Investigating telemonitoring practice: a proposed work-applied methodology

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Abstract

Purpose – Diabetes is regarded as a global epidemic with 382 million people globally suffering from diabetes. It also has major implications on patients' quality of life. There are also high cost of treatment associated with diabetes for both patient and healthcare provider. Telemonitoring represents an excellent technology opportunity to redefine health care delivery. Using technology for home-based care promises the ability to deliver more cost effective care whilst also enhancing quality of care and patient satisfaction. The paper aims to discuss these issues.

Design/methodology/approach – The current research aims to contribute to the methodological design of action research projects in their use to implementation health technologies such as telemonitoring. In particular, it seeks create a model which can be used to demonstrate the efficacy of the use of the action research method as a viable alternative to the traditional randomised control trials methodology currently employed in healthcare.

Findings – The paper contributes towards the methodological design to investigate the area of practice making use of the telemonitoring programme within a Victorian Health Services Network using action research.

Originality/value – It intends to address the research problem of the low utilisation of telemonitoring within Monash Health as a whole, and more specifically within the diabetes unit. In this context the research intends to utilise the benefits of telemonitoring to improve clinical outcomes of patients by increasing insulin stabilisation. It is also intended the research organisation benefits by increased efficiency by decreasing clinical workforce time spent on managing patient insulin data.

Keywords Diabetes, Methodology, Action research, Telemonitoring

Paper type Case study

Introduction

Although there is a body of research on diabetes, there are few researches that used action research approaches in developing better clinical outcomes for patients with diabetes. Using both a cohort of diabetic as well as control patients in the current study, the introduction, and implementation of a telemonitoring programme for better management of diabetes patients constitutes a novel approach in action research methodology. In addition, the use of control groups is a new approach in action research.

Globally improvements in the standard of living and improvements in technology have resulted in increases in life expectancy (Bensink *et al.*, 2006). This has resulted in an increase in the overall age of the global population (United Nations Department of

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Economic and Social Affairs Population Division, 2002) (Gavrilov and Heuveline, 2003). This change has driven a large increase in the instance of age-related chronic diseases (Bensink *et al.*, 2006) and global expenditure on their treatment. The result of this being that chronic disease treatment is the single largest cost within global health care delivery (Merk and Monheit, 2001; Johnson, 2003; World Health Organisation, 2006) and also the largest single source of mortality (World Health Organisation, 2005). Healthcare spending in Australia accounted for an estimated $49.7 billion in 2010-2011, about 3.7 per cent of Australia's gross domestic product, or about $2,227 per person (Australian Institute of Health and Welfare, 2013a).

In addition to such increased demand for services, policy makers are also subject to supply side shortages within the medical workforce (nurses and doctors) (Schofield *et al.*, 2005; Bowes and McColgan, 2006). Facing such demand, cost, and shortages; policy makers require a change in the way in which healthcare services are provided. As stated by the National Health and Hospitals Reform Commission (2009, p. 6) "We need to redesign health services around people, making sure that people can access the right care in the right setting". Facing a perfect storm of increasing demand and cost, and a diminishing workforce policy makers increasingly view technologies such as telemonitoring and telehealth as providing a potential solution (Meystre, 2005).

Telemonitoring represents a promising technology opportunity to redefine health care delivery (Meystre, 2005). By combining information technology and healthcare delivery mechanisms such as home-based care there exists the ability to deliver more cost effective care whilst still also improving patient satisfaction and quality of care (Meystre, 2005; Schofield *et al.*, 2005; Bowes and McColgan, 2006). Telemonitoring has the potential to achieve this by redefining the existing hospital-centric delivery models of chronic disease management (Jennett *et al.*, 2004).

Despite such promise telehealth and telemonitoring remain to be widely adopted. The low utilisation of telehealth is a concern for both international and national healthcare management (Jennett *et al.*, 2003; Moffatt and Eley, 2011). This can be illustrated by the Australian Government Department of Health providing financial incentives to encourage the establishment and use of telehealth (Australian Government Department of Human Services, 2014). More locally the low rate of telemedicine utilisation is a concern within the Victorian Healthcare sector. Such a view can be illustrated by the ministerial Health Innovation and Reform Council noting that there was "significant potential to improve the rate of Telehealth adoption across the system" (Department of Health, 2013).

Likewise within the research organisation Monash Health the low rate of telehealth adoption is a thematic concern. Such a view is illustrated by the Chief Medical Officer who has stated in a meeting "Telemonitoring is currently not widely utilised within Monash Health. This emerging technology has the potential to improve outcomes for both patients and the health service".

It is now useful to turn to an examination of the chronic disease condition that is being examined in the context of the research – diabetes. Diabetes is a series of metabolic disorders associated with hypoglycaemia and caused by defects in insulin secretion or action. The two main types of diabetes are types Type 1 diabetes (T1D) and Type 2 diabetes (T2D). Diabetics have reduced life expectancy and increased instance of micro and macrovascular complications such as myocardial infarction and stroke (Dinneen, 2010).

The clinical management of diabetes has its foundation in the discovery of insulin by Frederick Banting in 1921 (Banting *et al.*, 1991) and subsequent finding that insulin therapy increased the lifespan of patients. These early discoveries were built on by the

Diabetes Control and Complications Trial (1993) and United Kingdom Prospective Diabetes Study (1998) which found that strict glycaemic control in type 1 and type 2 patients greatly reduced the complications of the disease. Both these studies set the modern standard care for diabetes to obtain a HbA1c or glycoheamoglobin measure of $\leqslant 7.0$ per cent. HbA1c is a measure of average plasma glucose concentration and provides a measure of average glucose levels over six to eight weeks. HbA1c is considered the "gold-standard" in assessing glycaemic and therefore diabetes control (Phillips, 2012).

Diabetes has been described as a global epidemic (Colagiuri and Walker, 2008). Internationally the importance of the disease is illustrated by the passing of United Nations Resolution 61/225 on December 2006 in which diabetes was acknowledged as a major global health issue. The resolution noted the human and economic cost of the disease and the risk it represented to member states achieving development goals including the Millennium Development Goals (United Nations, 2006). This is reflected in the high cost of treatment of diabetes for both patient and healthcare provider (Colagiuri *et al.*, 2003, 2009; Australian Institute of Health and Welfare, 2013b). In 2013 there were 382 million people globally living with diabetes. This is project to grow to 592 million by 2035 (International Diabetes Federation, 2013).

