

Service and Business Model for Technology Enabled and Home-based Cardiac Rehabilitation Programs

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Abstract— Cardiac rehabilitation programs are comprehensive life-style programs aimed at preventing recurrence of a cardiac event. However, the current programs have globally significantly low levels of uptake. Home-based model can be a viable alternative to hospital-based programs. We developed and analysed a service and business model for home based cardiac rehabilitation based on personal mentoring using mobile phones and web services. We analysed the different organizational and economical aspects of setting up and running the home based program and propose a potential business model for a sustainable and viable service. The model can be extended to management of other chronic conditions to enable transition from hospital and care centre based treatments to sustainable home-based care.

I. INTRODUCTION

CARDIOVASCULAR disease (CVD) is one of the largest burden of diseases and most common causes of death in developed countries. For example in Australia CVD caused 34% of all deaths in 2006 and accounts for more than \$5.5 billion annual spending on the acute and chronic management of this condition [1]. The aging population and increase in obesity and diabetes will likely further increase the total burden of CVD in the future.

Cardiac rehabilitation programs are used to offer strategies for reducing cardiovascular risk through a comprehensive life-style program including medical evaluation, exercise program, risk factor modification, and education [2]. A major problem in the provision of these programs is the low level of patient participation. Only 16% of the eligible patients complete a program in Queensland, Australia [3]. Similar numbers are consistently and globally reported [4]. The reasons behind the problem include low levels of service provision, lack of referrals, and poor uptake by patients [5]. It has been suggested that a range of different models for rehabilitation programs should be available for the patients, according to their own preferences and needs to overcome some of the underlying barriers [3, 4].

We have developed a novel model for a home-based cardiac rehabilitation program, which efficiently uses personal health technologies (mobile phone, Internet

technologies, sensors, monitoring devices, and software) in program delivery and patient empowerment [6]. We hypothesize that the developed care model offers a cost-efficient, sustainable, and effective alternative to overcome the limitations and barriers that exist in traditional cardiac rehabilitation programs.

The personal health system market is rapidly developing but the market place is still immature. Lack of existing business models and limited understanding of the associated costs and stakeholder requirements increase the complexity and risks of creating and especially employing new and alternative models of care in large scale. These factors may create a significant barrier in introduction and long-term uptake of novel care models that may require completely new organizational structures, technology infrastructure, or just new ways of working. In this paper we describe the care model and technology setup for our cardiovascular rehabilitation programme, analyse the different aspects of the service model, and propose a possible business model to provide the required services.

II. SYSTEM DESCRIPTION

A. Home based cardiac rehabilitation model and enabling technologies

We used the national framework for cardiac rehabilitation processes and principles [7], current community centre-based program at Queensland Health and established home-based rehabilitation programs such the Heart Manual [8] as reference models in the design of the new program. The developed Care Assessment Platform (CAP) model including the complete home program and enabling personal health technologies are described in detail in [6].

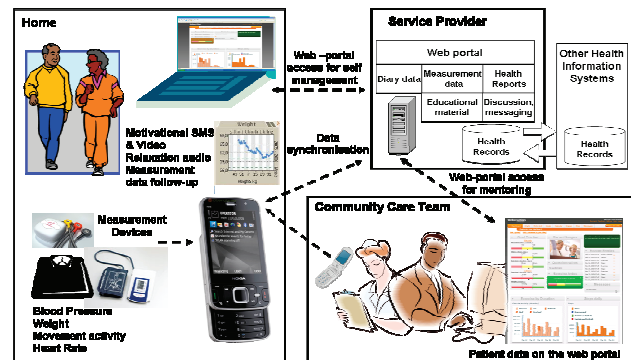


Fig. 1. CAP System Diagram, model for home-based Cardiac Rehabilitation programs.

Manuscript received April 23, 2009. This work was supported in part by the Queensland Health, Australia.

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Fig. 2. Patient Resource Kit

The CAP system shown in Fig 1 is based on a mobile phone platform, which is the central means to deliver education and mentoring as well as remote monitoring to the patients in their own homes or wherever they want. The patients receive a resource kit (Fig 2) including the mobile phone with a phone plan, blood pressure monitor, weight scale, HR and activity monitor (optional), “My heart my life” booklet, educational multimedia CD and user manuals. The mobile phone has in-built accelerometer and Step Counter software, which allows unobtrusive monitoring of the patient’s exercise [6]. In addition, the phone has Wellness Diary software [9, 10] which is used for monitoring several wellness related parameters, sending the data to the Mentors, and patient’s self observations. Technology training is part of the pre-assessment process to educate the patient to use the provided devices and software. There is no additional cost to the patient as the resource kit and data communication and phone plan costs are covered by the health care provider.

