Glycaemic control in Otago children with type 1 diabetes

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Final year medical students at the University of Otago undertake a research project, as part of their medical education, in the Department of Preventive and Social Medicine, to extend their knowledge of research methods and develop strategies for avoiding or ameliorating problems in the delivery of health care.

Abstract

Introduction: Type 1 Diabetes mellitus (T1DM) is one of the most common chronic childhood diseases. Regular glycaemic control audits are important for the Otago region to evaluate its management of this population. This audit aimed to describe the change in glycaemic control using HbA1c, by year from 2009 to 2011, and May 2016 to April 2017, in Otago children (aged <18years) with T1DM; and to compare these children to national HbA1c targets.

Methods: Recorded HbA1c data were retrospectively collected from the Southern District Health Board (SDHB) diabetes database on 131 patients, 0 - 18 years inclusive, with T1DM, for periods 2009, 2010, 2011 and 2016/ 2017. This data was analysed using Microsoft excel version 2016 and R v3.4.0 software.

Results: Mean all-age HbA1c values were lower in 2016/2017 when compared to 2009-2011 (71 mmol/mol and 77 mmol/mol, respectively). Average HbA1c value in the 0-12 age group remained constant while the 13-18 age group decreased (84 in 2009 to 73 in 2016/2017). The percentage of children achieving guideline HbA1c targets were 11% in 2011 and 30% in 2016.

Conclusion: Mean HbA1c values of children with T1DM in Otago in the 2016/2017 group were lower than National Diabetes Audit Mean HbA1c values. The average HbA1c (73 mmol/mol) is still above the recommended target value of 58 mmol/mol. There were more children meeting the target value in 2016/2017 compared with 2009-2011.

Ethics consultation:

Ethics approval was not required for this project, however the University of Otago Human Ethics Committee (Health) were consulted for use of health-related audit data. The Ngāi Tahu Research Committee were consulted during this process to ensure effective audit data research in accordance with benefiting Māori development.

Background

Type 1 diabetes is one of most common chronic diseases of childhood. Internationally the incidence of type 1 diabetes has been increasing.[1] Local research suggests that similar trends have been occurring in New Zealand. In a 2012 Auckland review of type 1 diabetes in children aged 0-14 years, the incidence increased from 10.9 per 100,000 in 1990, to 22.5 per 100,000 in 2009. The greatest increase in incidence occurred among children aged 10–14 years.[2] A similar review was done in Canterbury of type 1 diabetes in young people aged 15–24 years. The researchers found an increased prevalence of about 45 per 100,000 (12%) between 2003 and 2010.[3] A cross-sectional survey of 4,721 New Zealanders aged 15 years and above found a diabetes prevalence of 7.0%. They were unable to distinguish between type 1 or type 2 diabetes in their study. It was more frequent in men (8.3%) than women (5.8%). Pacific Islanders (15.4%) and Māori (9.8%) had a higher prevalence than NZ European and Other groups (6.1%).[4]

Diabetes is an illness of special interest for the Ministry of Health and the Southern DHB. The national priority of the National Diabetes Work Programme is on delivering and enhancing care and quality of life for people with diabetes.[5] This includes prevention, identification and management of the increasing burden of this disease. Maintaining glycaemic control is important as healthy control is associated with a lower risk of long term complications of diabetes as demonstrated by long-term follow-up studies.[6, 7]

Glycaemic control can be estimated by measuring the glycated haemoglobin A1c (HbA1c) level indicating the level of glucose in the blood over the previous 12-week period.[7] The International Society of Paediatric and Adolescent Diabetes (ISPAD) recommends a HbA1c target of <58 mmol/mol (7.5%) for those children who have T1DM, which is reflected in the *New Zealand Starship* guidelines.[8, 9] As adolescents progress into adulthood, this level is reduced slightly to the adults' target HbA1c of 53 mmol/mol (7.0%).[10] It has been reported that children and adolescents often fail to meet glycaemic targets. Analysis of international paediatric diabetes registers show that 54-58% of paediatric patients fail to achieve the international target haemoglobin for young people (58 mmol/mol).[9] This is particularly noticeable as children enter the pubescent period with a number of studies showing poorer glycaemic control in the adolescent population.[11] A 2006 New Zealand national audit of diabetes in young people aged 0 - 26 years suggested inadequate glycaemic control with a group mean HbA1c of 76 mmol/mol (9.1 +/- 0.3%).[12]