Correspondingly diabetes is a significant national health problem in Australia. As at 30 June 2014, 1,133,414 Australians had been registered by the National Diabetes Services Scheme (NDSS) with 712,888 aged 60 or older (Diabetes Australia, 2014a). Within the state of Victoria, 282,214 Australians had been registered by the NDSS with 181,656 aged 60 or older (Diabetes Australia, 2014b). Furthermore as at the 30 June 2014, 282,214 people or 4.8 per cent of the population of the state of Victoria were diabetic (Diabetes Australia, 2014b). The instance of diabetes patients within the state of Victoria is significant for the proposed research as the research organisation is the Victorian healthcare service Monash Health and the chronic disease to be managed by the telemonitoring programme is diabetes.

To conclude, the research presents the utilisation of the action research method to implement a telemonitoring programme to manage diabetic patients. It intends to address the research problem of the low utilisation of telemonitoring within Monash Health as a whole, and more specifically within the diabetes unit. In this context the research intends to utilise the benefits of telemonitoring to improve clinical outcomes of patients by increasing insulin stabilisation. It is also intended the research organisation benefits by increased efficiency by decreasing clinical workforce time spent on managing patient insulin data.

Literature review

Although there exists a lack of consensus within the literature as to a detailed definition (Kevin *et al.*, 2007), Telemedicine can be broadly defined as:

> The delivery of health care services, where distance is a critical factor, by all health care professionals using information and communication technologies for the exchange of valid information for diagnosis, treatment and prevention of disease and injuries, research and evaluation, and for the continuing education of health care providers, all in the interests of advancing the health of individuals and their communities (World Health Organisation, 1998, p. 10).

Within this context telemonitoring can be defined a sub-type of telehealth which uses "audio, video, and other telecommunications and electronic information processing technologies to monitor patient status at a distance" (Institute of Medicine (US)

Committee on Evaluating Clinical Applications of Telemedicine, 1996, p. 248). Telemonitoring differs from teleconsulting or telediagnosis in that it is concerned with the transmission of patient clinical data from one location to another for interpretation or decision making (Güler and Übeyli, 2002). Teleconsultation is concerned with inter clinician communication and has been defined as "audio, video, or other electronic consultation between two or more geographically separated clinicians" (Institute of Medicine (US) Committee on Evaluating Clinical Applications of Telemedicine, 1996, p. 248). Telediagnosis focus is the transmission of clinical data from patient to a remote physician for the purposes of diagnosis. It has been defined as "the detection of disease by evaluating data transmitted to a receiving station from instruments monitoring a distant patient" (Institute of Medicine (US) Committee on Evaluating Clinical Applications of Telemedicine, 1996, p. 248). A common example of telediagnosis is the use of clinical picture archiving and communications systems by radiologists to diagnose patients remotely.

Despite its association with the emergent field of information communication technology Telemedicine has a long history. Long before the phrase "Telemedicine" was coined physicians have experimented with devices allowing the transmission of clinical information for remote interpretation. The first such documented example is the Dutch physician and physiologist Willem Einthoven who in 1906 outlined a mechanism for the transmission electrocardiograms to a remote clinician to monitor heart function (Einthoven, 1906). These basic principles were further advanced in 1920 when which Bergen's Haukeland Hospital in Norway established the first remote consultation radio service for medical advice for ships at sea (Rafto, 1955). This service not only provided medical and diagnosis advice but also conducted remote surgical procedures via instruction (Elford, 1997; Goethe, 1984). The first example of what is considered modern telemedicine was described by Gershon-Cohen in his system of transmitting radiology images via telephone lines (Gershon-Cohen *et al.*, 1952). This pioneering work was built on by a number of physicians culminating in the first use of the phrase "telemedicine" in 1969 (Murphy and Bird, 1969). These early proof of concepts and pilot programs provided the foundations which continue into the current "maturation" era of telemedicine which commenced in the 1980s and continues until the present day (Bashshur, 2009).

Telemedicine as a mode of health care delivery has seen expansion in since the 1980s (Dávalos *et al.*, 2009) driven by two factors. First, there has been a significant change in government policy. An example of this is the USA with the introduction of the Patient Protection and Affordable Care Act of 2010 Hospital Readmissions Reduction Program, and the Telecommunications Reform Act 1996 and associated Joint Working Group on Telemedicine.

Second, there have been large decreases in the cost of technology and transmission on which telemedicine is dependent (Bashshur, 2009). To understand the growth and interest in the field of telemedicine it is useful to examine the changes occurring in global demographic trends and their impact on healthcare delivery. Globally improvements in the standard of living and improvements in technology have resulted in increases in life expectancy (Bensink *et al.*, 2006). This has resulted in an increase in the overall age of the global population (United Nations Department of Economic and Social Affairs Population Division, 2002; Gavrilov and Heuveline, 2003). As a result there has been an increase in the instance of age-related chronic diseases (Bensink *et al.*, 2006).

There is a growing body of healthcare management literature which supports the assertion that telemonitoring has benefits (Pare *et al.*, 2007). These benefits are clinical such as improved patient outcomes, and financial such as decreased costs for

healthcare providers (Cryer *et al.*, 2012). Telemonitoring in particular has the potential to combine the benefits of communications and information technology with traditional hospital in the home-based care models to provide a healthcare delivery model able to deliver more cost effective care whilst still also improving patient satisfaction and quality of care (Meystre, 2005; Schofield *et al.*, 2005; Bowes and McColgan, 2006). The potential cost savings, and decreased utilisation of hospital services combined with increased quality of care and patient satisfaction (Reardon, 2005; Rosenberg *et al.*, 2012; Cryer *et al.*, 2012; Baker *et al.*, 2011; Rojas and Gagnon, 2008; Jackson *et al.*, 2008) present an attractive delivery model for healthcare providers.

Despite this promise concerns have been raised over telemedicine. These concerns are centred on the accuracy of purported benefits, legal and regulatory issues associated with usage and impact on of quality of care. Some within the literature question the cost effectiveness (Henderson *et al.*, 2013) and the rigour of the benefits analysis applied to existing telehealth programs (Bergmo, 2009; Dávalos *et al.*, 2009; Jennett *et al.*, 2003). Others assert that there still remain a number of technical and legal challenges (Kienzle, 2001; May *et al.*, 2003) that must be overcome particularly the areas of legislation and licensure, informed patient consent, and reimbursement (Baker and Bufka, 2011; Mars and Jack, 2010). In addition some have highlighted (Stanberry, 2001) that such a change in the care delivery model and dependency on technology may have negative consequences on the traditional patient clinician relationship and quality of care.