In the program, the patients have a personal Mentor who is responsible for their care during the 6-week program. The Mentors conduct the pre- and post-assessments at the care centre and call the patients weekly to set the exercise and lifestyle goals with the patient and deliver education. The phone is also used for monitoring exercise and various health parameters through measurement devices and sensors and patient’s self reported observations. All the data is synchronised to a server from the phone. The patients additionally receive daily motivational SMS messages and can view educational multimedia material on their phones. The Mentors use a web-portal to view their patients’ measurement data and self-observations, such as sleep time, stress, diet, alcohol and smoking, prior to the weekly mentoring sessions. This will allow them to have objective information on the patient’s exercise, behaviours and progress in the program and personalize the mentoring sessions to suit each individual patient. The patients will also have the possibility to access the portal and view rich content and more elaborate feedback.

B. Costs related to the home based mode

Our goal is to provide evidence that the CAP model is a cost-efficient, effective and viable alternative for traditional institution-based cardiac rehabilitation. Using an Activity Based Costing Model developed by Nexus Online Pty Ltd [11], fixed and variable costs for an existing gym based program and the proposed technology-enabled home-based program have been compared on a per patient basis. The costing model includes both direct and indirect costs related to the delivery of a six week program, with re-assessment after 6 months. Based on an average sized facility providing rehabilitation to 160 patients per annum, the cost per patient receiving a traditional gym based program has been compared with the costs per patient receiving the technology-enabled home-based program. Both the gym- and home-based program modes of delivery offer comprehensive rehabilitative care by encompassing exercise, risk modification and mentoring. The home-based program has been designed to include equal level of services as the gym-based program. The health and other outcomes of both models will be evaluated and compared in a clinical trial [6].

TABLE I
COMPARATIVE COSTS OF EACH PROGRAM

| Cost Elements | Gym-based program | Home-based program |
|----------------------------|-------------------|--------------------|
| Education | 35 | 130 |
| Assessment | 195 | 195 |
| Coaching / Mentoring | 225 | 225 |
| Gymnasium | 180 | 0 |
| Communications | 125 | 195 |
| Facility | 595 | 120 |
| Technology | 40 | 280 |
| Administration | 450 | 485 |
| Total Program Costs | \$1,845 | \$1,630 |
| Patient travel | \$400 | \$80 |
| Total Costs | \$2,245 | \$1,710 |

Preliminary analysis on Table I shows an average cost of \$1,845 and \$1,630 per patient rehabilitated for the gym- and home- based programs, respectively.

Although the preliminary analysis shows the costs of each program to be quite similar, patient travel costs for the home-based program are substantially less than that for the gym-based program (calculated at \$20 per trip). The Facility and Gymnasium costs are the main reason for the slightly smaller cost in the home-based program. The technology costs in the home-based program include mobile phones, other devices and estimated price of the software licences. We have made a conservative estimate that the Coaching/Mentoring time and thus cost is equal in both groups. We hypothesize that the home model would eventually require less personnel time for mentoring. The CAP evaluation trial will provide data on the actual staff time spent on both models. Additionally, because the home-based program is not restricted by the limitations of the gym capacity, per no. of patients, it has the potential to benefit from economies of scale. Increasing the number of patients utilizing the home-based program by

100% would reduce the above stated costs per patient by approximately \$80. Our analysis aligns with the results from other similar studies on home-based care models [12].

Another important consideration is the impact of the home-based program on the readmission rate. In a review by Oldridge [13] of 20 randomised trials conducted throughout the world, they concluded that all-cause mortality, cardiac mortality and non-fatal reinfarction decreased by 20-25% over 3 years where substantiate exercise-based rehabilitation takes place. Two key impediments to completing gym-based rehabilitation were identified; the need to take time away from work, and the costs of travel. The home-based program addresses both of these impediments and may potentially further increase the number of patients that attend and complete a rehabilitation program thus creating savings through reduced amount of readmissions. The cost of one cardiac readmission is estimated at \$39,670 [14]. Canyon and Meshgin reported a significantly smaller number of total readmissions in patients participating a community based program compared to those patients that did not attend the program (8% and 28% respectively) [15]. Assuming the same reduction in readmissions and 20% increase in participation (3000 new patients of the over 15000 patients/year discharged with cardiac diagnosis in Queensland, Australia), the model would create annual savings in the order of \$24 million in Queensland only.