Over the past 10 years considerable changes have occurred in New Zealand and Otago regarding access to diabetes technologies (insulin infusion pumps), insulin therapies, and target orientated goal setting. Insulin pump therapy has gained popularity since its advent. In New Zealand, insulin pumps became eligible for public funding in September 2012. Between 2012 and 2014, funded pump use among patients with type 1 diabetes (n = 13,727) increased from 1.8 to 9.3 % overall.[13] This change follows a similar pattern worldwide as insulin pumps may offer a number of advantages. Continuous infusions have been shown to achieve HbA1c targets, lower insulin requirements and decrease treatment induced hypoglycaemic crises and/or ketoacidosis hospital admissions, ultimately improving patient quality of life.[14]

It is unclear how well these apparent clinical benefits seen in randomised clinical trials translate into clinical practice in New Zealand. Quality of control of T1DM may be affected by many variables such as patient selection and motivation, and the insulin pump experience of the medical

team. Bock et al.'s retrospective analysis compared glycaemic control of paediatric T1DM patients in Auckland using insulin pump therapy or non-pump therapy, it was affirmed that there were significant improvements in HbA1c and episodes of hypoglycaemia for insulin pump users in accordance with international data.[15]

The objectives of project were to describe the change in HbA1c, by year, for periods 2009, 2010, 2011, and May 2016 to April 2017, in Otago children (aged <18years) with T1DM; and to compare these children to the national and international T1DM HbA1c targets.

Methods

Recorded HbA1c levels were extracted by the SDHB from three databases based on the following criteria: patients seen in paediatric diabetes clinic from 2009-2016 and aged <18 years of age at time seen in clinic. The three databases that were interrogated included the SDHB database of paediatric patients, and two laboratory databases of HbA1C results, covering 1998-2011 and May 2016-April 2017 respectively. The databases were linked, matching paediatric patients to their HbA1c values, giving matched cross-over data for 2009, 2010 and 2011. HbA1c data were not available for 2016 in its entirety, so data in the 12-month period from 1 May 2016 to 30 April 2017 were used instead. Linking the databases resulted in 2291 HbA1c records.

Mean HbA1c per year per patient was calculated, resulting in 331 measurements. 51 measurements were excluded based on the following criteria: non-type-1 diabetes or a date of diagnosis less than three months prior to the latest available HbA1c measurement. After exclusion, 280 measurements per patient per year remained. There was 85-90% overlap in patients between the 2009, 2010, 2011, and 2016/17 year groups enabling HbA1c trend evaluation. Data was stratified by age into two groups (0-12, 13-18), to reflect changes in glycaemic control between children and adolescents. Mean and median HbA1c were calculated for each year group. The proportion of all patients meeting international HbA1c targets was calculated.

Results

As seen in Table 1 Mean all-age HbA1C values were 77, 77, 77 and 71 mmol/mol in 2009, 2010, 2011 and 2016/2017 respectively. In the 0 to 12 age group, mean HbA1c values were 71, 70, 70 and 69 mmol/mol in 2009, 2010, 2011 and 2016/2017 respectively. In the 13 to 18 age group, mean HbA1C values were 84, 85, 84 and 73 mmol/mol in 2009, 2010, 2011 and 2016/2017 respectively.

As seen in Table 2, the proportion of children meeting the HbA1c target of 58 mmol/mol was 7%, 6%, 11% and 30% in 2009, 2010, 2011 and 2016/2017 respectively.

Summary

Otago HbA1c values for paediatric patients with Type 1 Diabetes are lower when compared with the 2006 Diabetes Audit.[12] However, the average HbA1c for each year was above the 58 mmol/mol recommended target for diabetic control in young people. There is a lower mean HbA1c value in the 2016/2017 year compared with the HbA1c values in the 2009-2011 year groups. This change came primarily from the 13-18 year group while the 0-12 age group remained consistent. It is not clear what proportion of the 0-12 year group 2009-11 moved on to the 13-18 aged by 2016/17 in the sample. The percentage of children who met the target HbA1c value increased in the 2016/2017 year compared with the 2009-2011 years. This result is consistent among both age groups measured.

