

Glycaemic Control among Rural Health Consumers: A Retrospective Study of a Diabetes Center

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Abstract Aim: The aim of this paper is to highlight the successes of and challenges faced by a publically funded diabetes center in a regional area. Methods: Demographic and laboratory cross sectional data were collected from electronic patient records. Data from a patient's very first test undertaken when attending the hospital and the latest test undertaken at the Diabetes center were noted and included age, sex, residential postcode and glycated haemoglobin (HbA1c) levels. Results: A third of patients reached the therapeutic guideline of 'very good control' for HbA1c levels. Females had lower HbA1c levels, while males and those that lived further away from the diabetes center had higher levels of HbA1c. However, a significant improvement in glycaemic control among men and those who lived 'out of town' was noted, while the corresponding pattern for women was not evident. Conclusion: The study demonstrated that there was an overall improvement in diabetes control among health consumers who attend the regional diabetes center, however, female patients residing in town showed a negligible change over time. At risk' patient groups may need further targeting for intensive intervention to achieve optimal diabetes control, even within the diabetes center.

Keywords Regional Hospital, HbA1c, Diabetes Control, Diversified Care, Diabetes Mellitus Type 2, Diabetes Mellitus Type 1

1. Introduction

Diabetes mellitus is a common and an insidious disease that if untreated has a systemic impact on overall health and can lead to the development of other conditions such as heart disease, stroke, kidney disease, diabetes neuropathy and retinopathy [1-3]. Within the Australian population, 1.09 million (5.1%) adults live with diagnosed Type 2 diabetes, though there are another estimated 712,000 (3.3%)

undiagnosed cases [4, 5]. In the Hume region of Northeast Victoria, between 3.2% and 8.9% of people live with diabetes, [6] compared to the Victorian state average of 4.4% [5]. The rate of undiagnosed diabetes in the same region has been shown to be as high as 26.3% [6]. Diabetes complications are the top cause of preventable hospital admissions for the region [7-9].

Early diagnosis of diabetes remains essential to reduce the long term impact of the condition and risk of diabetes complications [1]. Within Australia, it is recommended that screening be undertaken by people at risk of diabetes every three years from the age of 40 and that once a diagnosis is confirmed a number of routine tests are to be conducted. These include eye and feet examination, body mass index, blood pressure, lipids, microalbuminuria, and hemoglobin A1c (HbA1c) [10-12]. Glycaemic control is essential in reducing the risk of diabetes complications, and HbA1c is routinely use as a surrogate indicator of this [13, 14]. Although patients typically have a good understanding of diabetes, more than half of the patients in a Victorian study were not meeting clinical targets of HbA1c, and this was similar between urban and rural communities [11].

Typically, patient care among those with diabetes is provided by GPs, with more than half of those with diabetes also seeing diabetes nurse educator, ophthalmologist or optometrist [15]. The involvement of a number of key services such as GPs, diabetes educators, and allied health professionals can assist, particularly within an integrated diabetes outpatient setting where services are combined to meet the overall needs of patients [11]. In a rural or regional setting, access to all of these services may not be possible, and solutions may be found to meet the needs of the local population. Diabetes centers in regional and rural areas often have fewer resources in terms of diabetes educators, access to endocrinology specialists, podiatrists and dieticians than centers in metropolitan areas. This may have an effect on the adequacy of treatment of individuals with diabetes and is an important consideration when managing people with

diabetes outside of metropolitan centers.

The Goulburn Valley Health Diabetes Center was developed to meet the needs of the local community, whilst circumventing difficulties maintaining endocrinologist oversight. The aim of this paper is to highlight how patients in this publically funded diabetes center in a regional center are monitored and managed, using Hb1Ac as a measure of glycaemic control. The results from the overall project are to evaluate the diabetes center's ability to meet the needs of regional patients in the Goulburn Valley of Victoria.

2. Methods

All patients, both with Type 1 and Type 2 Diabetes mellitus ages 18 years and older, who attended the Diabetes Center at Goulburn Valley Health (a regional hospital in Northeast Victoria) during a 2.5 year period were included in the study. Data were collected retrospectively from patient records. Patients were referred to the center from medical clinics or from general practices. While attending the clinic patients were seen by a variety of service providers at various times, which included nurse practitioners, diabetes educators, dietitian, podiatrist and a visiting endocrinologist.

