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Patient-Centred Outcomes of Tele-Diabetes

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Abstract

Objective: The benefits of telemedicine are widely recognised in terms of equity of access, reduced travel burden for patients and clinicians, and upskilling of local staff in rural locations. However, clinical outcomes and clinical efficacy of telemedicine have not been robustly tested on a large scale.

Setting: In our tertiary institution, tele-diabetes clinics have been developed over the past decade, for management of diabetes patients, in rural and remote areas of Australia.

Participants: We examined the change in glycated haemoglobin (HbA1c) measures during a finite time period in two cohorts. Group 1 consisted of 75 face-to-face consultations of patients with diabetes specialists at our hospital at routine out-patient clinics, while Group 2 consisted of 75 patients reviewed remotely via Telemedicine clinics.

Results: Statistical analyses indicated that changes in HbA1c were non-inferior in patients seen via the Telemedicine group as compared to patients reviewed at routine outpatient clinics.

Conclusions: Tele-diabetes represents a viable option in improving diabetes care in patients dwelling in remote regions of Australia. To our knowledge, this is the largest comparison of HbA1c measures between patients seen via video-conferencing and patients seen at routine out-patient clinics in Australia.

Trial Registration: HREC/15/QGC/319

Keywords: Diabetes; HbA1c; Management; Telehealth; Tele-Diabetes; Telemedicine

Introduction

The ever-increasing prevalence of chronic diseases is providing a significant challenge for health care providers, and diabetes is a major contributor to the array of chronic diseases. The burden of diabetes is substantial, being the principal or additional diagnosis in 9% of Australian hospital presentations in 2011-2012 [1]. With approximately half of Australians suffering from a chronic disease [2], an integrative management plan is required for these long-term conditions; its success will be measured by improvements in health outcomes, quality of life and cost-effectiveness.

In particular, rural and remote areas harbour a conundrum for the delivery of not only clinically effective, but cost-effective health care [3]. Specifically, Australia bears a large rural population, many of whom have poor accessibility to health care [4]. Queensland has the most decentralised population of any mainland state, with over 50% of the population living outside the Brisbane metropolitan area and approximately 18% living in areas classified as outer regional, remote or very remote [5]. This represents an inequity in access to healthcare, as patients must travel long distances to receive specialist review, entailing not only hefty travel and accommodation costs, but a reduction in adherence to their chronic disease management [4]. Poorer access to health care has been established as a factor contributing to poorer health outcomes for rural and remote Australians and indigenous Australians [6-8].

Telemedicine provides an alternative platform for face-to-face consultations in the delivery of health care to those suffering chronic diseases. In utilising telecommunication systems to deliver health care at a distance, telemedicine aims to improve health outcomes, equity of access to health care and associated costs [9]. Patient communication, monitoring, and education are all exploited in telemedicine in order to facilitate greater adherence to chronic disease management [10]. Pertinently, a systematic review was published in 2015 by Cochrane Database of Systematic Reviews, regarding health outcomes of telehealth management in chronic diseases [9]. In 16 eligible studies consisting of 2768 diabetic patients, glycated haemoglobin (HbA1c) levels were lower in those allocated to telemedicine in comparison to controls ($P<0.00001$) [9]. Similarly, in a meta-analysis including 55 randomised controlled trials with 9258 diabetic patients, telemedicine was compared favorably to conventional care in comparing mean HbA1c levels ($p<0.001$) [10]. However, such systematic reviews on telemedicine were not inclusive of Australian data.

Furthermore, Australia's telemedicine research is limited. Substantial savings in travel costs have been demonstrated via the use of a tele-oncology model [4], whilst others have shown significant patient satisfaction with their respective telemedicine models [12-15]. Australian tele-diabetes (the application of telecommunications technology for the management of diabetes) research is even scarcer and has focused primarily on telephone consultations as the method of telecommunication with varying results. Williams et al. compared 120 type 2 diabetics with telephone interventions and usual care, showing improved glycemic control (HbA1c) ($p=0.002$) and health-related quality of life ($p=0.007$) for those in the telephone group [16]. However, other studies have shown no difference in glycemic control (HbA1c) for those who have telephone consultations compared to usual care [15,17].

Although telemedicine's benefits are widely well-documented, it has not been extensively researched in Australia and warrants further evidence into its feasibility for application in the future. This article aims to determine if the management of diabetes by videoconference is non-inferior in comparison to face-to-face consultations. To our knowledge, this is the largest comparison of HbA1c measures managed by tele-diabetes versus routine outpatient consultations in Australia.

Method

Aim

To determine if there is a non-inferiority in diabetes management (HbA1c measurements) using tele-diabetes video-conferencing in comparison to face-to-face consultations in an Australian cohort.