Discussion

Based on these findings it would appear that overall glycaemic control has improved slightly in the 2016/17 year compared to 2009-2011, with more individual means trending closer to the national and international HbA1c target of 58 mmol/mol. This trend is primarily seen in the 13-18 year group, while the 0-12 age group remained fairly consistent over the 2009-2011 periods. It is unclear if continuous insulin infusion pumps are a possibly, explanation in an age group where one would expect poorer glycaemic control, as children in the pubescent period start assuming autonomy over their glycaemic control, typically showing elevated HbA1c measurements with the multiple insulin injection regime. However, there are many limitations to our dataset which make this difficult to confidently assert. If we accept that our results accurately represent an improvement in glycaemic control, this could possibly be due to the funding and subsequent uptake of insulin pumps for type 1 diabetics which occurred in 2012.

Despite the National 2006 audit not containing any data for the Southern DHB, it is reassuring that our results for Otago children with type 1 diabetes are roughly concordant with those found for other regions.[12] This lower mean HbA1c in 2016/17 may indicate diabetic control improving over the last 10 years for children and adolescents in the Otago region. However due to the significant limitations of our data as described above, it is difficult to make any meaningful conclusions about diabetes control in this population.

For this study, we had initially intended to investigate the trend in HbA1c over the past 8 years. However, we encountered many challenges in acquiring the appropriate data in the limited time available for this project. Due to time restraints, our final data set was lacking HbA1c data for the years of 2012-2015, which limited us to describing the average HbA1c levels by year and age group. We had initially planned to perform a more in-depth analysis of diabetes control, investigating the effect of insulin delivery method, ethnicity and BMI on HbA1c levels as a marker of diabetes control. However, the datasets lacked the information required to perform these analyses.

In our analysis, we used both mean HbA1c for each unique patient per year, as well as using only their last HbA1c measurement each calendar

Table 1. Mean cohort HbA1c (mmol/mol) measurements per year. Key: x (mean); M (median); n (number).

	2009			2010			2011			2016-2017		
Age	x	M	n	x	M	n	x	M	n	x	M	n
0 to 12	71	73	34	70	69	41	70	72	37	69	64	23
13 to 18	84	78	35	85	83	38	84	83	39	73	71	33
All ages	77	75	69	77	75	79	77	75	76	71	68	56

Table 2. Proportion of children meeting international HbA1c target by year

	2009			2010			2011			2016-2017		
	%	No. meeting target	Total No.	%	No. meeting target	Total No.	%	No. meeting target	Total No.	%	No. meeting target	Total No.
0 to 12	12	4	34	12	5	41	14	5	37	35	8	23
13 to 18	3	1	35	0	0	38	8	3	39	27	9	33
All ages	7	5	69	6	5	79	11	8	76	30	17	56

year. This was to assess whether using a mean value would bias the results towards higher values. Conversely, using only their latest measurement would theoretically provide an overall lower HbA1c level as ideally, the longer a patient is under the care of a diabetes team, the better their diabetes control becomes, as represented by a lower HbA1c. However, in our analysis we found that overall, using the mean HbA1c value resulted in either no difference, or at most a 1 mmol/mol higher mean HbA1c in each year compared to using only the latest measurement.

Using a single value for HbA1c per patient, rather than including multiple measurements from each patient, avoided overrepresentation in the data of patients who had poorly controlled diabetes and therefore who may have had more frequent monitoring. We excluded those patients diagnosed in less than 3 months prior to their latest HbA1c measurement, as we acknowledge that HbA1c values from these would reflect blood glucose levels from prior to starting treatment. The dataset was combined for 2016/2017 to obtain an adequate sample size for comparison with 2009, 2010 and 2011 datasets. We noted the lower patient numbers (n=56 in 2016/2017) are possibly due to patients lost to follow-up whether having moved out the region for work or study, or having transitioned to the adult diabetes services. This group also displayed greater variance compared to previous years. Although this is unlikely to affect the mean (Table 2), this may have resulted in more patients falling below the HbA1c target value by chance. This limitation to the data must be considered prior to asserting conclusions regarding glycaemic control.

