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Assessing the Return on Investment in Health IT: An Exploration of Costs and Benefits in Relation to the Remote Monitoring of Chronic Diseases

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Abstract

In the evaluation of many technology-based interventions in the health sector there is a lack of information about the costs and benefits of the application. This is markedly so in the case of telemonitoring of home care patients with chronic diseases such as Chronic Obstructive Pulmonary Disease (COPD) and Congestive Heart Failure (CHF). This paper provides a brief overview of the effectiveness of such systems as reported in the literature, and identifies a lack of rigorous cost benefit analysis in such reports. The paper investigates some issues related to cost benefit analysis where there are multiple levels of care providers involved in the delivery of care, and suggests that these issues need to be resolved in order to gain a better understanding of the true costs and benefits of telemonitoring chronic care support systems. This would assist the government, as the social planner, to identify the most cost effective solution, as well as the optimal clinical solution, for all stakeholders involved in telemonitoring programmes. It would also help identify the contribution of new telecommunications channels in optimising the returns on telehealth initiatives.

1. Introduction

Healthcare deliverers around the world are making substantial investments in Health IT applications that depend on reliable transmission of data. At the same time, the telecommunications industry is looking for applications to support their bid for government investment in ultrafast broadband and fibre optic technologies. The business case for such investment often includes statements about the potential health benefits obtainable from network-based health care delivery, and these claims are quickly endorsed by government[1]. Predicted returns on this kind of investment are frequently used to justify the massive expenditure involved in developing national fast fibre networks [1-3]. But the question must be asked, how well have these claims been tested? Where do the true costs and benefits lie?

This paper looks at some of the issues that need to be addressed when assessing the costs and benefits associated with specific broadband-enabled health technologies or using the results of studies to support the investment case for new and more capable networks. The issues are discussed in the context of the example of assessing the economic impact of telemonitoring systems for domiciliary support of patients with chronic diseases such as congestive heart failure and chronic obstructive pulmonary disease. Given the high cost to both patients and healthcare providers of these diseases, telemonitoring technology would appear to offer a very promising alternative for domiciliary care of such patients, well warranting significant investment in both systems and infrastructure. However, where the true costs and benefits lie, and which of the many stakeholders receives the actual return on investment is not always clear. Whilst the benefits are often easy to identify, the costs incurred are often spread across a wide array of stakeholders, and may not be transparent in analyses conducted from a narrow perspective. A role exists for government, as social planner, to ensure that the assessments used to inform the development of both broadband and health purchasing policy take account of all of the relevant perspectives. This may mean that government has to take an active role in commissioning appropriate research.

[1] See for example, statements on the web site of CrownFibre (http://www.crownfibre.govt.nz/) established to manage the Government's $1.5 billion investment in Ultra-Fast Broadband infrastructure. The Government's objective is to accelerate the roll-out of Ultra-Fast Broadband to 75 percent of New Zealanders over ten years, concentrating in the first six years on priority broadband users such as businesses, schools and health services

2. The impact of chronic diseases: COPD and congestive heart failure

Chronic diseases place a heavy burden not only on patients and their families but also on society, through the excessive demand they place on healthcare resources. As the population ages, the prevalence and incidence of chronic conditions such as cardiovascular disease and COPD is increasing, as is the demand for services [4]. It has been reported that the prevalence of chronic diseases is one reason why, in many healthcare systems, expenditure is highly skewed with 5 % of patients responsible for an estimated 55% of costs [5]. In addition, the global prevalence of COPD is increasing; it affects an estimated 210 million people worldwide, and according to the World Health Organisation's latest estimates (2008), it will become the third leading cause of death worldwide by 2030 [6]. In New Zealand, the estimated prevalence of COPD in adults aged 40 years or over is 14% [7] increasing to 32% of those aged over 70 years. COPD patients suffer breathlessness, shortness of breath, and chronic cough. During an acute episode, a hospital admission is commonly required. It has been reported that, on average, patients with COPD have between one and four exacerbations per year [8], leading to a significant demand for inpatient beds and services. Associated costs are substantial.

Congestive heart failure (CHF) is also a highly debilitating condition which is becoming increasingly common. It is one of the leading causes of mortality, morbidity and hospitalisation for people 65 years of age or over, and subsequent hospital readmission rates within six months have been reported to range from 25% to 50% [9]. Overall, the general population prevalence of CHF is 1-3%, and approximately 10% of the very elderly [4]. The lifetime risk of developing congestive heart failure is roughly one in five for a person aged 40 years [10]. The condition is associated with high levels of mortality: approximately 60% of patients diagnosed with CHF will die within five years, a death rate that is higher than that for many types of cancer [11].