Design

This is a retrospective study. 167 random patient Unit Record Numbers (URNs) were randomly extracted from the patient register of most recently conducted diabetes outpatient and telemedicine clinics conducted at Gold Coast Hospital and Robina Hospital inclusive of the years 2015 and 2016. Of these, 87 patients had encountered face-to-face consultations between January 1st 2011 - December 31th 2016, whilst 80 patients had engaged in telemedicine consultations during January 1st 2014 - December 31st 2016, using the Queensland Health videoconferencing network. Four Diabetes specialists each were involved with the face-to-face clinics, as well as the Tele-Diabetes clinics. Robina Hospital happens to have a large Insulin pump Diabetes clinic service, in addition to catering to patients suffering from Type-2 Diabetes who are not on insulin pumps, and the authors thus acknowledge that several of the randomly selected patients in the face-to-face arm were on Insulin pumps as opposed to those who were not. The network utilizes protected government fibre and Cisco hardware and software videoconferencing systems. URNs were used to locate patients' HbA1c measurements on their initial and most recent consultations, via Queensland Electronic Medical Records (EMR). The following demographic and health status data were also extracted: age, sex, smoking status, ethnicity, postcode, comorbidities (neuropathy, hypertension, dyslipidemia, cardiovascular disease, peripheral vascular disease, nephropathy,

lower limb ulcers), type of diabetes (1, 2 or other), duration of diabetes, most recent diabetes treatment (oral hypoglycaemics, insulin only, insulin and oral agents, no medication) and the date (months and year) of HbA1c measurements prior to their initial and most recent consultations.

Setting

Face-to-face consultations were conducted in the specialist outpatient department of Robina Hospital, between November 2011 and August 2016. These were labeled diabetes clinics, whereby diabetic patients were monitored, assessed, educated and managed. Consultations were 30 minutes long with scheduled follow-ups usually occurring at 2-3-month intervals.

Telemedicine clinics were conducted at Robina Hospital and Gold Coast University Hospital in a private room using Cisco Jabber desktop video-conferencing software, with patients being seen between December 2014 and August 2016. All patients had a confirmed diabetes diagnosis and were consulted for assessment, monitoring, education and management of their diabetes. These clinics were provided 2 times per week, and were staffed by a consultant endocrinologist and a diabetes educator nurse. Consultations were 30 minutes long with scheduled follow-ups usually occurring at 2-3-month intervals.

Characteristics of Participants

All patients had a confirmed diagnosis of diabetes. Patients presenting to the face-to-face clinics resided in South-east Queensland or North-east New South Wales. Patients seen at the telemedicine clinics resided in regional areas ranging from 800-1500 kilometers from Gold Coast City; these areas included Northern Queensland, North-east New South Wales, and South-west Queensland towns such as Roma, St George and Surat, as illustrated in Figures 1,2 and 3.

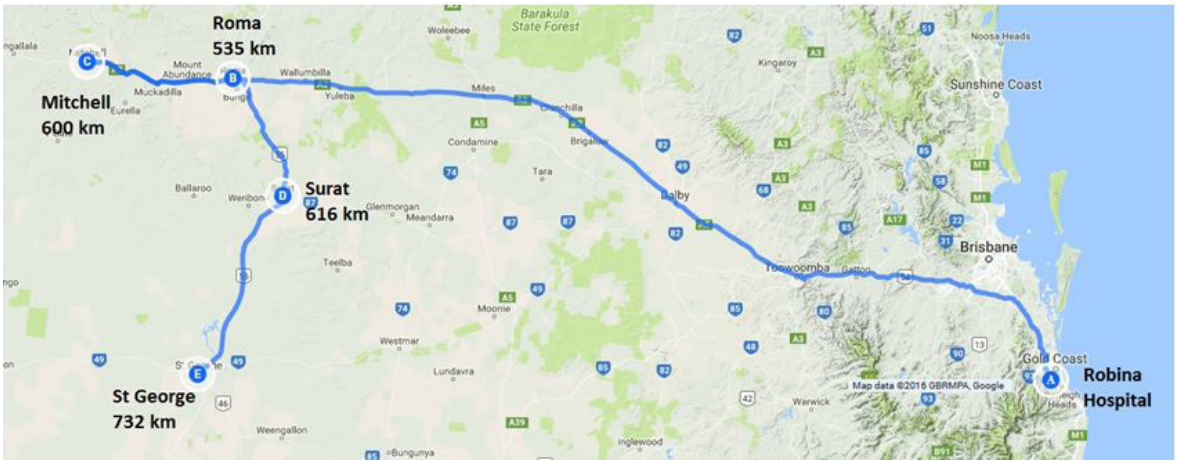

Figure 1: Map of North Queensland: Distances from Robina Hospital are in kilometres

