsultation servers. Sometimes we also carry out videoconferences, using NetMeeting (Microsoft).

In 2000-2003 we carried out 210 teleconsultations. In carrying out the teleconsultations we considered 210 case histories, 45 digital clinical photographs, 375 digitised X-rays, 65 computer tomograms, 111 magnetic resonance scans, 4 sonograms, 7 graphical images, 30 records of additional medical data (myelograms, blood tests, experts decision, ECG, biopsy data, clinical tests) and 5 cytological micrographs. The reliability of the diagnosis using the digital data in teleconsultations was 73%.

Teleconsultations were carried out for 92 men and 52 women. The age range was 3 months to 80 years. The most common questions were those about treatment (128), as well as the questions concerning possible surgery (26). The majority of teleconsultations concerned various problems of traumatology and orthopaedics, bone oncology and neurosurgery. The suggested treatment was used in 80% of cases. We investigated whether the use of off-line teleconsultation was effective in treating patients with multiple trauma. There was a 16% reduction in-hospital treatment; a 9% reduction in complications; a 10% reduction in the relative risk of having complications; and a 0.4% reduction in re-hospitalisation.

Health informatics online: e-learning for e-health

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Summary

E-learning has enabled the University Department of Rural Health in Tasmania to tailor its e-health (health informatics) graduate programme[1] to the needs and interests of students from diverse professional backgrounds and widely different levels of technological expertise. The majority of students (84%) are health professionals drawn from:

- large and small government and private sector health organisations, hospitals or community based health services
- clinical and non-clinical environments
- metropolitan, rural and remote locations across Australia.

Catering for this diversity was a challenge that has since become an important element of the programme. We have been able to tailor the learning experience and ensure its relevance by linking course content to the specific professional environment of participants. This enables students to produce projects which have practical application to their work. We also cater for a range of technological skills with a course structure offering alternative learning pathways and different levels of technology use. This allows for different learning styles, a range of technology skill levels and differential access to technology. At the same time, progress through the units encourages students to become more confident, independent and skilled with e-learning and subsequently with e-health.

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Development and initial trials of a broadband, critical-care telehealth system

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Summary

Many of Australia's smaller and more isolated hospitals lack the specialist staff and patient load to maintain skills across a broad range of specialities. They are increasingly looking to telemedicine to assist in supplying such services. However, most current telehealth technologies are not useful across a wide range of medical services, notably in complex, critical clinical settings. We have developed a Virtual Critical Care Unit[1] This is a telehealth system using digital video (DV) and broadband Internet technologies for telepresence support in the emergency, high dependency and obstetric departments of a remote hospital.

The system can transmit four channels of DV over a dedicated fibre-optic link, as well as output from an ultrasound scanner, vital signs monitor and cardiocograph for presentation to a clinical specialist. One DV stream back from the specialist provides real time, interactive telepresence for the remote hospital. The system is designed so that the operators at the peripheral end do not have to interact with technology, is nurse-initiated and permits true telepresence in a complex clinical area in which there has been little experience of telehealth to date[2].

The system has identified the importance of human factors and the need to develop clinical protocols specific to broadband telemedicine, as well as the need for simulated training using virtual patients. In particular, the need to involve clinical staff in the system design, and to design the system around the protocols and specialised needs of emergency medicine were key influences on the design process. The system has been in operational use since December 2003 between Blue Mountains District Hospital and Nepean Hospital on the western outskirts of Sydney. In the first six months of use it has demonstrated its effectiveness in 115 episodes of

patient care, exceeding expectations about its user acceptance, the range of applications and the number of uses.

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Challenges to the adoption of mobile and wireless technology in Australian aged care

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Summary

The Australian aged care industry, which is still in the early stages of adopting information technology (IT), is seeking methods for improving efficiency. New mobile and wireless technology may be relevant. As nurses are always moving around beds, and to different wards and community care centres, mobile solutions are attractive for assisting with nurse documentation needs, which will affect the accreditation and level of funding that the facility will receive.

To date, however, no convincing mobile and wireless technology has been implemented in health care. In order to provide IT solutions that satisfy the business needs and work practices of aged care nurses, a study on the barriers to the adoption of mobile and wireless solutions for aged care has been undertaken. The research took an exploratory approach, featuring structured and unstructured interviews, and an experimental approach, in which prototype mobile solutions were developed. A total of 11 senior management personnel were interviewed, belonging to 11 management groups in the Sydney region. All of the respondents agreed that mobile and wireless technology might offer the ultimate solution to the documentation needs of mobile aged care nurses. However, there were significant strategic, managerial and operational issues to be solved before the implementation would be feasible.