Further research could be undertaken in this area for the purpose of improving glycaemic control in the Otago paediatric diabetes population. With a more comprehensive data set, it would be possible to compare insulin regimen and patient characteristics with trends in HbA1c, which could help inform clinician management choices. An audit of progress in glycaemic control, as measured by HbA1c, in terms of age and insulin regimen would be of great interest and help with future goal setting and monitoring of paediatric teams' progress over the region, especially given that public funding of insulin pumps began in 2012 in New Zealand. This information may assist in negotiations for accessing additional resources in the Otago region.

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Conflicts of Interest: None

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Supplementary figures

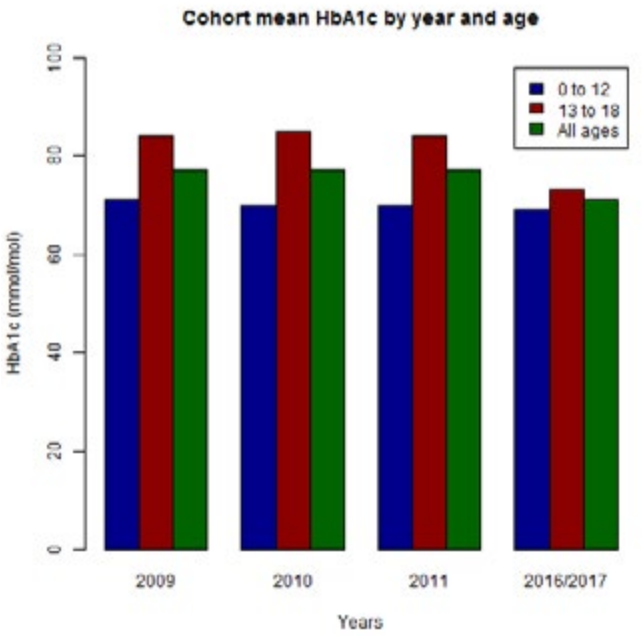

Figure 1. Graphic representation of mean cohort HbA1c measurements by year and age.

A lower mean HbA1c value in 2016/2017 compared to the 2009-2011 year groups. This is noticeable in the 13-18 year while the 0-12 age group showed similar trends over the study periods.

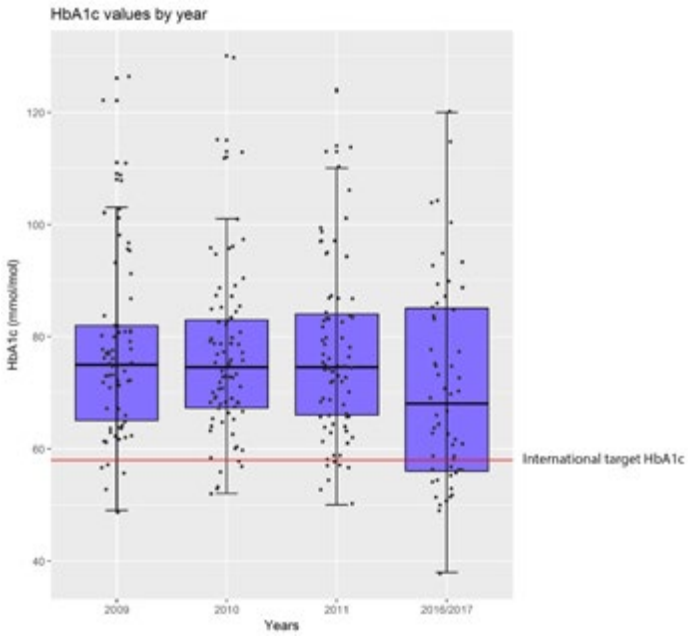

Figure 2. Bar-and whisker mean HbA1c measurements in all ages by year compared to guideline targets.

The average HbA1c values for each year in Otago T1DM paediatric patients were above the recommended target (58 mmol/mol). The percentage of children who met the target increased to 30% for all ages in the 2016/2017 year compared with the range of 6-11% for the 2009-2011 years.

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