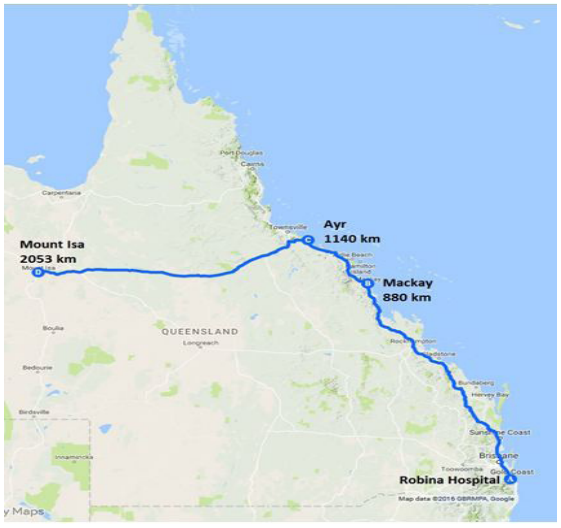

Figure 2: Map of Northern New South Wales: Distances from Robina Hospital are in kilometres

Figure 3: Map of South West Queensland: Distances from Robina Hospital are in kilometres

Inclusion criteria: patients must have been diagnosed with diabetes and had HbA1c measurements prior to two separate consultations. Exclusion criteria: patients presenting to the clinics for endocrine or alternative conditions other than diabetes.

Additional Processes

URNs and EMR were used to extract the data, including from the three laboratories which our patient's utilize, namely, Queensland Medical Laboratories (QML), Pathology Queensland and Sullivan and Nicolaides Pathology (SNP).

Due to a high amount of unknown data, smoking status and ethnicity were excluded from statistical analysis. Postcode was not entered into statistical analyses. Additionally, the type of diabetes treatment was excluded from statistical analysis.

Statistical Analysis

Differences between the face-to-face and telemedicine groups were analysed using independent samples t-tests for the following study variables: age, sex, number of years since diabetes diagnosis, type of diabetes, insulin only treatment, number of comorbidities, initial HbA1c measurement, and number of months between HbA1c measurements. Statistical analysis of change in HbA1c levels between patients' initial and most recent measurement controlling for the covariates listed above was performed using multiple linear regression in SPSS Statistics 24, with telemedicine versus face-to-face consultation forced into the regression model and stepwise removal of covariates which did not improve model fit.

Results

Table 1 and Table 2 shows descriptive statistics for the study variables by telemedicine versus face-to-face diabetes management groups, using independent samples t-tests for differences between groups.

Table 1

	Face - to - Face Mean SD	Telehealth Mean SD	p value for difference between groups
Number of subjects	87	80	
Age (yrs)	46.92 ± 17.9	53.91 ± 16.2	0.009
Duration of diabetes (yrs)	14.46 ± 11.5	14.11 ± 9.5	0.831
Number of reported comorbidities	1.55 ± 1.42	1.50 ± 1.35	0.81
HbA1c prior (%)	9.2 ± 1.7	8.7 ± 1.5	0.023

Table 2

	Face - to - face Mean SD	Telehealth Mean SD	p value
Number of subjects	75	75	
HbA1c post (%)	8.41 ± 1.78	8 ± 1.33	0.111
HbA1c post minus prior	- 0.711 ± 1.59	- 0.725 ± 1.39	0.952
Months between HbA1c measures	20.69 ± 17.96	5.92 ± 4.62	0

Table 1 and Table 2: Descriptive statistics for the study variables by telemedicine versus face-to-face diabetes management groups, using independent samples t-tests for differences between groups.

HbA1c measurements at initial consultation were not significantly different between groups, however HbA1c measurements from their most recent presentation were significantly higher in the face-to-face group ($p<0.05$). Importantly, in comparing the difference in patients' HbA1c measurements from initial and most recent consultations, there no statistical significance between the two groups.

There was a loss to follow-up included in both groups (n=12 face-to-face, n=5 telemedicine) whereby patients did not present for a second consultation or had not had a second blood test to check their HbA1c levels.

Multiple regression analyses were performed to test for significant differences in HbA1c measurements from first measurement to most recent measurement in the presence of the covariates listed in Table 1. The final regression model (Table 3) showed that only one variable included in the study predicted change in HbA1c: there was a strong association between higher HbA1c measurements at initial presentation and a smaller difference in final HbA1c measurements. Face-to-face management of diabetes did not predict change in HbA1c measures.

