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Smart House Infrastructure for Chronic Disease Management

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Abstract and objective

Information and Communication Technologies are enablers for next generation home healthcare. This poster describes a proposed ICT-based home care system for chronic disease management. Key characteristics are patient-centred data ownership, broadband Internet connectivity, self-configuring networked instruments for measurement and treatment, individualized treatment rules and regimes, and automatically cascading levels of alarms and interventions.

Keywords:

chronic disease management, internet, home care services

Introduction

Over the next 50 years, Australia can expect to see an increasingly aging population. A particular problem, most pronounced in the aged, is appropriate care and management of chronic conditions, whilst maintaining quality of life and opportunity for independent living.

The most common 10 chronic diseases (illness which has lasted longer than 6 months) accounted for 43% of the total disease burden in Australia in 2002-3. In that time, more than 17% of hospital admissions were for management of chronic disease which cost $11 billion from the total health budget of $60 billion. These ten diseases were: Coronary Artery Disease; Lung Cancer; Cerebrovascular Disease; Dementia; Chronic Obstructive Pulmonary Disease (COPD); Diabetes; Depression; Colorectal Cancer; Asthma; Osteoarthritis.[1]

A model of health care delivery whereby the diagnosis, treatment and ongoing management of chronic conditions occurs in total or in part, remote from a hospital is clearly of benefit. Hospital-based care of chronic conditions is expensive, and an inefficient use of hospital resources. The benefit in terms of psycho-social wellbeing of the individual, the family and community is an additional bonus if care can be migrated to the home setting.

Many health home-monitoring projects have aimed to provide very low-cost, low-bandwidth solutions, using technologies such as modems and phone-lines, and these continue to be an area of active interest amongst many groups. However, the more widespread availability and adoption of broadband Internet, home computers, mobile phones and wireless technologies suggests better solutions are possible.

Methods

This paper presents our initial system design, based on analysis of existing telemedicine solutions for diagnostics and health-care management, combined with insights regarding the changing population demographics and societal attitudes to healthcare.

The results presented below include both our analysis of the relevant aspects of current western healthcare systems, plus our predictions of how to better address the requirements of such systems.

Results

Assertive, well-educated and politically astute baby boomers are now taking a major role in caring for their parents, and will soon start to enter old-age themselves. There is already a move away from professionally-centred patient care models (where doctors take primary responsibility for health care decisions) to patient-centred care models where patients (and their families and friends) take an increasingly dominant role in health care management, with professional staff assuming more the roles of consultants and advisors.

With an increasingly aging population and increasingly costly health-care, future health care models for health management in the aging will necessarily depend on a distributed community of volunteer carers. Jointly with the move to patient-centred care regimes, and with the desire to maintain independent living well into old age, this all suggests a substantial shift in models of care for the chronically ill will occur in the coming decades.

Current practitioner-centred medical records systems and health monitoring systems are inadequate to deal with these forthcoming significant changes in models of care. There will be an increasing emphasis on the role that modern Information and Communications Technology (ICT) can play in enabling and supporting these new models of care. Our project investigates new models of care, and the Smart House technologies that will assist in implementing them.

1 Australian Institute of Health & Welfare Report. 2002-3.

In terms of diagnosis, ICT technologies can extend the range of scenarios and locations where extended diagnostic testing can be done. For example, in Obstructive Sleep Apnoea, first level diagnostic filtering can be done with low-cost Pulse Oximetry in general hospital wards, or even at home rather than in specialized sleep-medicine wards, with just the diagnostic information (not the patient!) being relayed to the sleep specialist. However, detailed information needs to recorded and validated before meaningful remote diagnosis can be done.

In terms of long-term home-based care, ICT technologies can assist in patient-centred record keeping, in recording care regimes (diet, exercise, drugs), in implementing those regimes (eg. automatic monitoring of drugs taken, physiological monitoring), in remote communications with other volunteer carers such as friends and relations, and also with health professionals, and in automated alerts of atypical behaviour (perhaps indicating a fall or a chronic episode).

Incorporating Smart Home technology into new housing developments might differentiate such developments by making Smart Home technology an agency for improved health outcomes, not just improved convenience and entertainment. The same technologies might be applied to residential aged care facilities, particularly those with independent and semi-independent living units.

Such new models of patient care need input from clinicial researchers who would design, implement, trial and evaluate the health care regimes. There appears ample scope for significant clinical research outcomes from such a program.

The electronics of an ICT-based home health-care support system centres on a secure home healthcare portal device, basically an inexpensive embedded computer, which provides local data storage, a broadband Internet connection, a secure web-server for remote access and data analysis, and a wireless networking capability to connect to instruments.

Measurements can be analysed and filtered on the basis of required level of care. Basic measures of body attitude, activity and daily weight can be progressively augmented with electrocardiographs, pulse oximetry and blood glucose levels for example. Instrumentation can be ambulatory for some sensing modalities. Wireless is the preferred means of communication from sensor to the portal. Therapeutic devices (such as automated medication dispensers) are similarly connected.

The software of the system (running on the portal) consists of a home healthcare monitoring executive, whose particular characteristics are customized for the disease and the patient. Reminders for measurements to be taken, and medications to be taken can be scheduled into the executive. Customization of care regimes occurs at three levels. Firstly, dosing can be customized to the individual patient. Secondly, dosing can be adjusted (within approved limits) in response to measurements. Thirdly, a remote practitioner can review and manually change either of these first two regimes.

The system can also initiate cascading levels of alarms in response to events. Lack of user input might trigger a notification to a nurse, unexpected measurements might trigger notification to a doctor, a panic button might trigger an ambulance.

Discussion

Clinical/Systematic research issues include:

- How can new patient-centred care regimes be designed so as to put more control into the hands of the patient, and what should the role of the health care professional be?
- What sorts of technological assistance might be required to implement such care regimes, which are not adequately addressed by current mechanisms?
- How are patient outcomes measured, and what improvements can be made to patient outcomes by such technologically-enabled patient-centred care regimes?
- What are the cost/benefit tradeoffs of such home-based, technology-enabled care regimes?
- How can such benefits be realised within the constraints of the current health funding systems? – Who would pay for such models to be developed and implemented?

Computer systems research is needed to investigate appropriate devices, communications, networking and database technologies that are needed to implement such a system in a cost-effective manner

Human Computer Interaction (HCI) research is needed to investigate appropriate interaction methodologies between patients and the Smart Home technology.

Trials are needed to validate the potential of such an ICT system to better facilitate patient-centred healthcare. Figure 1 shows the change in data-management.

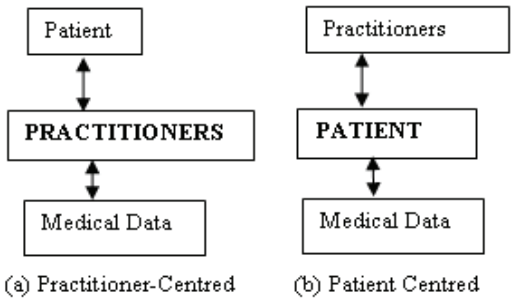

Figure 1 - (a) Current and (b) proposed models of medical data ownership and control

Conclusion

If patient-centred healthcare is to become a reality, with an emphasis on keeping the aged and chronically ill out of hospitals and nursing homes, then the ICT support for the management of patient care also needs to be devolved to the Smart Home under the control of the patient. This requires new ways of thinking about ICT support for healthcare, based on patient-centred, semi-autonomous, widely-distributed and highly networked patient information systems.