If we focus further on the condition of diabetes there exists a growing body of work illustrating the potential benefits of telemedicine when compared with existing models of delivery (Stone *et al.*, 2010; Medical Advisory Secretariat, 2009; Jaana and Pare, 2007; Marcolino *et al.*, 2013; Rami *et al.*, 2006; Pihoker *et al.*, 2009; Montani *et al.*, 2001; Horan *et al.*, 1990; Chase *et al.*, 2003). The literature in this area is summarised by (Polisena *et al.*, 2009) home telehealth for diabetes management. This paper summarises in quantitative terms the potential benefits of home-based telemonitoring vs traditional inpatient models for diabetes management. This coupled with the successful utilisation of telehealth for the management of other chronic disease conditions such as hypertensions, cardiac, and pulmonary disease (Pare *et al.*, 2010; Hersh *et al.*, 2001) provides weight to the hypothesis that clinical and financial benefits are able to be realised by the development of a telemedicine programme for a chronic disease condition such as diabetes.

The proposed research builds on the already widely established clinical fields of healthcare management, and healthcare delivery. The proposed research also adds to the emergent field of information technology in healthcare delivery. The research seeks to address an apparent gap within healthcare management and healthcare delivery literature being the design and implementation of a telemonitoring programme for diabetes using action research in a Victorian health service.

Research questions

The main research question involved "Can action research be used in the design and implementation of home-based telemonitoring care to improve efficiency and effectiveness of diabetes management?" Several corollary research questions have been developed to further guide the collection and analysis of data used in this action research study. This included:

(1) What was the telemonitoring model using action research that was developed and implemented at Monash Health?

(2) What were the characteristics of the action research method that were identified in this study?

(3) What were the action research processes that emerged within the action research cycles of planning, action, observation, reflection and evaluation during the development and implementation of the telemonitoring programme?

(4) What were the issues and problems that were faced in the development and implementation of the telemonitoring programme at Monash Health?

(5) What were the approaches used to overcome such issues and problems?

(6) Were improvements observed in patient insulin stabilisation, and time spent by clinical staff in obtaining and managing patient insulin data?

Research method: proposed action research approach

Research design

The study presents the action research approach. The use of the phrase "action research" and the concept of the practical research method of action research have been attributed to Kurt Lewin (Lewin, 1946, 1947, 1951, 1952). The action research method consists of 12 general characteristics (Abraham, 2012). The main tenets of action research have been defined as "problem focussed, context specific, participative, involves a change intervention geared to improvement and a process based on a continuous interaction between research, action, reflection and evaluation" or simply "learning by researching" (Hart, 1996, p. 454). In doing so action research addresses the gap between theory and practice of traditional research in (O'Brien, 1998; Abraham and Daton, 2009). Despite generally agreed concepts, there exists a lack of consensus concerning a formal definition and considerable discourse on the practice (Cassell and Johnson, 2006; Docherty *et al.*, 2006; Reason and Bradbury, 2008). The characteristics of action research are further elaborated in Table I. In addition, the researchers have critically analysed and evaluated other possible methodologies and the use of action research, as demonstrated in Table I, has been considered best method to use within the context of the current research. The overall research approach including specific structures (such as the action research group) and research design in this research are based on those proposed in *Work Applied Learning for Change* (Abraham, 2012).

The action research process presents a design phase and two major cycles. The major first cycle consists of the initial implementation of the telemonitoring programme. Second major cycle consists of the further development of the programme post an independent review. This approach mirrors that suggested by Baskerville (1999) to conduct action research in healthcare.

The telemonitoring programme runs over a period of ten months. The trial is provided for a group of ten patients. A clinically matched control group is used that do not undergo home-based telemonitoring to verify results. The proposed telemonitoring system to be used is My Health Point (http://myhelathpoint.com/en/) the system and equipment are provided by Telstra.

Diabetes patients newly commencing insulin are assigned to telemonitoring insulin stabilisation or to usual insulin stabilisation via e-mail or phone. Data are collected and compared to the control group to determine the HbA1c results, number of insulin adjustments made, average blood glucose level, number of contacts with health professionals, and time spent by health professional on insulin stabilisation data collection and management.

	Characteristic	Relevance to research project
1	Problem focus	The research is problem focussed in that it seeks to investigate the use of an action research method in the design and implementation of a telemonitoring system for use by diabetes patients in a Victorian Health Services Network. In addition the research seeks to make a contribution to the action research body of knowledge in the area of designing and implementing telemonitoring system for use by diabetes patients in a Victorian Health Services Networks
2	Action orientation	The research is action oriented in that the action is part of the process to implement the plan. The research examines the use of an action research in both the design and implementation of the telemonitoring system. The research is also action oriented in that it brings an action element to the solving of an immediate problem being the low rate of adoption of telemedicine within Monash Health
3	Cyclical process	The action research process for this research consisted the design of the system (major cycle 1), its implementation (major cycle 2), and its subsequent further development (major cycle 3). Each of the major cycles consisted of multiple mini cycles. In this way the research demonstrated the action research method of cycles of planning, action, observation, and reflection
4	Collaboration	The research achieved collaboration via ensuring a high degree of diversity within the action research group. The action research group consisted of the researcher, the patient advisor, the diabetes unit clinical lead, and a telemonitoring systems provider representative. A level of collaboration was achieved as each of the participants in the action research group where dependant on each other for their specialised area of expertise and the overall success of the project
5	Ethic practice	Ethical practice was achieved within the research via formal means (the approval of the research by an Australian Government approved Human Research Ethic Committee HREC) and approval from the researcher's academic institution Australian Institute of Business (AIB). In addition specific representation to groups of people with limited power (in this instance the patient group) was addressed via the inclusion of a patient advocate role within the action research group
6	Group facilitation	The effective operation of the action research group was achieved via the use of multiple techniques including setting clear boundaries in terms of interactions during AR meetings, and the initial introduction of participants to each other in an informal setting prior to the formal setting of the AR group meetings
7	Creative thinking	The research project demonstrated creative thinking in the solving of issues that eventuated through the major and minor cycles. Examples include the localisation of the telemonitoring platform, and the development of a historical results viewer
8	Learning and re-education	The research project can be reviewed as re-educative as it has contributed to a change in the knowledge base of the organisation via the development of knowledge in the area of design and implementation of a telemonitoring system for diabetes patients. The research as also contributed to a change in the skills and knowledge for the action research group and researcher by exposing them to practice areas outside their traditional areas of expertise or specialisation
9	Naturalistic	The research incorporated a naturalistic approach inclusive of the collection of qualitative information. Examples of used within the research included participant observation, which was supplemented with archive analysis, focus group discussion, and group reflection