Model	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	t	Sig.
(Constant)	3.114	0.779		3.997	0
Telemedicine group	-0.005	0.246	-0.002	-0.018	0.985
Months between HbA1c measures	0.013	0.008	0.128	1.567	0.119
HbA1c_prior	-0.448	0.065	-0.495	-6.899	0

Table 3: Results of multiple regression analysis of change in HbA1c levels. Adjusted model R squared = .25

Discussion

This retrospective study evaluated the efficacy and potential for video-conferencing in the management of diabetes in Australia and other countries with large regions of rural and remote areas. To the best of our knowledge, this is the largest comparison of HbA1c measures managed by tele-diabetes versus routine outpatient consultations in Australia. Ultimately, we have shown that there is non-inferiority in the management of diabetes by telemedicine when compared to face-to-face consultations.

Although there was a marginally greater decrease in the HbA1c following clinicians' reviews for the telemedicine group compared to the face-to-face group (-.725% vs -.711%), this was not statistically significant. However, these results do suggest there is a non-inferiority in the management of diabetes by telemedicine when compared to face-to-face consultations. This has noteworthy implications for the application of tele-diabetes in Australia if there is a cost-effective scheme in operation simultaneously. Preliminary cost-effective research has suggested feasibility and potential for telemedicine's application in Australia, with the main driver of net savings coming from avoidance of travel costs for patients, their escorts and for specialists [4]. Ideally, the net savings would be redirected back into the health care system to further improve rural infrastructure and potential [4].

Notably, the telemedicine group's mean age was significantly higher than the face-to-face group's mean age. This may have favoured the telemedicine cohort's success as it has been shown that telemedicine is more effective in patients over the age of 40. Moreover, there was a significantly lower length of time between the initial and most recent HbA1c measurements for the telemedicine group. Subsequently, they were managed for less time (average 5.91 months) and had less consultations than their face-to-face counterparts. The fact that we have compared changes in HbA1c between face-to-face patient consultations seen over a long period of time (2011-2016) to the Telehealth group seen over a short period of time (2014-2016) presents a confounder. One potential reason for this occurrence could well be external (private) pathology laboratories for blood tests used by general practitioners for interim measurements of HbA1c, to suit convenience for patients, as opposed to our public hospital laboratory. However, it has been demonstrated that telemedicine programs lasting six months or less have a greater reduction in HbA1c levels than programs longer than six months [11]. Ultimately, it is well-known that short-term therapies for chronic disease management harbor a higher compliance rate in comparison to longer-term plans [18]. Therefore, it is important for medical practitioners to be aware that compliance and, thus, the likelihood of longer term diabetic management plans succeeding may decrease over time.

Surprisingly, there was a strong correlation between low HbA1c levels on initial presentation and a greater change in their final HbA1c measurements. This suggests patients with lower HbA1c measurements are at a lower stage of disease progression and, therefore, able to modify their HbA1c levels greater than patients with uncontrollable diabetes.

The greatest limitations of this study were the type of diabetics in each group and the length at which each group was managed. As the majority of face-to-face patients were type 1 diabetics presenting with insulin pump treatments (52% of subjects in the face-to-face group compared to 22.6 % in the Telemedicine group), it is difficult to make a direct comparison to the telemedicine group. Further research should minimize such confounding factors.

Most other research into tele-diabetes has primarily used telephone consultations by their means of telecommunication [9]. Whilst patient satisfaction was not measured in this study, it has been suggested that video-conferencing provides better patient satisfaction and health outcomes over telephone conferences [9]. Also, videoconferencing has already been utilised for various disciplines, so there should be less hesitation towards adopting this method [19]. There are a number of prospective Australian telemedicine trials being undertaken that are awaiting results [20-23], and will presumably investigate and explain such disparities in health outcomes via different means of telecommunication.

Nonetheless, telemedicine represents a viable option for providing effective and cost-effective management of chronic diseases, particularly in countries with larger rural and remote communities. Barriers to the progression of telemedicine include: confidentiality concerns, inadequate funding, workforce shortages, time spent by receptionists in arranging Telehealth appointments, and anxiety about change [6]. Further research to support the profound potential of telemedicine must be paralleled by adequate training and encouragement of health professionals in using such models in chronic disease management [24].

Conclusion

Tele-diabetes represents a viable option in improving diabetes care in patients dwelling in remote regions of Australia. To our knowledge, this is the largest comparison of HbA1c measures between patients seen via video-conferencing and patients seen at routine out-patient clinics in Australia.

List of Abbreviations

HbA1c – glycated haemoglobin

Declarations

Ethics Approval: This study has received ethics approval from the Gold Coast Hospital Ethics Committee in 2015 and there are no competing interests. Additionally, there were no sources of funding for this project.

Consent for Publication: Not applicable.

Availability of Data and Materials: The datasets generated

during and/or analysed during the current study are available in the Queensland Health Electronic Medical Records (EMR) or within the pathologies Sullivan Nicolaides Pathology or Queensland Medical Pathology. Any data requested from the corresponding author will be made available on reasonable request.

Author's Contributions: All authors and co-authors have contributed towards development of this manuscript.

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