If it can be shown that the impact of these conditions can be significantly reduced in terms of hospital admissions and mortality, and quality of life for patients improved by the use of an intervention such as a remote monitoring system, then these benefits should also be able to be measured in terms of a reduction in the cost of health care delivery, and the economic impact of reduced morbidity.

3. The clinical effectiveness of chronic care systems using telemonitoring

There are a number of systematic reviews of telemonitoring initiatives for patients with chronic diseases. One such review of studies reporting home monitoring of a group of related chronic diseases; pulmonary disease, diabetes, hypertension and cardiovascular disease found that while the impact of telemonitoring on patients' conditions across all four diseases was inconclusive, the impact on specific outcomes, related to hospital services (hospital visits, admission and length of stay) were consistently observed in the studies related to cardiac and pulmonary disease [12]. This review, which covered 65 studies, on the use of automated transfer of patient data, by the patient or a care giver, showed a positive impact on both compliance (85% of the studies), and the patient's clinical condition (78% of studies). A good level of accuracy and reliability in transmitted data was reported where this was included in the metrics used, and the authors conclude that "data transferred by telemonitoring become as reliable as those collected through face-to-face patient examination" [12]. However, the authors note, only a relatively small number of the studies presented include cost related data or perform some form of cost analysis. An updated study focused more in depth on the clinical effects of home telemonitoring programmes for patients with diabetes, congestive heart failure, asthma and hypertension [13]. Findings were consistent with the earlier review, with positive effects reported for diabetes, asthma and hypertension attributed by the authors mainly to the fact that telemonitoring allows more frequent follow-up of patients and provides earlier detection of warning signs of deterioration in the patient's condition. However, the authors note that "many studies of heart failure have failed to show a reduction in either mortality or hospitalization rates". Significantly, the authors note "certain issues appear to be associated with the tension that is created when the telehomecare is added to home care services" [13], implying that the clinical resources required for monitoring data and deciding on action needed, may potentially change workflow, and possibly workload.

A systematic review by Clarke et al [14] investigating telemonitoring, and structured telephone support programmes for patients with congestive heart failure analysed 14 studies. The meta-analysis of data showed that remote monitoring of programmes reduced the rates of admission to hospital for congestive heart failure by 21% and mortality from all causes by 20%. All cause mortality was impacted more by the use of telemonitoring systems than by telephone support alone. In other systematic reviews [15, 16] home telemonitoring was shown to reduce rates of emergency department visits and hospitalisations, with reduced mortality in groups using telemonitoring systems compared with telephone motoring. Finally, a 2010 Cochrane review similarly showed that telemonitoring could reduced all-cause mortality by up to 34%, and CHF-related hospitalisations by about 20%, noting that in several

studies reviewed, improved quality of life and reduced costs were demonstrable outcomes [17]. This widely promoted review, which took place in a climate of increasing healthcare costs, and constraints on access to routine care for patients with chronic disease, attracted more attention than earlier reviews, and some negative feedback, some from within the Cochrane Collaboration itself [18]. In particular, its findings were challenged by Dr Garcia Lizana of the ICT for Health Unit Directorate of the European Commission [19], who argued that the degree of variability amongst the interventions included in the meta analysis undermined its findings, and any conclusions that could demonstrate cost savings. This was due largely to the lack of clarity over the degree of clinical input into monitoring and contact with patients, which prevented any adequate economic analysis.

In summary, these systematic reviews show evidence that telemonitoring may well provide an effective way to implement intensive routine monitoring of the medical status of patients with CHF, COPD and other cardiovascular diseases, allowing for timely clinical intervention where this is indicated. And they provide some (albeit imperfect) evidence of a reduction in the rate of hospital admissions, although the extent of such reductions vary. However, it is clear that the literature to date includes a limited number of randomised studies with validated assessment instruments. Furthermore, very few of the studies included in these systematic reviews provide a sound analysis of costs, and therefore are limited in their ability to address the issue of costs and benefits. No trials appear to have been conducted to date by agencies, such as the EU's Health Unit Directorate, or the UK's National Institute for Health and Clinical Excellence (NICE) which have the capacity to produce data which would enable a clearer cost benefit analysis.