Demographic and laboratory data were collected from medical notes and electronic patient records retrospectively for up to 3.5 years in a number of cases. Data were collected from a patient's very first test that was undertaken when attending the hospital, either as an outpatient or inpatient, and the latest test undertaken at the Diabetes center. Data included age, sex, residential postcode and HbA1c levels. HbA1c is defined as the average glycaemia that accumulates in the red cell during its circulation in the body over a 6–8 week period where the rate of glycosylation is dependent on blood glucose level of an individual [16]. Suggested guidelines for control of diabetes using HbA1c [17] are given in Table 1.

Table 1. Guidelines for HbA1c control

HbA1c level (mmol/mol Hb)	Guidelines
45-53	Very good control
54-64	Adequate control
65-75	Suboptimal control
>75	Poor control

Due to a number of differences between men and women in the HbA1c response in diabetes [14], adjustments for age and sex were made within SPSS version 22.0 as part of the statistical analyses. Parameters between groups were determined by undertaking independent t-tests, paired t-test, one-way and two-way between groups Analysis of Variance (ANOVA) using a general linear model (GLM) procedure. Results are shown as means, confidence interval (CI 95%), range or standard deviation (SD). Significance was determined by two-tailed $p \leq 0.05$. Ethical approval for the research was granted December 2014 (GVH 30/14).

Thirty-three individuals were excluded from the sample as 20 were under the age of 18 years; 11 were from metropolitan areas; one was an interstate patient not living permanently within the catchment area; and one was an individual visiting from overseas. In addition, postcode was used to determine proximity to diabetes center. Those postcodes within (3629-3631) and outside (<3629 and >3631) the regional center were those that were considered to be 'in-town' and 'out-of-town' patients respectively. All postcodes in the study region fell within the same Australian Standard Geographical Classification – Remoteness Areas (ASGC-RA) and this measure of rurality could therefore not be used to differentiate localities [18].

3. Results

Between June 2012 and December 2014, 1167 patients attended the diabetes center. Within this cohort the mean age of patients was 51 years and 7 months. Less males (533 or 45.7%) than females attended the center. Males were significantly older (56 years and 7 months) than females (47 years and 5 months) $F(1, 1167) = 29.32, p = 0.001$. A greater number of patients resided 'in town' (685 or 58.7%) than 'out of town' (482 or 41.3%). 38 patients (3.3%) from the adjacent state attended the diabetes center for care, which is due to the location of the center being less than 100km from the state border.

The mean duration between first and last HbA1c test among patients was 2.03 years (95% CI 1.96-2.11) with no significant difference between this time period between males and females. At initial presentation, only 30.4% of patients (55.1% female, 65.0% town residents and 44.8% aged 60 years and over) were meeting the recommended targets for very good control of HbA1c ≤ 53 mmol/mol [17]. At the most recent visit, this proportion had improved to 33.4% of patients meeting this target (50.2% females 61.4% town residents and 43.3% aged 60 years and over). Overall, the mean HbA1c at initial presentation, was considered 'suboptimal control' at 65.6 (95% CI 64.1-67.1), and these levels were shown to be significantly improved at the most recent visit, where the mean HbA1c fell within the limits of 'adequate control' at 63.7 (95% CI 62.3-65.1), $p = 0.001$, as shown in Table 2

Table 2. Mean HbA1c levels at presentation and most recent visit

	n	At presentation	Most recent visit	p
Mean HbA1c (mmol/mol Hb)	777	65.6 (26.0-164.0)	63.7 (26.0-220.0)	.001

In addition, there was a significant difference between male and female HbA1c, where female patients had significantly lower HbA1c levels than males at presentation and at the last Hb1Ac test as indicated in Table 3.

Table 3. Mean HbA1c levels between sexes at presentation and most recent visit

	Sex	n	Mean HbA1c (mmol/mol Hb)	P
At presentation	Males	417	67.3 (95% CI 65.2-69.4)	.002
	Females	353	62.7 (95% CI 60.4-64.9)	
Most recent visit	Males	421	64.6 (95% CI 66.1-70.0)	.044
	Females	355	61.7 (95% CI 59.5-63.9)	

Despite males having higher HbA1c levels than females, the HbA1c levels among men were significantly reduced between their initial test, 67.3 (95% CI 65.2-69.4), and their most recent test, 64.6 (95% CI 66.1-70.0), $p=0.001$. Whereas females showed no significant change in mean HbA1c levels between the first and most recent tests.