(*continued*)

Table I.
Action research justification

Characteristic	Relevance to research project
10 Emancipatory	The changes experienced as a result of the research project have been personal in terms of action research group, but also wider in terms of social action and reform. All of the participants within the action research group have a personal connection to the treatment of diabetes whether as clinician, patient or provider of services. The AR group has provided an opportunity for the participants to assist in the development of telemonitoring programs not only within the research organisation but also more generally in the management of chronic disease conditions in Victoria
11 Normative	Within the context of the action research not only were norms of the action research group and wider research organisation considered but also modified as a result of the process. By its very nature the planning and implementation of the telemonitoring programme using action research incorporated the norms of existing practice and models of care via the input of the AR group. The design and implementation of the telemonitoring programme also challenged existing norms in that way that it redefined existing hospital-centric delivery models of chronic disease management
12 Scientific	In order to ensure scientific rigour multiple techniques where utilised throughout the research. Examples of data analysis techniques include content analysis, clustering, and chain of evidence. Examples of validation techniques utilised include the use of an independent review via the Review Committee, triangulation, and the use of a case study protocol. Most notably the action research utilised a clinically matched control group that did not undergo home-based telemonitoring

Table I.

Source: Adapted from Abraham (2012, pp. 7-8)

The design stage involved several phases. Design phase is summarised in Figure 1 and included three phases. Phase 1 was Monash Health Support Phase. This involved obtaining support and approval from Monash Health to design and implement a telemonitoring programme for diabetes patients using the action research method. In addition, submission to Monash Health Human Research Ethics Committee (HREC) research approval documentation was done. Several other steps were performed including briefing of required individuals on a 1:1 basis, briefing of required group and obtaining required formal approval of Monash Health Human Research Ethics Committee (HREC) and support to conduct the research.

Phase 2 involves establishing, developing, and designing the programme. The researchers select, justify, have consultations and establish the action research group made up of personnel within Monash Health involved in the delivery of diabetes services. This adheres to the multidisciplinary model of care delivery adopted within Monash Health. This model has been adopted due to the positive impact on patient care (Sainsbury *et al.*, 1995; Junor *et al.*, 1994; Blumberg and Ramanathan, 2002; Van Laethem *et al.*, 2001). Furthermore as noted by Seidel and Fixson (2013, p. 21) as "there are many potential benefits of staffing innovation projects with members that come from a range of disciplines because of the breadth of perspectives offered". In addition several other steps involve identification and selection of potential action research group members, processing contacting potential action research group members, briefing selected action research group members, holding first action research group meeting, developing the Action Research group in the nature of action research and reflective practice, in the programme design and working as a group to design the implementation of the programme.

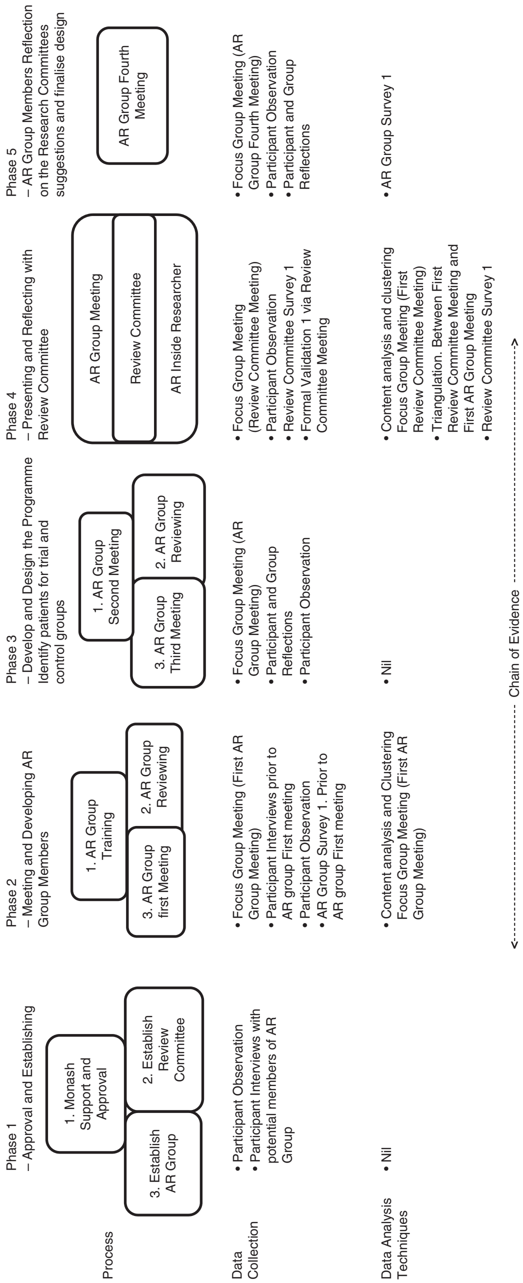


Figure 1.
Design stage: three to four months duration

The action research group include a representative from each key stakeholder group, clinical staff, information technology, patient representative. This is to ensure that there is adequate representation of the three major stakeholder groups impacted by the potential action research programme. These participants are the key stakeholders potentially impacted by the proposed research. Patient involvement in healthcare-based action research has proven to have significant benefits (Williamson, 2012).

