The CSIRO National Telehealth Trial: significance for rural and remote health care

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Abstract

The results of the CSIRO National Telehealth trial were recently released and very widely publicised. In a Before and after Controlled Intervention (BACI) design involving >230 patients, the keynote results included a reduction of 46% in the rate of expenditure on medical services after one year, a 53.2% reduction in the rate of admission to hospital and a 70-76% reduction in the rate of LOS. Patient acceptance of the technology was >83%, and >89% of care coordinators would recommend telemonitoring services to other patients. The return on investment, calculated as the ratio of net benefit to net cost of providing the telemonitoring service was estimated to be between 5-6 times.

These results strongly suggest that new models of care for the management of chronic disease in the community, based on at home telemonitoring and care coordination can improve healthcare outcome and reduce hospitalisation in both urban and rural and remote settings.

Longitudinal vital signs data and periodic patient administered clinical questionnaires provide powerful tools for early identification of an exacerbation of a patient's condition and permit the early mobilisation of clinical resources to avoid unnecessary hospitalisation.

In this paper we consider the consequences of this trial for the delivery of health services in rural and remote communities and discuss whether at-home or community health centre based telehealth could alleviate the impact of clinical shortages, overcome the tyranny of distance and facilitate better patient self-management and healthcare outcomes.

Given the lack of clinical specialists in rural and remote communities, the ability to connect to specialists in urban and regional centres becomes a critical necessity. Whilst traditional telehealth systems provide a good baseline for the provision of tele monitoring services, are they sufficient to support remote specialist consultations in emergency settings? We will discuss a blueprint for telehealth solutions for mobile community nursing as well as telehealth services that can be delivered from community health centres under remote medical supervision.

Introduction

Telehealth, the delivery of health services at a distance has been extensively studied in various at-home, primary care and hospital based settings for more than twenty years [1-2], but relatively few randomised control trials have been reported. The objectives of the CSIRO National Telehealth trial [3] were to develop a robust set of data reporting on outcomes of introducing a telehealth model of service delivery for the management of patients with complex chronic conditions, based on at home telemonitoring of vital signs and the administration of a range of clinical questionnaires. A complete
report on the study is available from the CSIRO\(^1\) and publication of results in peer reviewed international journals is underway.

In summary, the trial was undertaken at five locations along the Eastern coast of Australia from Townsville to Launceston. Each location attempted to recruit up to 25 test patients and 50 control patients from a list of eligible patients provided by the local hospital. Details of the research protocol have been previously published \([3]\). A total of 114 test patients and 173 patients were consented. Test patients were supplied with a sophisticated clinical monitoring unit\(^2\) which could record non-invasive auscultatory blood pressure, pulse oximetry, forced spirometry, blood glucose, body temperature and body weight. Not all subjects were necessarily required to carry out all tests, but were required to take their measurements in the morning before taking their medications.

Approximately 50% of patients had a primary diagnosis of heart disease, 30% with lung disease and the remaining 20%, diabetes. Other than at-home tele-monitoring, test subjects received normal care, primarily through their GP. Control patients filled out an initial and final questionnaire but otherwise received normal care. PBS, MBS and Hospital data was sourced from the DHS and the local hospitals.

The model of care developed for the trial involved a Clinical Care Coordinator (CCC), typically an experienced registered nurse, reviewing the patient longitudinal record on a daily basis and identifying early trends indicating an exacerbation of the subject’s chronic condition. The CCC would then mobilise the necessary resources (family, GP, specialist or community nurse) to avoid any further exacerbation that could lead to an avoidable admission to hospital.

Patient data were available for a period of three years before the start of telemonitoring and one year after. Data were synchronised with the start date of telemonitoring, and linear regression and anocova analysis was used to identify changes before and after the intervention. Results were generally positive, with a reduction of 46% in the rate of expenditure on MBS medical services after one year, a 53.2% reduction in the rate of admission to hospital and a 70-76% reduction in the rate of LOS. Patient acceptance of the technology was >83%, and >89% of care coordinators would recommend telemonitoring services to other patients. The return on investment, calculated as the ratio of net benefit to net cost of providing the telemonitoring service was estimated to be between 5-6 times.

These results are better than those reported in the UK Whole Systems Demonstrator \([2]\) but comparable to a number of studies reviewed by Bashur and co-authors \([1]\) who reported that for CHF patients, reductions in mortality were between 15-56% compared with patients undergoing “usual” care. They concluded that “…the preponderance of the evidence produced by telemonitoring studies points to significant trends in reducing hospitalisation and emergency department visits, and preventing and/or limiting illness severity and episodes, resulting in improved healthcare outcomes”

The CSIRO study also reported on the importance of local clinical support, capacity for organisational change management and the impact of local workplace culture.