TABLE II
STAKEHOLDER ANALYSIS

| Stakeholder | Interest(s) in the CAP model |
|--------------------------------------|---|
| Patients | Alternative care model that may be better fit to personal preferences |
| Mentors | New model of coaching: more personal and potentially less time per patient than in traditional model – better workload management |
| Doctors (GP and Cardiologists) | New alternative for secondary prevention - increase referrals |
| Services: Dietician, Physiotherapist | Alternative model to deliver additional services linked to cardiac rehabilitation |
| Health Care Administrators | Potential benefits: increase in service provision, cost savings, better health outcomes, low upfront investments |
| Private and Public Health Insurance | Better health outcomes and access to care - new insurance policies to cover home-based care models |
| Device vendors | New business for home-care measurement devices |
| Content providers | New business for electronic educational and motivational material |
| Software providers | New business related to software tools for remote Mentoring and self-management |
| Web-service provider | New business in hosting portal services and related health records. |
| Training provider | Education for the clinicians to engage in patient mentoring |
| Telephone operator | New business for mobile tele- and video conferencing, messaging services and data communication |

III. SERVICE MODEL ANALYSIS

A. Stakeholder analysis

A simple stakeholder analysis is summarised in Table II. CAP model affects several organisations and groups of people that have a specific interest in the home-based model and can positively influence the model uptake. All the listed stakeholders are essential in successful implementation of the CAP model and a co-ordinated effort to engage the different players is required.

B. Key benefits

CAP care model provides many potential benefits, including:

1. Increased participation – CAP can either be used as a stand alone program, or more likely in conjunction with an existing gym-based program, increasing patient options and participation.
2. Cost savings – Increased participation will reduce expensive readmissions.
3. Scalability – With increasing demand on skilled resources the home-based model provides an excellent opportunity to leverage existing cardiac rehabilitation resources on an incremental cost basis.
4. Flexibility – CAP enables cardiac rehabilitation teams to integrate and coordinate service delivery in conjunction with appropriately qualified, community based providers
5. Transparency – CAP enables other members of the care team, e.g. the patient’s GP, Physiotherapist and Dietician to contribute to the care plan and outcomes.
6. Patient involvement – CAP enables patients to actively interact with and contribute to their rehabilitation program via a mobile phone tools and web portal.
7. Personal – The patients can conduct private discussions with their treating Mentors and receive personal feedback and coaching that is not easily possible in a traditional group exercise setting.
8. Research – CAP provides rich data that could be used by researchers to create new and novel tools to further improve rehabilitation outcomes.
9. Implementation – CAP is a Turn-key solution that can be implemented as an additional service at low cost, with minimum infrastructure and training requirements.
10. Service Model – CAP could be offered as an inclusive service, so that all technology and support costs are provided on a usage basis, minimising up front investment.
11. Technology improvement – CAP offers vendors and service providers an open ended opportunity to deliver new technologies and solutions to cardiac rehabilitation.
12. Government – CAP addresses both State and Federal government e-Health initiatives [16] [17].

C. Barriers

The care model implementation has several potential barriers. Organisational changes within the health care provider will be required to implement the model. Training, organising and rescheduling the workforce may be challenging in the often under-resourced organisations. The need to create new reimbursement models in private and public health insurance policies may slow down the implementation. For device and other 3rd party vendors the model need to create sufficient sales volumes to allow for development of new device models and material.

D. Business model proposal

During the evaluation trial of CAP, it is anticipated that a commercial entity, with Australian and International experience in the delivery of home-based health care technologies, would be licensed to support and distribute the model and service. One possible model is described in Fig 3. The organisation “Company A” would:

1. Provide CAP as an integrated Turn-key solution to Government and Private Health Services, including portal hosting with staff and user access, mentor training and patient resource kits including the mobile phones, other devices and material.
2. Offer a range of CAP specific phone plans, with business level pricing on calls to the mentors, data transfer and messaging. Alternatively, support the health care provider in setting up their own plan.
3. Provide the automatic messaging services to deliver SMS and multimedia to patient’s phones.
4. Provide 24x7 help desk for mentors and participants, with a rapid swap in-out service for equipment.
5. Manage all related billing and service fees.
6. Update and improve the service in line with user requirements, and technology and policy changes.