Phase 3 involves establishing and seeking approval of the validation committee. A review committee comprising of independent stakeholders to critically assess the programme and provide feedback during the validation stages of this study was established. The review committee acts as a form of "cross-checking" (Perry, 2013, p. 143) to establishing validity. As a result it is critical that the members of this group be outside the action research group. The use of a review committee draws on the techniques outlined by Mason (2002) in establishing the validity of data. This phase involved several tasks which included selecting of potential review committee members, contacting potential review committee members, briefing selected review committee members on a 1:1 basis, planning for the first review committee meeting and presenting to the review committee. One of the review committee's primary functions will be to conduct an independent review of the research and findings at the conclusion of the design major cycle 1 and major cycle 2. This will occur in order to address any potential personal bias of the researcher who will be responsible for the undertaking of interviews, briefing of the research group members, undertaking participant observations as well as providing personal notes and reflections on the process. Triangulation of data gathered throughout the research will also be used as a method to address potential researcher bias.

Researcher bias is of a particular concern in qualitative research methodologies such as AR and therefore a risk for the researcher. This is of a result of "qualitative research is open ended and less structured than quantitative research […] tends to be exploratory" (Johnson, 1997, p. 284). In such a setting researcher bias results from "selective observation and selective recording of information, and from allowing one's personal views and perspectives to affect how data are interpreted and how the research is conducted" (Johnson, 1997, p. 284). The concept of researcher bias in particular inside researcher bias within qualitative research has an established foundation in the literature (Van Heugten, 2004; Mercer, 2007; Drake, 2010; Roland and Wicks, 2009; Kim, 2012; Madhu Ranjan, 2013).

A number of approaches have been developed within qualitative studies to protect against researcher bias and enhance the reliability and validity of such studies. These include statistical sampling methods such as random sampling and systematic non-probabilistic sampling, the use of independent assessment to increase the reliability of analysis, triangulation, grounded theory, direct data collection, peer review, external audit, member checking, and the presentation of qualitative research in a scientific paper format to enabling the reviewer to clearly distinguish between the data, framework, and interpretation utilised (Mays and Pope, 1995; Cohen and Crabtree, 2008; Lincoln, 1985; Kirk, 1986; Maxwell, 1992; LeCompte, 1993). The various approaches available are summarised well in Table II by Johnson (1997).

The researcher intends to protect against research bias by the utilisation of the several techniques. This includes peer review via the action research meetings and review committee meetings as well as reflexivity done through personal and group reflective practice both reflection-in-action (reflection on action while it is occurring) and reflection-on-action (reflection on actions taken) inherent in the action research

Strategy	Description
Researcher as "Detective"	A metaphor characterizing the qualitative researcher as he or she searches for evidence about causes and effects. The researcher develops and understanding of the data through careful consideration of potential causes and effects and by systematically eliminating "rival" explanations or hypotheses until the final "case" is made "beyond reasonable doubt". The "detective" can utilise any of the strategies listed here
Extended fieldwork	When possible, qualitative researchers should collect data in the field over an extended period of time
Low-inference descriptors	The use of description phrased very close to the participants' accounts and researchers' filed notes. Verbatims (i.e. direct quotations) are a commonly used type of low-inference descriptors
Triangulation	"Cross-checking" information and conclusions through the use of multiple procedures of sources. When the different procedures or sources are in agreement you have "corroboration"
Data triangulation	The use of multiple data sources to help understand a phenomenon
Methods triangulation	The use of multiple research methods to study a phenomenon
Investigator triangulation	The use of multiple investigators (i.e. multiple researchers) in collecting and interpreting the data
Theory triangulation	The use of multiple theories and perspectives to help interpret and explain the data
Participant feedback	The feedback and discussion of the researcher's interpretations and conclusions with the actual participants and other members of the participant community for verification and insight
Peer review	Discussion of the researcher's interpretations and conclusions with other people. This includes discussion with a "disinterested peer" (e.g. with another researcher not directly involved). This peer should be sceptical and play the "devil's advocate", challenging the researcher to provide solid evidence for any interpretations or conclusions. Discussion with peers who are familiar with the research can also help provide useful challenges and insights
Negative case sampling	Locating and examining cases that disconfirm the researcher's expectations and tentative explanation
Reflexivity	This involves self-awareness and "critical self-reflection" by the researcher on his or her potential biases and predispositions as these may affect the research process and conclusions
Pattern matching	Predicting a series of results that form a "pattern" and then determining the degree to which the actual results fit the predicted pattern

Source: Johnson (1997)

Table II.
Strategies used to promote qualitative research validity

method will be done. In addition, participant feedback through discussion with the patient representative to ensure participant community insights will also be used. Data Triangulation through group discussions at the first, second, and third Review Committee Meetings, first AR Group Meeting, Major Cycle 1 Close-Out AR Group Meeting, and Final AR Group Meeting, committee Survey one, two and three and AR Group Survey one, two and three are also to be utilised. Extended fieldwork where the trial will consists of three action research cycles with a minimum of ten months active monitoring of participants utilising telemonitoring is to be utilised. In addition, low-inference descriptors where possible technology such as video recording and direct transcription utilised to ensure verbatim capture of information will be done.

There are a number of issues specific to insider bias particularly within interviews. Some contend that outside researchers are more likely to be presented with a false image

often presenting what he or she believes the researcher is expecting to see or an embellishment of the reality (Paredes, 1979; Zinn, 1979). Others (Schuetz, 1944; Preedy and Riches, 1988; Drake and Heath, 2008) assert that the inside research is captive of her or her own organisational history, politics and pragmatism due to the ongoing relationship with the workplace extending beyond the duration of the research. The potential factors which are summarised well by Platt (1981) with include shared group memberships, background knowledge and shared understandings, equality and status, all having a potential impact.

The researcher intends such potential via utilising the techniques of outlined by Gregg (1994), Merton and Kendall (1946), Drew (2014), Fielding (1993) in observing and "abstemious style" (van Heugten, 2004, p. 211) in conducting interviews by keeping guidance to a minimum, avoiding opinion, and self-disclosure. All phases of the research are demonstrated in Figures 1-3.

Action research group. The action research group formed for the research appears in Figure 1. The selection of action research group members was based on a multidisciplinary approach. This approach was adopted due to the positive impact on patient care (Sainsbury *et al.*, 1995; Junor *et al.*, 1994; Blumberg and Ramanathan, 2002; Van Laethem *et al.*, 2001). Furthermore as noted by Seidel and Fixson (2013, p. 21) as "there are many potential benefits of staffing innovation projects with members that come from a range of disciplines because of the breadth of perspectives offered". The action research group consisted of the researcher, a patient advisor, the diabetes unit clinical lead and a representative of the telemonitoring systems provider. This ensured that there was adequate representation of all the key stakeholder groups impacted by research – patients, clinical staff, information technology, and the system provider as demonstrated in Figure 4.