The pilot software development activity suggested that the critical factor for mobile solutions was a thorough understanding of the work process and accurate identification of the tasks suitable for automation. The mobile solution proposed for the trial, "Handheld-based Bowel Movement Management", was appealing.

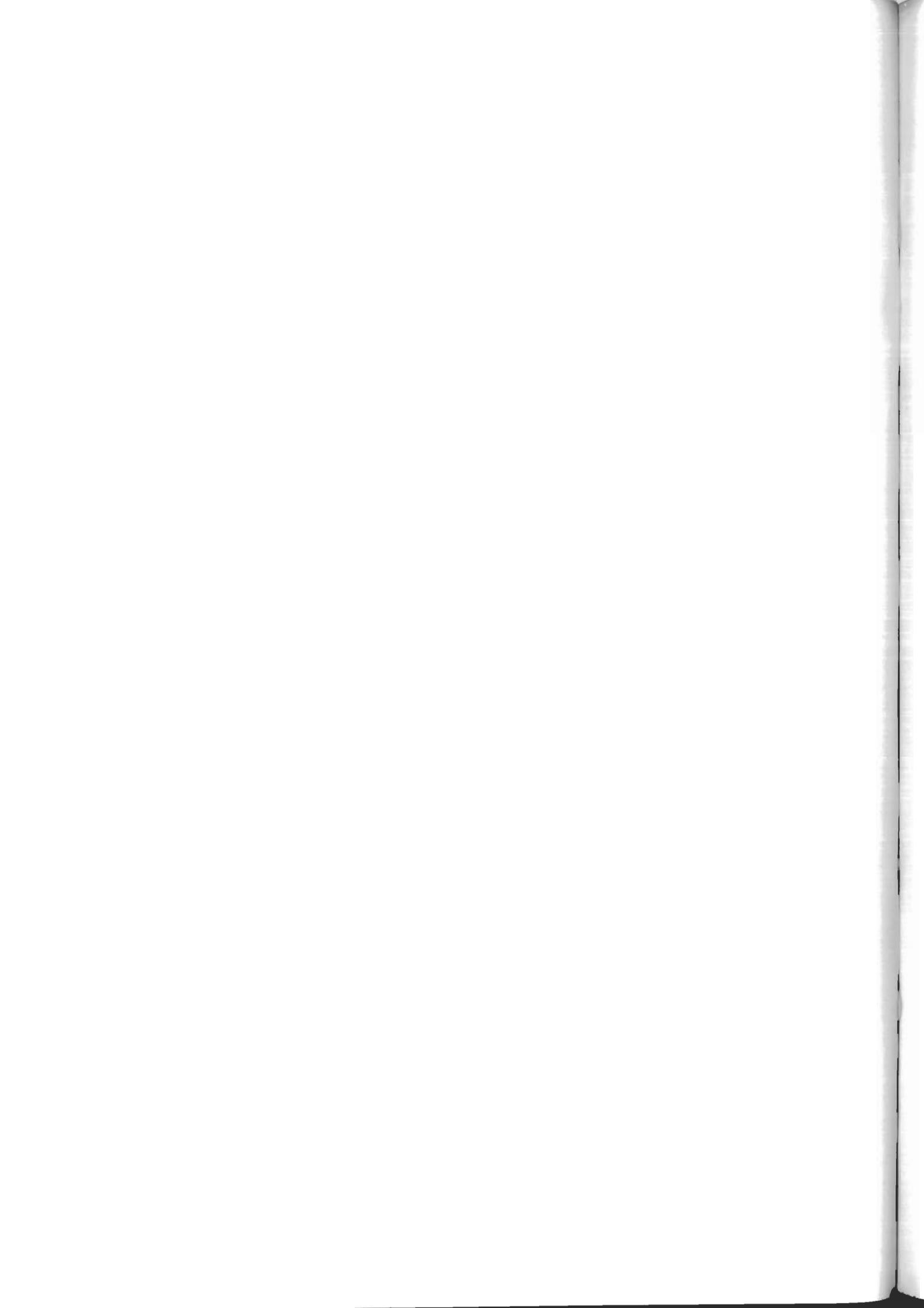
However, not enough applications were available to justify the investment, and coupled with the infrastructure cost, the difficulties in managing the small devices and the scepticism of the work force, the implementation has not yet been considered seriously by the managers.

