

Using information technology to improve the management of chronic disease

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EFFECTIVE MANAGEMENT OF CHRONIC ILLNESS requires a close partnership between the patient and all healthcare providers.¹ Patients with chronic disease are inevitably personally responsible for their own day-to-day care, and are often the best placed to gauge the severity of their symptoms and the efficacy of any treatment. As a result, they must be active participants in the treatment, and, indeed, must adopt self-management as a life long task.^{1,2} However, compliance with self-management regimens is often poor.³⁻⁵ This is hardly surprising when patients are confronted with such complex instructions as “monitor and track your blood pressure”, “recognise and report any symptoms”, “reduce your stress levels”, “monitor and track your blood sugar” and “take six prescription medications, all at different intervals”.

The problem of compliance, as well as the need to provide effective communication between patients with chronic illness and healthcare professionals to enhance care, highlights the need for the use of appropriate and cost-effective information and communications technology (ICT).^{6,7}

Key application domains for ICT in healthcare delivery include telemedicine,^{8,9} telehealth (or e-health) and home telecare. Telemedicine, typically defined as “a system of healthcare delivery in which physicians examine patients through the use of telecommunications technology”,¹⁰ is very well developed in Australia.¹¹ It may encompass telepsychiatry, teleradiology, telepathology, teledermatology and teleophthalmology. However, its primary function is to provide specialist consultation to distant communities, rather than to provide a tool for self-management of chronic disease. In contrast, telehealth incorporates a broad range of health-related activities, including patient and provider education, and health services administration, as well as patient care. In Australia, HealthConnect is an e-health initiative designed to provide patients with rapid access to general health information, reduce duplication of services, provide greater portability of health records and enhance the quality of information exchange between providers (see Box 1).

Clinical decision support is another important area of application of ICT. It is heavily dependent on ready access to medical knowledge databases, as well as sophisticated search engines, which automatically adapt and learn from the user’s search history. The Clinical Information Access Program (CIAP), which provides information resources to

ABSTRACT

- Information and communications technology (ICT) is increasingly being used in management of chronic illness to facilitate shared services (virtual health networks and electronic health records), knowledge management (care rules and protocols, scheduling, information directories), as well as consumer-based health education and evidence-based clinical protocols.
- Common applications of ICT include home monitoring of vital signs for patients with chronic disease, as well as replacing home visits by nurses in person with telemedicine videophone consultations.
- A patient-managed Home Telecare System with integrated clinical signs monitoring, automated scheduling and medication reminders, as well as access to health education and daily logs, is presented as an example of ICT use for chronic disease self-management.
- A clinical case study demonstrates how early identification of adverse trends in clinical signs recorded in the home can either avoid hospital readmission or reduce the length of hospital stay.

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support evidence-based practice at the point of care, is an excellent example of such a service.¹² Another example is the Quick Clinical project which is developing an experimental online information retrieval system for use in the clinical setting.¹³ Quick Clinical is designed around the specific information needs and resource constraints within the clinical context (Box 1).

Recent literature has identified home-based disease-management programs as an evolving and important application of telemedicine.¹⁴ Unlike the other applications outlined above, home telecare is a rapidly evolving subspecialty of telemedicine focused on providing care in a home or community setting,¹⁵ with the primary role of providing support for the patient rather than the health professional.

Typical applications include the management of chronic heart failure (CHF),^{16,17} asthma,¹⁸ diabetes¹⁹ and hypertension.²⁰ These and other applications may be based around videophone systems which allow nurses or doctors to view and talk to the patient while collecting data from equipment that records vital signs.²¹

Evidence of effectiveness

As is common for most telemedicine applications, a strong evidence base for cost effectiveness and improved healthcare

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1: Internet resources

- Telehealth (or e-health) initiatives
 - HealthConnect (www.health.gov.au/healthconnect)
 - HealthInSite (www.healthinsite.gov.au/)
- Clinical decision support
 - Quick Clinical (www.chi.unsw.edu.au)
- New technologies
 - American TeleCare (www.americantelecare.com)
 - AMD Telemedicine (www.amdtelemedicine.com)
 - March Networks (www.marchnetworks.com)
 - SHL Telemedicine (www.shahal.co.il)
 - HomMed (www.hommed.com)



outcomes is still not available.²² The reason for this is that most reports in the literature deal with short-term pilot projects and do not present either a business case or the potential for sustained viability.