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Conclusions of the CSIRO National Telehealth Trial

High levels of acceptance were recorded by both test patients and CCCs. Cost savings and improved healthcare outcomes were evident through reduced hospitalisation and hospital LOS, reduced MBS costs and small reductions in PBS costs. Part if not all local costs of implementing telehealth can be saved through increased case-loads and more efficient use of clinical staff. The process of implementing a telehealth service is relatively straightforward, providing there is sufficient clinical buy-in and a capacity for organisational change. There was a high level of acceptance by community nurses and patients despite entrenched workplace cultures in some sites leading to slower uptake. Despite strenuous efforts by the project team, there was very poor participation and buy-in by GPs, leading to an enhanced and indeed critical role of CCCs in the telehealth program.

Implications of the outcomes of the CSIRO trial for rural and remote health service delivery

The CSIRO study reports numerous examples where observation of changes in vital signs indicative of an exacerbation of the patient's condition led to timely intervention and avoidance of an unscheduled admission to hospital. The study could not however, categorically determine whether the positive outcomes were due exclusively to the support of patients by the CCCs or the availability of a longitudinal patient record that could track the patients' condition on a daily basis and thereby identify and manage early exacerbations of the patients' chronic condition before they became acute.

We note that CCCs spent an average of 20-30 minutes a week reviewing patient data and making contact with patients. Other studies involving intense telephone coaching [1] as well as numerous integrated and coordinated care trials have not delivered comparable results. This suggests that the availability of a daily record of the patients' vital signs together with their self-reported symptoms should be considered a powerful diagnostic tool previously unavailable to clinicians for the management of patients with chronic conditions.

General medical health as well as medical conditions that could contribute to symptom exacerbation can be evaluated by medical history, physical and neurological examination, and appropriate laboratory, electrophysiological, and radiological assessments, as well as measurement of vital signs. In hospital intensive care units it is well recognised that serious adverse events can be prevented [6], by recognising early warning signs of clinical and physiological deterioration, and responding appropriately. Serious physiological abnormalities often precede cardiac arrest, unanticipated admission to ICU or death [7]. Premonitory abnormalities in vital signs are often observed before adverse clinical outcomes [8], and within 6 hours [9] to 8 hours [10] of cardiac arrest, particularly if hypoxaemia and hypotension are not treated adequately [11]. In one large study [12] recognition of critically abnormal vital signs was used to identify critically ill patients for activation of rapid response teams. This study observed that the simultaneous presence of three critically abnormal vital signs can occur at any time during the hospital admission and is associated with very high mortality. They concluded that early recognition of these events presents an opportunity for decreasing mortality.

A variety of vital signs monitoring tools that incorporate early warning scoring (EWS) systems designed to track signs of deterioration and trigger a rapid response to improve patient safety have been introduced across the UK [13] and Australasia [14,15] These have been reviewed by Kyriacos [16]. As an example, the modified early warning scoring (MEWS)/EWS track and trigger system (TTS) is based on the recording of physiological parameters in boxes, according to predefined ranges [17] and points are allocated to disturbed physiological values, with weightings, to guide intervention.
[18,19], and to monitor the effectiveness of interventions [20]. These replace traditional charts where values are plotted on graphs and intervention levels are not specified.

In general practice the monitoring of vital signs either in the surgery or at home is generally undervalued [21] and the traditional model of GP based primary care where patients attend episodically a general practice, is not conducive to the longitudinal monitoring of vital signs, and is as a consequence, neither common or widely practiced.

There is however a clear analogy between the use of EWS tracking systems in ICU and ED and the early warning that is available through the longitudinal monitoring of vital signs at home of chronically ill individuals who have frequent unscheduled admissions to hospital. The results obtained in the CSIRO National trial are therefore not unexpected.

Implementing telehealth services for rural and remote communities—some international examples

Telehealth and Telemedicine is being increasingly seen as a cost effective way of delivering health care to remote isolated communities both in developed countries and in developing countries [22-30], primarily through interventions in primary care, where care is provided in community health centres or through rural and remote GPs. In many developing countries where medical resources are poorly distributed, community health centres when they exist, may be staffed by nurses or allied health workers. The extension of these community based services to home telemonitoring however is still not common.

Three examples will be briefly described where large scale programs are being rolled out supported by national policy frameworks and funding.