These particular action research group participants were selected as the inclusion of key stakeholders impacted by research increases the chance of success (Morton-Cooper, 2000). In particular patient involvement in healthcare-based action research has proven to have significant benefits (Williamson, 2012). It should, however, be noted that the number of members was constrained by the limited number of staff available within the diabetes units available to participate in research activities. The rationale for the participation of each of the action research group members appears in Table III. The specific questions or issues that this group will seek to address have their basis in the research questions with a focus of the emergent access research process and its outputs. For example exploring identifying issues and problems and the development of approaches to overcome such issues.

Review committee. The review committee should consist of independent expert stakeholders. The review committee would be responsible for the critical assessment the programme and to provide feedback via review committee meetings. In this way it would act as a house of review. Such meetings would act as validation checks during the research project. The review committee members would not be part of the action research group. In addition the review committee was responsible for acting as a body of review, reduce researcher bias, and act as a form of "cross-checking" (Perry, 2013, p. 143) to establish the validity of the findings and data generated by the research (Mason, 2002). Similar to the action research group the specific questions that the review committee will seek to address will be based in the research questions. Given the review committees oversight and verification function committee the focus will be on the telemonitoring model developed, characteristics of the action research method, and the action research processes that emerged.

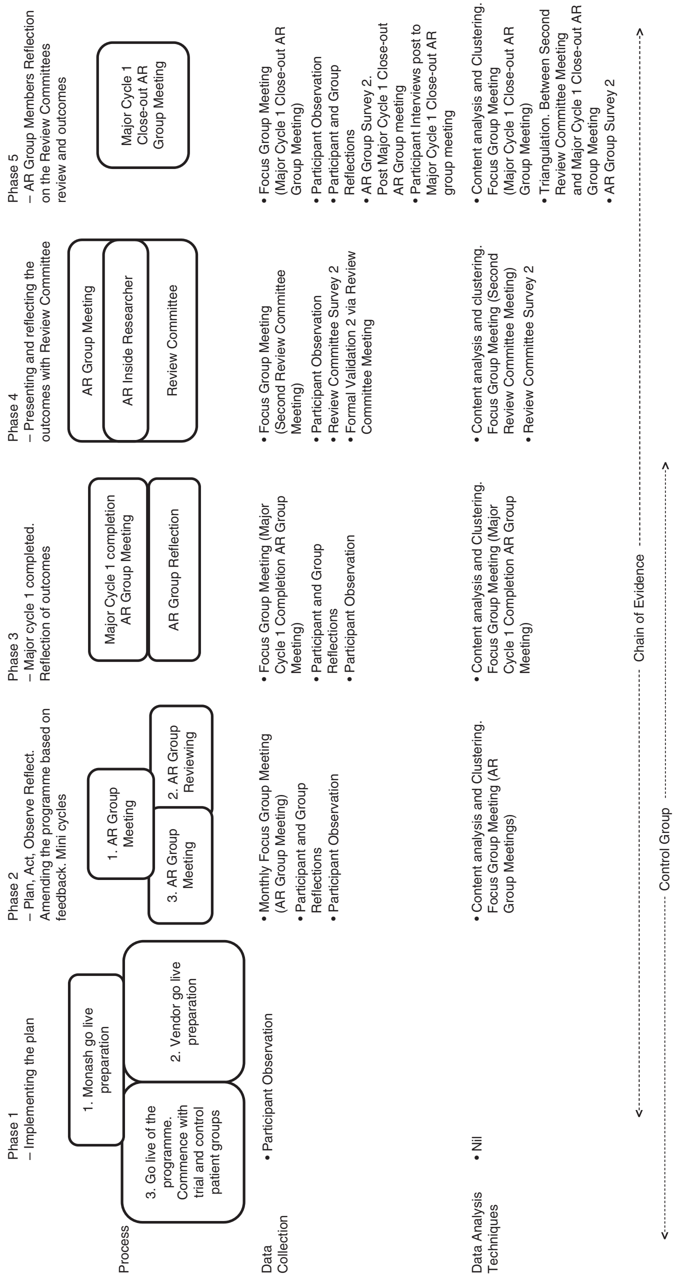
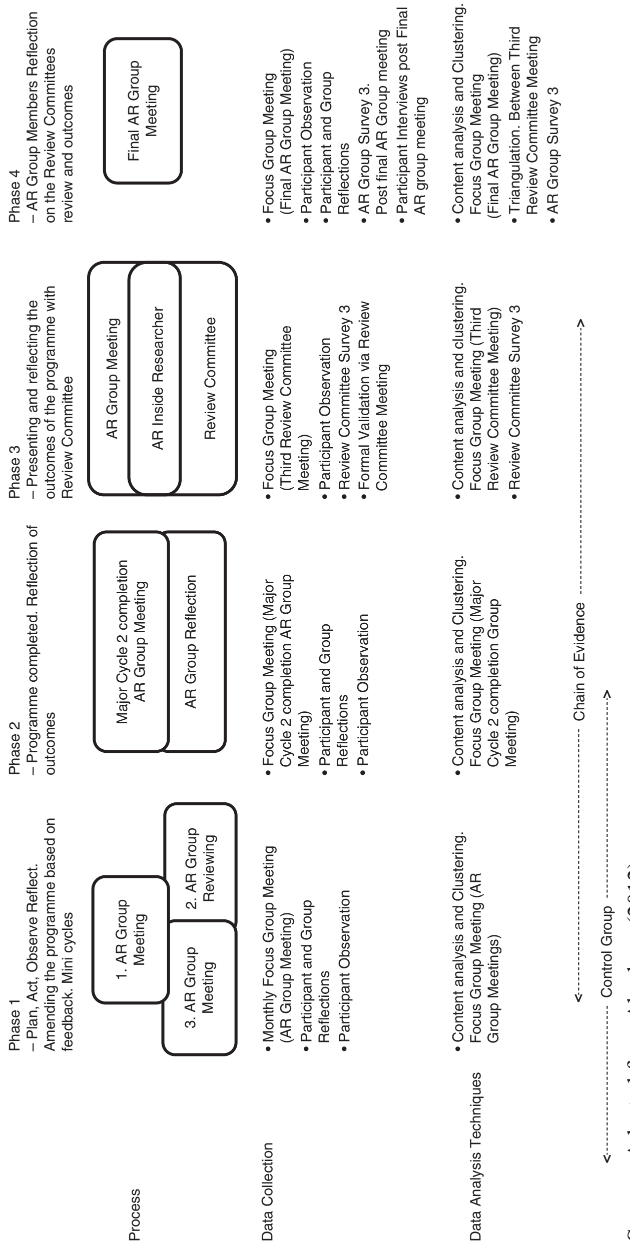