In our review of 175 articles on telecare and telemedicine in chronic disease management, we found only four²²⁻²⁵ that looked at cost-effectiveness. Reports on clinical outcomes and cost effectiveness of ICT for chronic disease are thus very limited,²²⁻²⁴ with the strongest evidence available for telepsychiatry and teledermatology.²³ An attempt to carry out a formal meta-analysis of cost-benefit research considered 38 journal articles in which real costs or cost benefits had been considered, but concluded that their design or methods were inadequate for a formal meta-analysis, and that it was premature for any statements to be made on the cost effectiveness of telemedicine and telecare services.²⁴

Probably the only large-scale study of home telecare that has any statistical validity is that by the Kaiser Permanente health maintenance organisation.²⁵ This study examined the cost of delivering nursing services by means of remote video technology in the home healthcare setting, comparing an intervention group of 102 patients with a control group of 110 patients. Patients in the intervention group received video visits in addition to the standard inperson and telephone visits offered to the control group.

The total mean costs of care were US\$1948 in the intervention group and US\$2674 in the control group, the

difference being mostly attributable to hospitalisation costs. The study concluded that, while patients were very pleased with the video technology, the potential for using video visits for reducing the number of actual caregiver visits was not fully realised.

The benefits of home telecare for managing CHF, however, have been extensively reported and some studies have found significant cost savings. One found an 83% decrease in the admission rate for those with CHF in the third quarter of the year after the intervention, compared with the third quarter of the year before the intervention ($P=0.008$).²⁶ Another reported that when a telecare group of patients with CHF was compared with patients receiving usual care, mean CHF-related readmission charges were 86% lower (US\$5850 versus US\$44 479), with fewer CHF-related emergency department visits ($P=0.034$).²⁷

It is thus clear that there is an urgent need to develop a business case for new telemedicine services. This should consider government policy, remuneration and the question of who pays, as well as analysing outcomes from long-term clinical trials evaluating healthcare outcomes and cost benefits.

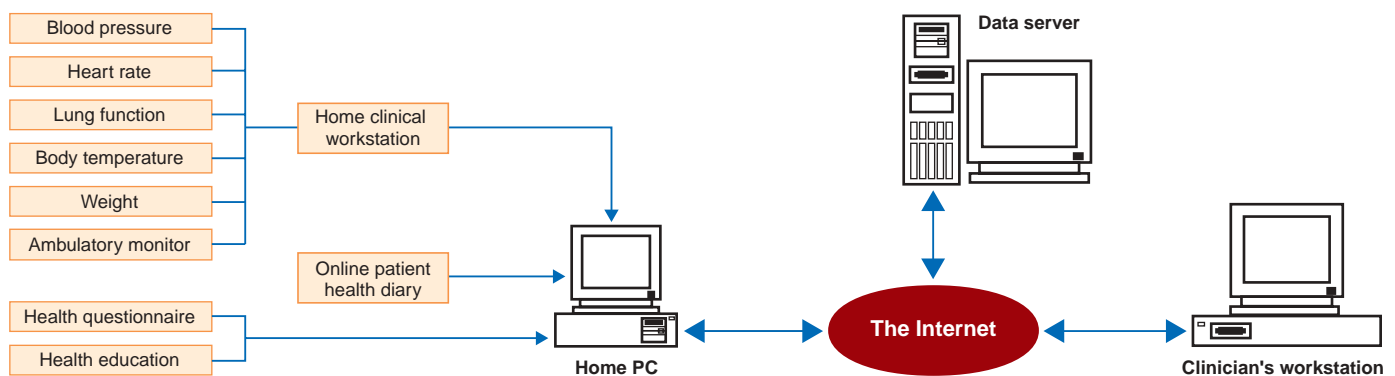
Demonstration home telecare system

Although there are now many examples of home telecare services in the literature,^{28,29} and in the last few years a range of new technologies have become available (see Box 1), we will use as an example a locally developed Home Telecare System which integrates a range of e-health services and advanced ICT applications³⁰ to manage chronic disease at home.

Key design specifications included low relative cost, modularity (pick and choose), simplicity of use, clinically relevant vital-signs monitoring, highly automated scheduling, provision of patient feedback, access to information services and very limited use of wearable devices to promote user compliance. The Home Telecare System is shown in Box 2. It is connected to a home personal computer and includes:

- the ability to record electrocardiogram, blood pressure (auscultatory method), spirometry modules, patient weight and temperature; and

2: Schematic diagram of a home telecare system for the management of chronic disease



■ a wireless interface to an ambulatory patient-worn device for:

- telephone voice connection on emergency button press; and
- continuous monitoring of acceleration forces on the body to measure energy expenditure and record falls and stumbles.