Canada covers a vast area populated by a relatively small population, not unlike Australia and faces similar challenges of harsh climate, few transportation options and a concentration of health services in in large cities. Like Australia, Canada has a number of indigenous peoples (First Nations, Inuit and Metis) many of whom live in isolated remote and disadvantaged communities [29]. The National First Nations Telehealth Research Project 1998, was one of the first projects to address the needs of these isolated communities and were rapidly joined by Northern Ontario Remote Telehealth Network (NORTH), KO Telehealth³ and MBT Telehealth⁴, a 24 site province-wide telehealth network. These remote area networks are complemented by more regional services such as the Ontario Telemedicine Network⁵ (OTN) [4], one of the largest telemedicine networks in the world, consisting of more 1200 sites and 2200 endpoints. OTN supports access to care across a wide variety of clinical therapeutic areas of care which include 65 community care access centres, 72 community health centres and 28 nursing stations on aboriginal reserves (in collaboration with the Keewaytinook Okamakanak Telemedicine Network⁶).

Alaska, shares many of the characteristics of the Canadian Norther provinces, and in step with Canada has developed the Alaska Federal Health care Access Network (AFHCAN)⁷, an extensive telemedicine network, managed by the Alaska Native Tribal Health Consortium, which together with

³ https://tm.knet.ca/
⁴ http://www.mbbletelehealth.ca/
⁵ https://otn.ca/
⁶ http://www.kochiefs.ca/telemedicine
⁷ http://www.afhcanc.org
the Alaska Native Medical Centre (ANMC) provides tertiary and specialty healthcare services in the state.

An important element of the services provided is a diagnostic “store and forward” telehealth platform which combines, text, data, EHR and a range of biomedical peripherals [30]. Healthcare professionals can view patient data and can provide diagnostic support to local allied health staff remotely from their own desktop or mobile device. Approximately 75% of AFHCAN’s telehealth usage is for primary care services.

India is a different example where more than 400 million people and 75% of doctors live in first world urban settings whilst more than 75% of Indians, almost 1 billion, live in rural villages lacking access to even basic health care facilities. This challenging environment has led the Indian Government to initiate two Five year Plans (2006-2012, and 2012-2017) which drafted National standards for Telemedicine and EMR/EHR on Public Domain networks and initiated a National Rural Telemedicine Network in 2007, which implemented a low cost rural telemedicine infrastructure.

A key element of this infrastructure is the INSAT satellite system [31] established in 1983, which is now one of the world’s largest domestic communications system with seven satellites and 130 C-band transponders linking many hundred earth stations in rural and remote areas with thousands of very small aperture terminals (VSAT). These services now reach over 65% of the Indian landmass and 80% of the population, with a minimum guaranteed bandwidth of 300kbps.

A characteristic of telehealth services in rural and remote villages in India, is rapid innovation and deployment based around rudimentary community health centres connected via satellite to remote telemedicine centres, some of which are funded by philanthropic organisations such as the Apollo Hospitals Group [32] and the TATA Trust. Services provided in community health centres typically involve low cost low bandwidth (250kbit) video conferencing, facilities for monitoring vital signs and simple biochemical urine and blood analysers and telehealth connectivity to services in regional centres.

**Telehealth for rural and remote health services in Australia**

It is probably fair to say that telehealth services in Australia have been historically focused on video conferencing between health professionals and their patients, providing stringent requirements are met. Extensive full service telehealth networks such as those developed in Canada, Alaska or India are missing in Australia. Other than for small pilot trials there is no large scale state or federal funding of Home Telehealth or telehealth services designed to support Primary Health Care delivery in rural and remote communities.

A study by Moffatt [34] reporting on the benefits of telehealth for rural Australians identified telehealth services as primarily video-conferencing, or specialist services in psychiatry, paediatrics, dermatology, ophthalmology, diabetes and wound care, and concluded that the greatest benefit to rural health professionals is through the up-skilling and professional development acquired through observing a specialist during video conferencing.

Use of telemonitoring for remote diagnosis and management of chronic conditions is reported by Meade and Dunbar [35], but other than for this small pilot projects, this essential feature of telehealth services is strangely missing in the Australian literature.
Overcoming the barriers for use of telemedicine in rural and remote communities in Australia

Moffatt [36] reports that primary barriers to the take-up of telemedicine in Australia were funding, time, infrastructure, equipment, skills and a preference for traditional approaches to health service delivery. However a fundamental impediment to the deployment of telemedicine in rural and remote communities has been the lack of an affordable, reliable, high bandwidth internet service.

Many larger Aboriginal communities now have access to free to air television and many have access to adequate mobile telephony services. The infrastructure for the provision of these services has often been provided at high cost under cost sharing arrangement between the communities, the states and the commonwealth and occasionally in partnership with telecommunications companies.