A significant difference between town and out-of-town patient HbA1c levels were also indicated, where town patients had significantly lower HbA1c levels 64.1 (95% CI 65.9-69.8) than out-of-town patients 67.7 (95% CI 62.2-66.1) at presentation $p=0.021$. Despite this, the difference between town and out-of-town patients with their most recent HbA1c test showed no significant difference between levels. Regardless of the differences of HbA1c levels between town and out-of-town patients, both patient groups significantly reduced their mean HbA1c levels overall, between initial and most recent test, as shown in Table 4.

Table 4. Comparison of town and out-of-town HbA1c levels at presentation and most recent visit

Area of residence	n	At presentation	Most recent visit	P
Town patients	451	64.1 (95% CI 62.2-66.1)	62.6 (95% CI 60.79-64.4)	.041
Out-of-town patients	319	67.7 (95% CI 65.4-69.9)	65.3 (95% CI 63.2-67.5)	.007

In addition to residence alone impacting glycaemic control levels, a two-way between-groups ANOVA showed that there was a significant difference between mean initial HbA1c test levels among the sexes $F(1, 767) = 11.04$, $p=0.001$ and areas of residence $F(1, 766) = 5.20$, $p=0.021$, however the effect size was small (partial eta squared = 0.014 and 0.007 respectively). Conversely, there was only significance difference among the sexes $F(1, 773) = 4.26$, $p=0.039$ in the most recent HbA1c test, also with a small effect size (partial eta squared = 0.005). HbA1c levels were shown to be vastly different between men and women residing in town or out-of-town. Women regardless of residence showed little change in HbA1c levels, while men were had a significant reduction in HbA1c levels both in town and out-of-town, however, when adjusted for sex and age this reduction in levels was not significant.

Lastly, a one-way ANOVA between age groups was conducted to explore if there was a difference between age groups and HbA1c levels that were tested initially and at most recent visit to the clinic. Using Welch's ANOVA, there was a significant difference among the seven age groups at the initial test, $F(6, 769) = 4.801$ $p=0.001$, where the mean

HbA1c levels within the 41-50 age group was higher than all other age groups (Mean = 70.4 SD \pm 22.7). It was also shown that there was a significant difference among age groups within the last mean HbA1c levels, $F(6, 775) = 3.039$ $p = 0.006$, where the 18-30 age group was higher than all other age groups (Mean = 68.7 SD \pm 27.8). However, this may be impacted by other variables within this age group, such as diabetes type. This data is summarised in Table 5.

Table 5. Comparison between age group and HbA1c levels at presentation and most recent

Age group	n	At presentation	n	Most recent visit
18-30	85	69.7 SD \pm 24.7	85	68.7 SD \pm 27.8
31-40	81	59.9 SD \pm 23.5	82	60.5 SD \pm 23.7
41-50	105	70.4 SD \pm 22.7	105	64.5 SD \pm 20.8
51-60	166	69.4 SD \pm 21.3	170	67.1 SD \pm 19.9
61-70	192	62.8 SD \pm 16.9	193	62.0 SD \pm 15.7
71-80	101	62.4 SD \pm 17.1	101	60.9 SD \pm 15.3
81+	40	61.6 SD \pm 16.5	40	59.2 SD \pm 15.9
Total	770	65.6 SD \pm 20.7	776	63.7 SD \pm 20.0

4. Discussion

Diabetes remains a pervasive condition that continues to impact the health and wellbeing of individuals and communities, while having a large impact on consumer and health budgets. Despite these challenges, improvements from suboptimal to adequate control have been shown to occur among patients who attend diabetes clinics and centers.