In addition to monitoring clinical signs, the Home Telecare System can deliver questionnaire instruments which can be tailored to assess functional health status or a specific condition. The Home Telecare System also provides access to EDU-CATE (a comprehensive library of health education leaflets)³¹ and easy-to-use links to other validated Internet resources, and allows the patient to maintain a daily log of health service use. All data collection is scheduled by patients' general practitioners on the basis of the severity of symptoms; data collected are then automatically synchronised and replicated on a central server and immediately available to the doctor for remote viewing from any web browser. This approach is seen as a workable intermediary between a stand-alone program that must be installed on each doctor's computer, versus full integration into a standardised electronic health record. The latter is not currently possible due to the lack of clear international or Australian standards for such records. Our Web-based approach allows for ubiquitous access to patient data and provides a standard user interface (Web browser) with which most clinicians are familiar.

A clinical trial of the Home Telecare System is described in Box 3 and a clinical case study using the system in Box 4.

Impact on clinical practice

Comprehensive chronic disease assessment often involves a long consultative process by a clinician backed by a multidisciplinary team of other clinicians, allied healthcare staff and community healthcare workers. Such assessment and management is often difficult in general practice, because of time constraints imposed by practice costs and demands of

other patients. Furthermore, GPs may sometimes only be made aware of a patient's deteriorating condition after weeks or months.

Telecare introduces new modes of assessment to improve the quality and variety of information about a patient's health status to the clinician. Measures of functional status and quality of life, in addition to physiological monitoring, can be translated into accurate predictors of health risk, and can be combined with electronic alarm systems as a platform to initiate an appropriate course of action. This information is invaluable in identifying and treating problems, sometimes at an earlier stage; small improvements in each can also dramatically affect the outcome, function and overall wellbeing of a patient with chronic disease.

Telecare can provide the infrastructure for coordinating multidisciplinary care outside hospitals, for example, scheduling visits with allied health staff and community health workers, automating collection of clinical findings and test results, and liaising with hospital and staff specialists.

For GPs, this will enhance their ability to manage chronic disease, by providing the necessary support to continue care outside the standard consultation and the ability to monitor treatment progress. Programs aimed at community groups at highest risk are more likely to improve long-term function, decrease hospital admissions and reduce mortality.

Conclusions

The transition from managing acute disease to managing chronic disease requires fundamental changes in healthcare service organisation and delivery, as well as recognition "that the patient with chronic disease is the principal care giver who must carry out the necessary actions continuously, interpret and report their results accurately and join in subsequent decisions".³² Critical to this comprehensive healthcare strategy are the provision of Web-based health education, better management of demographic data, promotion of and support for self-management in community

3: Clinical trial of the Home Telecare System



A clinical trial was carried out over at least 3 months in metropolitan Sydney and in Wagga Wagga (a regional centre) with 22 patients aged 58–82 years. All patients had a primary diagnosis of chronic heart failure and/or chronic obstructive pulmonary disease. Some patients were monitored continuously for more than 8 months.

The Home Telecare System set up in the patients' homes is shown in the Figure. All patients, despite having almost no prior computer experience, were able to use the system effectively with less than 1 hour of training. A final report on this trial is available on the internet (www.gpcg.org/publications/docs/projects2001/GPCG_Project4_01.PDF).

In summary:

- All patients found the Home Telecare System easy to use
- 21 of the 22 patients used the system at least once a day
- 21 of the 22 patients were satisfied with it
- 21 of the 22 patients wanted to continue using the system on a regular basis
- 13 of the 14 GPs who responded stated that they were either very satisfied or satisfied with the system; none expressed dissatisfaction with it.

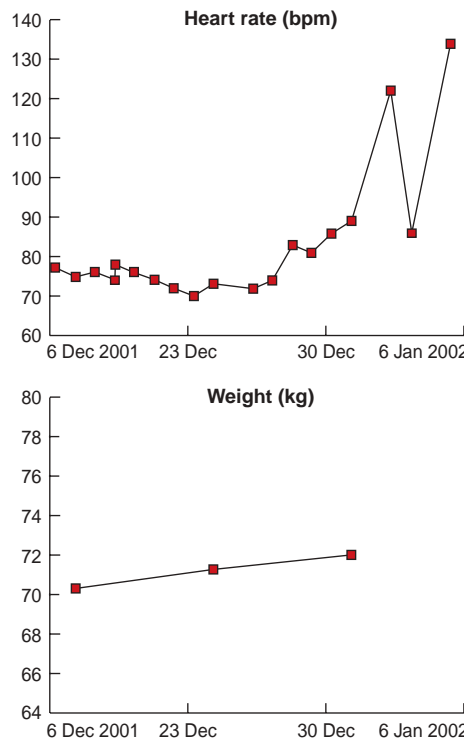
A: Spirometer; B: Home clinical workstation; C: Antenna for ambulatory monitoring; D: ECG plate electrodes; E: Blood pressure cuff.