Whilst mobile telephony is important for security and maintaining family links and communications in remote indigenous communities, data services over 3G networks can be prohibitively expensive and patently inadequate for key applications such as health, education, training and business development.

The recently deployed NBN SkyMuster™ satellite service with a maximum of 25Mbps download and 5Mbps upload will dramatically improve access to internet services for businesses and health service providers and create new opportunities for implementing telehealth services in community health centres. Given the very low economic base of these communities, individual contracts for ADSL, Cable or Satellite services however, are neither feasible or economic.

Yet community access to the internet is essential for connecting to government services at Medicare or CentreLink and failure to connect can often result in the withdrawal of benefits. Individual access to satellite internet services will thus continue to be limited unless Governments rethink their responsibility for providing community connectivity [37] through the provision of free wireless enabled hot-spots and community access points.

Many remote area community health centres are staffed by nurses with doctors and specialists dropping in for the occasional clinical session. As an example, at Warburton (Milyirrirjarra), in the Western Desert, the health centre is staffed 24x7 at high risk to staff, by seven community nurses. A GP is typically available on site for a maximum of two months a year. Until recently there was a 1/1Mbps video conference facility available, but was rarely used for clinical purposes. Ten patients a month on average are flown to Kalgoorlie or Alice Springs at a cost of approximately $20,000 each. A total cost of over $2.4m per annum!

Careful alignment of those who pay with those who benefit across the silos of local, state and federal government as well as the community and private for profit sector could provide a sustainable economic basis for the provision of telehealth services. Thus for example the Commonwealth bodies funding the $2.4m annual cost of fly-outs from Warburton could find it economically rational to subsidise the internet costs of the telehealth service if as a consequence fly-outs could be reduced by 50% and the burden of chronic disease in the local community reduced.

Conclusion

Telehealth applications have been shown to offer significant socio-economic benefits to patients and families, health care providers and the health-care system [22-34] and are being rapidly deployed internationally.
Wakerman [38] identified supportive Government policy, Commonwealth/State relations and community readiness as environmental enablers with workforce, funding, governance, management and leadership as well as Community ownership of essential infrastructure as essential service requirements. Whilst Australia has the infrastructure, technical, and intellectual capacity to lead the world in the creative use of telehealth services, the absence of these enablers and essential services are impeding the roll out of large government and community based telehealth networks such as already exist in Canada, Alaska and some developing countries.

A reliable high bandwidth symmetrical internet service to the community health centre, supported by web based electronic health records, flexible on demand HD video conferencing and easy to use telehealth enabled vital signs, imaging and diagnostic point of care equipment would up-skill the community nurses and enable them to receive social and professional support from their peers as well as doctors and specialists at regional centres and major teaching hospitals. This would improve staff retention, build on skills and reduce the requirement for fly-outs because of improved clinical triage and better local diagnosis. Management of chronic conditions in the community would also improve.

Although satellite internet services will continue to be uneconomical for many individuals in rural and remote communities, the use of low cost 3/4G wireless hubs operating in store and forward mode for the transmission of vital signs data from the home will open new opportunities for cost effective management of individuals with chronic conditions even in rural and remote communities. A small pilot project using these simple low cost tele-monitoring services is currently under way in Western NSW and the Bila Muju Aboriginal Health Services. The CSIRO National trial has demonstrated the socio-economic and healthcare outcomes that can be achieved without video conferencing, but with a focus on capturing critical vital signs and patient reported clinical questionnaires data from the home.

References


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Presenter

Professor Branko Celler is highly regarded as an innovator and pioneer in the development and use of biomedical instrumentation for the telemonitoring of chronically ill patients at home. He was Head of School of Electrical Engineering at UNSW for nine years and established the Biomedical Systems Laboratory, which was successful in winning more than $15m in competitive grants. He has an abiding and ongoing interest in supporting health and socio-economic development of rural and remote communities through the smart use of ICT. Prof Celler has previously held positions as Executive Dean of the College of Health and Science at Western Sydney University and Chief Scientist at the CSIRO ICT Centre. He is an inaugural Fellow of the Australian College of Health Informatics, a Fellow of the IEEE and a Fellow of the Australian Academy of Technological Science and Engineering. He has published more than 200 journal articles and refereed conference proceedings. In 2006 Prof Celler established a start-up company, Telemedcare Pty Ltd, which now operates internationally and is respected for its innovation and excellence in telehealth. Prof Celler is Emeritus Professor and an active researcher at UNSW and recently joined Telemedcare as its PT Director of Research.