Figure 2.
Major cycle 1: five months in duration



Source: Adapted from Abraham (2012)

Figure 3.
Major cycle 2: five months in duration

Control group

Within the industry sector of Healthcare there exists a growing body of literature concerning the use of action research (Winter and Munn-Giddings, 2001; Hughes, 2008; Koch and Kralik, 2006; Boss, 1989; Golembiewski, 1987; Hart, 1995; Margulies and Dundon, 1987). In particular action research has been widely adopted by the

Figure 4.
Action research group composition

Action research group member	Rationale
Researcher	The researcher is an information technology executive with more than 15 years experience in healthcare. Through his professional practice the researcher had identified the need to increase adoption of emergent healthcare technologies such as telemonitoring. This need is particularly high in the area of the management of chronic disease conditions such as diabetes where the researcher believes telemonitoring as a healthcare delivery method has the potential to not only provide increased quality of life and improved clinical outcomes for patients, but also decrease costs to healthcare providers
Patient advisor	As noted by Williamson (2012) patient involvement in healthcare-based action research has proven to have significant benefits. A patient advisor was included within the action research group to ensure "the voice of the patient" was not lost and that a patients perspective was considered throughout all stages of the research. In addition the patient advisor provided insights into patient behaviours. This is of importance to the research as successful patient adoption is critical to the implementation of any telemonitoring programme
Diabetes unit clinical lead	Diabetes unit clinical involvement in the research was required for a number of reasons. These included: the involvement of clinical staff ensured clinical oversight and safety of participants of the telemonitoring programme; second, it provided a clinical advisory capability to the action research group helping to identify any potential clinical barriers to adoption; third, it increased the likelihood of success of the research by encouraging clinician engagement; finally the inclusion of the diabetes unit clinical lead increased access of the research to the target participant group – type 2 diabetes patients
Telemonitoring systems provider representative	The systems provider was a crucial actor in ensuring the reliable provision of the telemonitoring system to ensure success of the research. Having a representative of the system provider as a member of the action research group ensured accountability for systems performance, reliability, and the timely delivery of requested enhancements by the action research group

Table III.
Selection rationale of action research group members

United Kingdom National Health Service (Bowling, 1997). Some (Bate, 2000, p. 481) have attributed this rise to the adoption of "evidence-based" practice within healthcare which requires that "all available research knowledge be incorporated into the protocols of everyday practice". Others (Dechairo-Marino *et al.*, 2001) assert that action research provides an alternative to the existing "gold-standard" in the medical field of randomised control trials (RCT) in that it is a less expensive, quicker, and has an increased ability to immediate operational interventions. The action research method is utilised as it has the ability to:

- increase the relevance of information technology to clinical practice (Baskerville and Myers, 2004);
- establish collaborative relationships between the traditionally "siloed" fields of clinical practice and information communication technology (Chiasson and Davidson, 2004); and
- demonstrate the capacity of information communication technology management to provide solutions to healthcare problems (Kohli and Kettinger, 2004).

It is this issue with the current methodological perspective in healthcare research and the potential contribution that action research as a methodology can make that this paper intends to explore. Stated differently this paper intends to present an alternative AR-based methodological approach to existing research approach in healthcare settings.

The telemonitoring programme actively monitored patients over a period of ten months. The trial was provided for two cohorts with a maximum of ten patients per cohort. A clinically matched control group was used that did not undergo home-based telemonitoring to verify results. The telemonitoring system used was My Health Point (http://myhelathpoint.com/en/). The system and equipment was provided by Telstra Health. Diabetes patients newly commencing insulin were assigned to telemonitoring insulin stabilisation or to usual insulin stabilisation via e-mail or phone. The following was collected and compared to the control group to determine the HbA1c results, number of insulin adjustments made, average blood glucose level, and number of contacts with health professionals.

The population size for the research (i.e. number of patients that participate in the programme) is 20. This consists of a control group of ten and a group of ten that utilise the telemonitoring system. This number has been selected as ten is the maximum number of participants that can be accommodated in a trial by the vendor providing the telemonitoring system. Participants are identified based on clinical suitability.

Data collection

Within action research literature there exists a number of methods of data collection available to the researcher including observation, in-depth Interviewing, focus groups, and narrative inquiry (Yin, 2009; Marshall, 1995; Denzin and Lincoln, 2008; Bouma, 2004; Thomas, 2003). The primary data collection method employed is participant observation and is supplemented with documentation, focus group discussion, and group reflection.

A research protocol is created as part of the project design phase. The research protocol described how the trial was conducted (including the design, methodology, data collection, and manipulation methods). In addition it ensures the safety of participants and the integrity of the data collected. The overall objective of the research protocols is to improve the quality of the research. The research protocol is designed in

accordance with the requirements of the National Statement on Ethical Conduct in Human Research (National Health and Medical Research Council *et al.*, 2007).

Participant observation can be defined as "the systematic description of events, behaviours, and artefacts in the social setting chosen for study" (Marshall, 1989, p. 79). This earlier description has been built on by Schensul (1999, p. 91) in defining the process of participant observation as "the process of learning through exposure to or involvement in the day-to-day or routine activities of participants in the researcher setting". The action researcher plans to make field notes of such interactions within the action research group meetings and committee review meetings, and external to such meetings.

Archive analysis occurs at the commencement and conclusion of the action research process via the examination of existing documentation related to utilisation and operation of telemonitoring and diabetes programs within Monash Health. Participant surveys are also undertaken at the commencement and conclusion of the action research process.

Use of reflective practice via notes of personal reflections and observations of the researcher during the action research process is important. Based on the concepts outlined by Donald Schön (1983) reflection takes the form of reflection-in-action (reflection on action while it is occurring) and reflection-on-action (reflection on actions taken). The reflective practice used by the researcher utilises the techniques of epistemology of practice, artistry of practice, embodied reflection, and frame reflection (Schön, 1983, 1987; Kinsella, 2007, 2010; Schön and Rein, 1994).