4: Clinical case study involving the Home Telecare System

A 58-year-old woman with smoking-related chronic obstructive pulmonary disease was enrolled into the Home Telecare System trial. She underwent automated monitoring of her lung function, temperature, heart rhythm, weight and blood pressure, and these data were reviewed regularly by her general practitioner.

The data subsequently showed the development of sinus tachycardia, decreasing forced expiratory volume in one second (FEV₁) and forced vital capacity (FVC), and increased weight (presumably due to fluid retention) (see graphs).

The GP contacted the patient and was told that she was acutely short of breath. The GP arranged for her to be admitted directly to hospital, where she was diagnosed with lung infection and mild heart failure. She was discharged after two days of antibiotic and diuretic therapy.



or home-based settings, and protocol-based regulation of clinical procedures and medications.

From our own studies and the evidence in the literature, it is probable that home telecare, supported by dedicated multidisciplinary care teams, can promote partnerships between the patient and other caregivers, facilitate patient self-management, improve compliance and medications management, and reduce the readmission rate for those with chronic disease.

Competing interests

The Home Telecare System described in this paper is being commercialised by MedCare Systems Pty Ltd [ABN 65 050 042 192] located at the Australian Technology Park, Eveleigh, NSW 1430. B G C and NHL are Directors of the company and JB holds a small shareholding.

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time capsule

The aged and the “chronics”

While it is not strictly correct to link the aged with those who are chronically ill in any discussion on the provision of a health service for the community, they may be grouped together because of the fact that special provision has to be made for them. The rising cost of the upkeep of hospital beds is one of the factors which make discussion necessary. At a recent meeting of one of the Branches of the British Medical Association in Australia it was stated... that the cost of upkeep of a bed in the teaching hospital... had risen to £14 14s. a week. This is fantastic, ... Quite naturally one asks for how long the cost of hospital treatment is likely to increase and what will happen in the future. To use hospital beds at two guineas a day for persons suffering from chronic illness or for those who are helpless because of senile changes is not common sense. When these people have to be admitted to hospital special institutions are needed for them – what they want is nursing attention rather than any of the elaborate equipment used for diagnosis and treatment in the large teaching hospital. This is well known to all who have anything to do with hospital management; but, like so many other features of the present social order, it needs to be drummed into those not intimately acquainted with hospitals who are in a position to correct anomalies or to create public opinion about them.

Let us look first of all at the “chronics”, as the chronically ill are commonly dubbed. They are a large, and in many respects a pathetic, body of people. We plead for special institutions... where they may be nursed and treated. And it is right that we should do this, especially when we find that they tend to occupy beds in which acutely ill persons should be placed. But such an attitude accepts the position as it exists and does nothing to make the problem less acute for the future. Prevention should be the note — and we should realise that prevention of chronic illness is no less important in the community than prevention of the acute variety. If we could prevent chronic illness, we should be

able to cease our clamour for “chronic hospitals”, we should be able to stem the ever-increasing expenditure on invalid pensions and we should have the satisfaction of knowing that many of our fellow citizens were able to enjoy life and make something of it. The most important of the chronic diseases have been named as heart disease, arteriosclerosis, arterial hypertension, nervous and mental disease, arthritis, kidney disease, tuberculosis, cancer, diabetes and asthma. It must be admitted that we are grossly ignorant of the causes of many of those conditions, but we must also confess that if everything was done that could be

... we should realise that prevention of chronic illness is no less important in the community than prevention of the acute variety.

done, if all our knowledge was correctly applied, much suffering could be avoided... In the prevention of some of the diseases named... the practising members of the medical profession are largely dependent on the steps taken by governments to make provision for sufferers and their dependants. But there is ample scope for the practitioner to exercise a personal influence and even supervision in many matters... The treatment of a chronically ill person should be carried out with the same assiduity as is displayed towards the acutely ill, and the object must be to restore the patient so that he will be an independent and self-supporting member of the community. If his illness has progressed to such a stage that he is permanently incapacitated, every effort should be made to preserve his morale and even to increase it so that mental factors will not be added to a physical disability...

... In this short discussion [we have drawn] attention to the problems of the chronically ill and the aged in the light of the constantly increasing costs of hospital management. These problems have their individual peculiarities and difficulties, but it is clear that each can be mitigated by the introduction and continuous use of preventive measures. Results will not be obtained at once, for prevention here, as nearly always, must be a long-range policy.

Med J Aust 1950; 1: 601-602 [editorial]