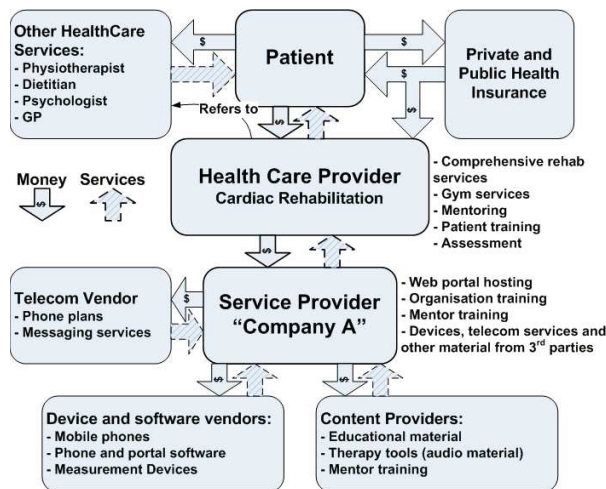


Fig. 3. CAP business model diagram.

The proposed CAP service charges include:

1. A one-off set-up fee per organisation, plus training and integration charges where applicable.
2. An annual fee per Mentor, including access to the portal and technical support.
3. A weekly fee per patient based on a standard mobile phone, scales and blood pressure devices. This price would vary depending on the phone model and devices.
4. Monthly data and communications charges billed from the health care organisation.

The company can set these service charges so that the total program costs to the Health Care Provider equals the cost of the traditional model (\$2245 in Table I). Because the home-based model is cheaper to run, the revenues would equal \$535/attending patient. According to this rough estimate Company A would create annual revenues in the order of 1.6 million dollars assuming that the program would attract 20% (3000) of the over 15000 patients/year in Queensland, Australia. Significantly higher service charges could be justified based on the major savings in reduced readmissions in patients that attend a rehabilitation program compared to patients that do not attend a program. The service can be extended to other states and countries with similar demand.

The proposed turn-key product would be attractive to the health care providers as the service and technology charges will be directly compensated by the savings in infrastructure and potentially in the staff time. Part of the expenses, for example the required phone plan, could be passed to the patients as they save significantly in reduced travelling. However, biggest savings come from the increased use of Cardiac Rehabilitation programs, which significantly reduces expensive readmissions as described in Section II B.

IV. DISCUSSION

We are currently evaluating the developed care model through a Randomized Controlled Trial (RCT) involving cardiac rehabilitation programs conducted in The Prince Charles hospital as well as Caboolture and Redcliffe hospitals of Northside Primary and Community Health Services, Queensland Health, Australia. CSIRO and Queensland Health jointly fund the trial. The RCT will provide results on the cost effectiveness and clinical viability of the new home-based care model in terms of health outcomes. Positive results would imply potential for large-scale roll out as an alternative care model and possibilities for implementing the described business model.

We have outlined a service and business model that could produce the required services and care model in an equal cost as the traditional gym-based model. The CAP model may also produce equal quality of care compared to the traditional centre based programs and thus create an alternative model of care. This would lead to increased provision of currently underused rehabilitation services and thus significant reduction of health care costs through reduced readmissions. The created model is flexible and can

be used in other clinical domains and chronic disease management in home environment including applications in mental health, COPD, arthritis, diabetes or heart failure.

The care and business models that we have developed for home-based cardiac rehabilitation programs may have extremely high impact by increasing the uptake of currently underused cardiac rehabilitation services and more importantly by introducing a new evidence-based model for businesses providing services for health care organizations. The business model can be extended to multiple clinical domains to enable urgent transition from hospital and care centre based treatments to sustainable home-based care.

ACKNOWLEDGMENT

We would like to acknowledge all the CAP project team at Queensland Health, Northside Primary and Community Health Services, at the Caboolture, Redcliffe and The Prince Charles Hospitals for their continuous support and invaluable clinical expertise.

We also acknowledge Nokia Oyj for providing the mobile phones and software for the clinical trial.

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