4. Cost benefit analyses of telemonitoring interventions

Most studies on the impact of telecare and telemonitoring focus on direct health benefits, with considerably less research attention having been given to economic evaluation of these interventions[2]. As noted by Seto, however, "both the costs and benefits of a telemedicine intervention should be weighed before decisions on implementation are made" [20]. In Seto's meta-analysis of the limited available literature recording economic costs and benefits of telemedicine in the management of congestive heart failure, ten studies were found which identified savings of between 1.6% and 68.3% comparing telemonitoring with usual care. Each of these studies used a different set of criteria to assess savings.

Whilst most studies identified direct cost savings to the healthcare system (principally savings from hospitalization avoided and fewer outpatient visits to or by healthcare providers), only one assessed direct costs to the patient (transport costs avoided). The author notes "very few attempts have been made to estimate the indirect costs associated with HF" [20]. Generally the extent of savings decreased the more factors that were considered in the analysis. The biggest savings were recorded in studies where only hospitalization and physician/nurse visits were included in the analysis [21, 22] and in these studies, savings over 40% were recorded. Savings decreased as other services were included, for example nurse and technician travel time [23]. patient travel costs [24] and nurse administration costs [25]. Of the intervention technologies employed in the studies considered in the review, all used existing telecommunications infrastructure and thus none included the costs, or potential benefits, associated with ultra-fast broadband or communications infrastructure more generally. Thus, the ability of ultra-fast broadband to significantly improve on current telemonitoring practices remains, as yet, undocumented.

The study exhibiting the least savings (Johnston: 1.6%) [26] included an analysis of the most comprehensive set of costs, including home health, laboratory and pharmaceutical costs. The Johnston study, however, may well be capturing additional laboratory testing and pharmaceutical costs arising from the increased availability of information in telemonitoring, with flow-on effects, such as additional demands on other testing facilities to adequately assess the origins of variations in readings taken. This finding is not surprising given that other information-generating interventions, such as community screening programmes, have been shown to lead to either increased demand for resources to treat otherwise-unidentified conditions, or bringing forward the time at which resources will be required to treat an identified condition.

The literature thus draws into relief the range of factors that must be considered when assessing the economic impact of an intervention. It also identifies the need to be clear about the timeframes over which the relative costs and benefits of both the telemedicine and usual care interventions are expended and accrued

[2] For a recent example, see the review of the ASSET trial presented at the Health Informatics New Zealand Symposium Telehealth – a Call to Arms, Auckland, New Zealand 22 February 2012 http://www.slideshare.net/HINZ/the-asset-trial?from=share_email

5. Designing an objective function and decision metrics for a more reliable economic analysis of telemonitoring

The focus on direct costs to the healthcare system in Seto's analysis can in part be explained by two factors: the availability of data collected by health care providers, and the interests of funding stakeholders (insurance companies, government agencies) in reducing their own direct costs of discharging duties of care to patients. This leads to a question about how the appropriate *objective function*, that is, the core function that needs to be optimized in an optimization problem, should be defined in such studies. That is, a project undertaken from the perspective of optimizing returns for a funder of services will require analysis only of those factors which fall within that funder's budget area. Hence, costs and benefits accruing to the patient (e.g. travel costs) are ignored. Likewise, care deliverers will optimize only on those factors affecting their own operations, thereby overlooking factors for which they do not hold budgetary responsibility (e.g. pharmaceuticals, laboratory tests). On the other hand, from a social planning perspective, that is from the viewpoint of a decision-maker who attempts to achieve the best result for all parties involved, the objective function should assess the total costs and benefits accruing, regardless of where they fall. In a state-run health and welfare system, the social planner is usually the government. However, in a healthcare system where services are partly delivered by either commercial enterprises subcontracted to government organisations, (e.g. private companies delivering domiciliary services under contract to a DHB) the social planner is not always in a position to optimize the return on investment.

Thus, in the New Zealand context, where state funding is distributed to a variety of health-care providers, it is not clear which stake-holding group best internalizes the social planner's objective function. The Ministry of Health has a statutory obligation to take this view, but is also the ultimate budget-holder for the government's share of sector funding. In this respect, in discharging its fiscal duties to the Crown in respect of optimizing the return for its share of sector funding, it is not necessarily obligated to take into account additional resources expended by other parties (e.g. patients, or voluntary sector contributions to charity-governed providers) in the delivery of services it funds. Despite this, the Ministry's objective function will most closely resemble the social planner's perspective as it crosses multiple boundaries (care delivery, pharmaceuticals, etc.). It also has stronger incentives to optimise across longer time periods.