The researcher is also a participant in the action research groups and process evaluation and validation techniques are utilised to avoid perception or personal bias. These techniques are independent review and triangulation.

Data analysis

Several data analysis techniques are utilised. This includes content analysis, clustering, chain of evidence. Content analysis can be defined as defined as "A research technique for making replicable and valid inferences from texts (or other meaningful matter) to the contexts of their use" (Krippendorff, 2004, p. 19). More simply this technique allows trustworthy inferences to be made from disparate data. Content analysis is used on the data obtained from the data collection techniques previously outlined. The data is broken down into "meaning units" (Berelson, 1952, p. 138) and "context units" (Abraham, 1997, p. 118). The data is categorised, codified, and placed in a matrix to allow for additional analysis and synthesis to provide meaningful responses to the corollary research questions. Content analysis was selected due to its comparative advantages over other analytical techniques (Berelson, 1952; Carney, 1972; Krippendorff, 1980; O'Brein and Briggs, 1987) in particular that it adapts well to unstructured material, is comparatively inexpensive, requires minimal research resources, and is unobtrusive.

Based on the work of Tryon (1939), Cattell (1944), Sokal and Sneath (1963) clustering or cluster analysis can be defined as a "term used to describe a family of statistical procedures specifically designed to discover classifications within complex data sets […] the purpose of the analysis is to arrange objects into relatively homogeneous groups based on multivariate observations" (Gore, 2000, p. 298). Clustering is utilised on the content analysis matrix to clarify the data to enable the researcher to answer the corollary research questions. The AR Group Survey 1-3 and Review Committee Survey 1-3 are developed utilising the clustering techniques proposed by Comrey (1988).

A data analysis technique used to illustrate the logical relationship between research questions, research procedures, raw data, analysis, and results. The overall objective of a chain of evidence is to ensure that the reliability of the data and conclusion presented is increased and that the same conclusions would be reached by an independent person (Yin, 2009).

Evaluation and validation

Formal validation via presentation to the Review Committee occurs three times. The first validation occurs in the design stage phase 4. The second validation occurs during major cycle one phase 4. The third validation occurs at the conclusion of the trial during major cycle two phase 3. During these sessions the Review Committee consisting of independent stakeholders critically assess the programme and provide feedback. This assessment provides a valuable independent mechanism to validate the data collected by the researcher via observation and group discussions.

Triangulation is utilised in the research as a data validation technique. Triangulation has been defined as "to the search for consistency of findings from different observers, observing instruments, methods of observation, times, places and research situations" (Chadwick *et al.*, 1984, p. 40). This data validation technique has been selected as data for this action research project is to be derived from many sources. The primary mechanism is the group discussions at the first, second, and third Review Committee Meetings, first AR Group Meeting, Major Cycle 1 Close-Out AR Group Meeting, and Final AR Group Meeting, Committee Survey 1, 2 and 3 and AR Group Survey 1, 2 and 3.

The group discussions and surveys allow the researcher to conduct comparative analysis both within the action research group and to with participants such as Review Committee members. Such triangulation has two functions; first, to enable the groups participating in the research (such as the action research and review committee) to identify systemic issues of themes for further investigation and second, to provide feedback mechanisms to enable the groups to make informed decisions concerning the programme or sub-projects and ensure adequate progress.

Ethical considerations

The proposed research approach was approved by the Ethics Committee of the Australian Institute of business. Australian Government approval of the research also occurred in the form of approval by the Monash Health Human Ethics and Research Committee. The Monash Health Human Ethics and Research Committee is a nationally certified by the Australian Government National Health and Medical Research Council in accordance with the National Statement on Ethical Conduct in Human Research (National Health and Medical Research Council *et al.*, 2007).

All data collected by the study was made non-identifiable prior to being published, shared or re-used. Non-identifiable data is data from which identifiers have been permanently removed, and by means of which no specific individual can be identified (National Health and Medical Research Council *et al.*, 2007). Data were made non-identifiable via the methods outlined in Australian Bureau of Statistics, National Statistical Service Handbook – Techniques to confidentialise data, and National Health and Medical Research Council *et al.* (2007). National Statement on Ethical Conduct in Human Research; Section 3.2.

Opt out consent was utilised for participants in the research. This type of consent was utilised as the proposed programme is considered part of routine care. As noted above informed consent was obtained from Monash Health in the form of official endorsement by the organisations Human Ethics and Research Committee.

A participant information sheet was made available to all participants in the research. This sheet contained the details of the proposed research including but not limited to roles and responsibility, data treatment, and purpose.

The reliability of the research was established via establishing a case study protocol also known as a research protocol. The use of a case study protocol has been asserted by Yin (2009) as a valid tool to increase the reproducibility and therefore reliability of case study research. The establishment of the case study protocol was also requirement of the Human Research and Ethics Committee to grant approval National Statement on Ethical Conduct in Human Research (National Health and Medical Research Council *et al.*, 2007). The case study protocol followed a modified format as proposed by Yin (2009) and was inclusive of an overview, field procedures, and case study questions.

Implications of the research

The paper contributes to the methodical design of action research projects in their use to implementation health technologies such as telemonitoring. In particular it seeks create a model which can be used to demonstrate the efficacy of the use of the action research method as a viable alternative to the traditional RCT methodology currently employed in healthcare. The use of action research in such a context is seen as desirable in that provides a less expensive, quicker, and more immediate (Dechairo-Marino *et al.*, 2001) method to implement healthcare technologies. In addition, the paper has the potential for use internationally for managing diabetes. This would be especially useful in areas and countries that would have access to information technology and telemonitoring systems that would support such intervention. This could include countries in Europe, USA, and parts of Asia. Furthermore, using action research in programme design can be of global interest within the context of healthcare for many chronic diseases and not just diabetes. It is also useful in a range of contexts outside of healthcare.

Conclusion

The proposed research into the design and implementation of a programme for diabetic patients to undergo telemonitoring is significant in that it identifies current issues preventing the increased utilisation of telemonitoring for the treatment of diabetes within a Victorian health service. In addition, it provides evidence to assist in the development of telemonitoring programs more generally in the management of chronic disease conditions in Victoria.

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