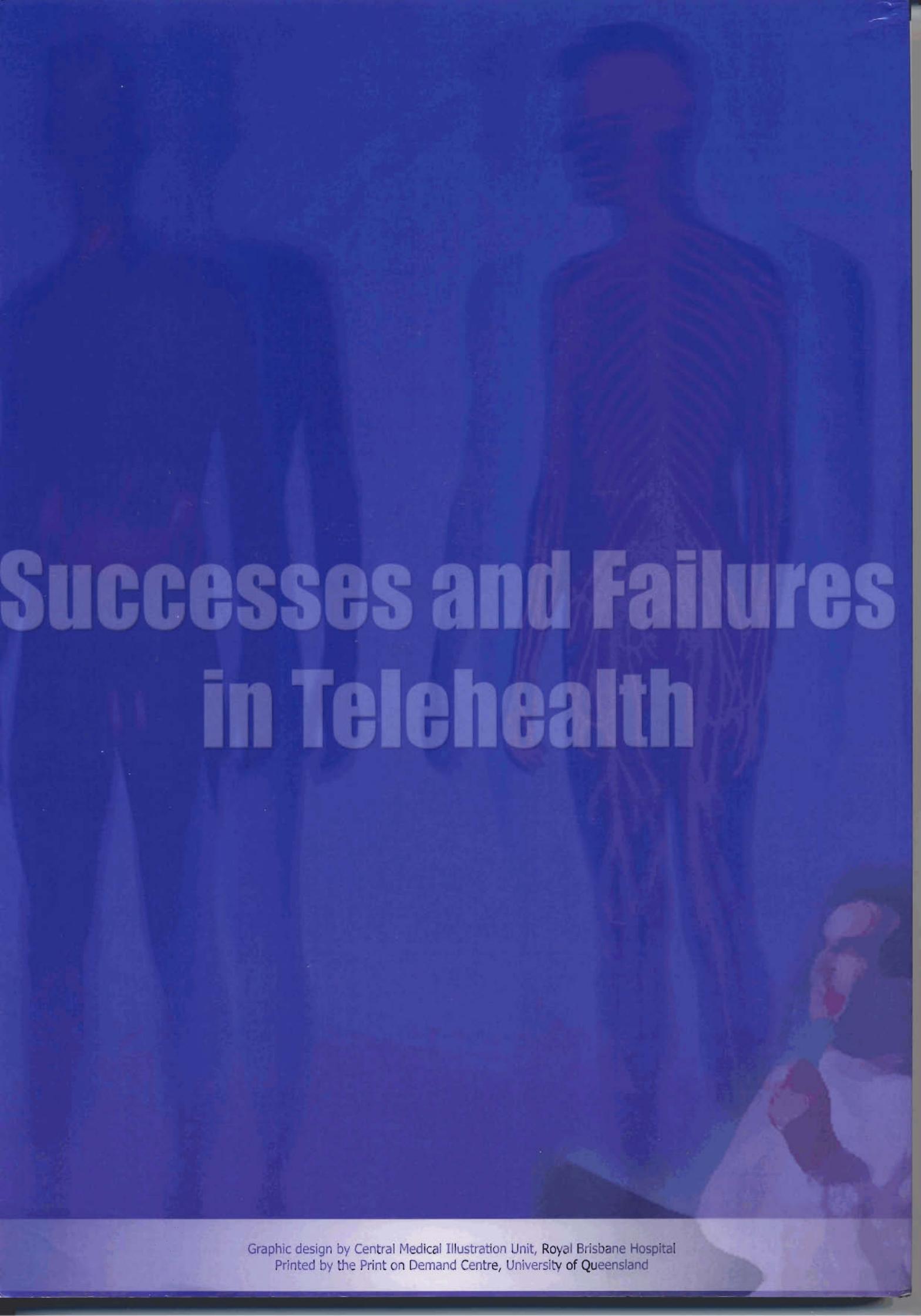
The survey indicates that there are a number of factors which hinder the adoption of information technology. These include the lack of evidence about the benefits of IT investment, lack of support for project implementation, a dearth of staff with computer competence and a general fear of change. The lessons learned from the prototype application development may be useful in implementing mobile solutions for other healthcare settings.

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