By contrast, other stake-holding groups are likely to have objective functions that will specifically exclude elements that should be considered in a comprehensive analysis. Whilst District Health Boards (DHBs), funded on a population-based model, internalize most of the costs indicated in Johnston [26] (for example, they hold pharmaceutical and laboratory budgets, in addition to home support assessment and care costs and administrative (co-ordination) responsibility), in practice their annual funding budgets leave them less well-placed to address the issue of timing of cost and benefit accrual. Cost savings in the short term will be given greater weighting than costs deferred to another time period. Moreover, as Primary Health Organisations (PHOs) are funded predominantly on a capitation model, even though DHBs nominally pay PHOs out of their budgets, they face no additional financial penalty from shifting medical care costs that they might otherwise have incurred. For example, the use of domiciliary telemonitoring of patients, which reduces hospital stays shifts the costs of treatment from a hospital physician onto a GP and nurses (either employed by PHOs or contracted by them), who must increase their workload (additional consultations), with negligible additional compensation. The small co-payment made by the patient is all the PHO receives for any additional workload incurred. Thus, seeing a GP as a consequence of a telemedicine intervention averts a hospital visit (cost saving) but incurs costs (to patient and the GP) that would not have been incurred had hospitalization occurred.

It is noted that under current funding arrangements, PHOs in most cases do not hold budgets for funding the types of interventions that are part of any telemedicine trial, including those currently underway in New Zealand. Whilst PHO activities may include dealing with trial participants (e.g. in domiciliary telemedicine trials), this is ancillary to their ongoing management of patients with CHF, which in New Zealand is routinely undertaken by home support and domiciliary nursing service providers contracted in the first instance to the DHB. Home care firms' objective functions will be determined by the ways in which they are funded. If funded by capitation (i.e. a fixed fee for a patient) they can internalize any savings made by the telemedicine project in respect of reduced domiciliary visits or altered case mix (e.g. using nurse time more efficiently), but are not required to take account of other costs and benefits imposed on or accrued to other entities. For example, additional information from the system may generate additional GP consultations at a net cost to the patient and GP (as patient co-payment is less than cost to the GP in time etc) and possibly to pharmaceutical and laboratory budgets, but avoiding hospitalization costs (DHB), meanwhile leaving the care agency in a neutral fiscal position. By contrast, if the home care firm is paid per visit (or faces differential payments depending upon the skill mix of the individual undertaking the visit), the benefit of telemonitoring is reduced.

An additional consideration in the New Zealand system is that low-income patients may prefer more costly 'hospitalisation' (i.e. an emergency department visit, even though it does not result in an admission) than a less costly GP visit simply because they must pay an out-of-pocket co-payment at the GP clinic, but no out-of-pocket payment is expected at the DHB.

6. Conclusion

It is these uncertainties, as well as shortcomings in the many trials of telemonitoring systems to date that make a cost benefit analysis of such systems so problematic. And yet, given the potential of such systems to deliver cost effective care, and enhanced quality of life to an increasing body of patients with chronic disease in our community, these are critically important issues, and ones that hold back a commitment to more widespread implementation of these and similar technology based interventions. A comprehensive analysis should ideally take the view of a social planner, optimizing the economic outcomes over a wide range of economic variables and over an extended time period. Either economic costs, patient-benefits or a combination of both should prevail as the decision metric. A Ministry of Health-centric or DHB-centric objective function is more likely to be a good proxy for the social planner objective than a PHO-centric or Home care deliverer-centric objective, but the key deviations noted above must be taken into account. A PHO-centric or Home care deliverer perspective is unlikely to provide an objective function that takes sufficient account of the relevant costs and benefits.

In addition, if we return to the scenario highlighted in the introduction, the government, in its role as social planner must include the costs of infrastructure, specifically in this case, ultrafast broadband, and its value across a range of social activity when identifying an appropriate objective function. Telemonitoring home care for patients with chronic disease may be may be one. Others may include educational and community objectives. Thus competing objectives across agencies make it a difficult task to identify an appropriate return on investment, when healthcare services become reliant on telecommunications infrastructure. We must continue to ask, where do the true costs and benefits lie?

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