Within this retrospective study of examining HbA1c as one key parameter of diabetes control, it showed that the mean glycaemic levels were above the guideline for very good control of HbA1c \leq 53 mmol/mol at the initial visit to the diabetes center with only 30.4% of patients at presentation and 33.4% patient at their most recent visit meeting the recommended targets for very good control. It should be noted that adequate control of diabetes (54-64mmol/mol) may be the preferred target for many patients to avoid risks of hypoglycaemia which can occur in patients with very good control with a HbA1c \leq 53 mmol/mol. The improvement in overall control seen between first and last visit at the diabetes center is significant in that it demonstrates a reduction in the mean HbA1c level which brings it down from signifying suboptimal control to signifying adequate control of diabetes. This study has demonstrated that that there is an overall improvement among health consumers who attend the regional diabetes center.

Males had significantly higher levels of HbA1c than their female counterparts at both the initial and final glycaemic tests, yet had a significant improvement in their glycaemic control levels compared to the female patient cohort. This shows that although males may present with, and continue to

have, higher HbA1c levels, there is a higher level of control over time than in females. In addition, male patients that were considered out-of-town that would have greater distances to travel to the diabetes center were shown to have the higher HbA1c levels than males that resided in town. This cohort had a high level of glycaemic control, which differed from out-of-town female patients, however when adjusting for age and sex, was shown not to be significant. In addition, female patients who were residing in town showed a negligible change in HbA1c levels over time. Perhaps this reflects the fact that females in the study had an initial mean HbA1c which was already in the adequate control range and therefore there was no need to concentrate on lowering HbA1c in most females. An alternate interpretation is that the center may have a greater focus on males who attend the diabetes center, a finding which has previously been observed in Europe [19-23].

4.1. The Needs for Changes in Clinical Practice

The findings demonstrate that although the diabetes center provides an adequate service that has led to improved glycaemic control among its patient cohort, there may need to be a greater focus on working with and improving diabetes control among specific patients who attend the center [23]. These include those within the 18-30 year old age group when first attending the clinic; patients who live beyond town boundaries, particularly those at greater distance from the health service.

To achieve these outcomes, specific protocols and guidelines are required to be developed that flag these individuals to ensure that these groups receive an adequate or a greater emphasis to meet the current deficits. In addition, it may be necessary to address the challenges that these patient groups may encounter to achieve enhanced diabetes health outcomes, which may include behavioral or psychosocial characteristics, distance from the diabetes center, cost and ability to travel to the diabetes center, or the capacity to manage their condition adequately within daily routines [22, 23].

4.2. Limitations of the Study

The laboratory data that were collected from electronic patient records showed that only 65.9% of patients had both HbA1c test undertaken at both presentation to the diabetes center and at the most recent visit to the diabetes clinic. This may be due to a lack of testing; patients recently having their first visit to the diabetes center therefore only having one test, or an error. In addition, the data that were collected were limited. For example, ethnicity data was not collected therefore the effect of ethnicity on glycaemic control could not be assessed. In addition, it was shown that males had significantly higher levels of HbA1c than their female counterparts at both the initial and final HbA1c tests, even when adjustment for age and sex were made. It is documented that haemoglobin is inversely correlate with

HbA1c among females and it was anticipated that higher HbA1c levels would be observed[14]. However, it was shown that lower levels were detected and further blood assays would have provided further insight into this determining this contrasting difference within this specific population.

5. Conclusions

This study has provided important data regarding the outcomes of the Diabetes Center that provides services across the regional area of Northeast Victoria. It has highlighted that patients who attend the service have shown overall improvements in their glycaemic control, while outlining areas where improvements can be made to have a greater impact on health consumers of the service. This study underlines the need for a diversified care that supports both men and women that is centered on clinical, sociodemographic, psychosocial needs and characteristics of the health consumers [23]. It emphasises the need for the establishment or further development of diabetes center protocols and guidelines to meet the needs of those patients that attend the clinic who live beyond town boundaries, and those patients in specific age groups with poor diabetes control. During the time of data collection, this regional diabetes center had a visiting specialist endocrinologist, but not employed at the hospital, however common to other regional centers, sufficient access to dietitians and diabetes educators was at times limited. The findings from this study may be of value for future planning and management in other regional areas that service both regional town and more rural populations.

Acknowledgements

This research was funded by the Australian Government Department of Health. Researchers would like to thank all those who generously gave their time including Goulburn Valley Health for their contribution.

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