Original Article

Glycaemic control in children with type 1 diabetes mellitus in Malta (2013 - 2014)

Nancy Formosa, John Torpiano

Abstract

Background: Suboptimal glycaemic control, measured by glycosylated haemoglobin (HbA_{1c}), increases the risk for long-term complications in Type 1 diabetes mellitus (T1DM).

Aims and objectives:

- To calculate and compare glycaemic control in children with T1DM in Malta during the period 2013 to 2014.
- To identify any need for changing way services are structured and delivered.

Methods: An estimated 96% of all children with T1DM less than 16 years of age in Malta are cared for by the same paediatric diabetes team, based at the main state hospital. The average HbA_{1c} of all measurements taken every 3 months by HbA_{1c} analyser was calculated for each patient and these results were validated by annual laboratory measurement of HbA_{1c} from venous samples.

Results: Overall, 43.8% of participants in 2013 and 49.6% of participants in 2014 achieved an HbA_{1c} target of < 7.5%. The mean HbA_{1c} in 2013 was 7.69±0.16% and in 2014 7.67±0.17%. A higher proportion of patients in the younger age-group achieved an HbA_{1c} target of <7.5%. The patients most likely to have a higher HbA_{1c} were in the older age-groups.

Conclusion: Glycaemic control achieved in Malta in children aged < 16 years with T1DM was stable over the two years analysed. Our data is comparable, or slightly better, to that achieved in other European countries. However, there is always room for improvement, as Swedish data have shown. Multidisciplinary team meetings could be one way to address those patients not achieving adequate control.

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Keywords

Audit, Type 1, diabetes mellitus, paediatric, HbA_{1c}, Malta

Abbreviations

Type 1 Diabetes: T1DM

Introduction

Suboptimal glycaemic control in persons with Type 1 Diabetes Mellitus (T1DM) increases the risk for long-term complications.[1-3] The HbA_{1c} is the best indicator of long-term diabetes control. Every 1.0% point decrease in HbA_{1c} can reduce the risk of microvascular complications by 40%.[1] Intensive glycaemic control has been unequivocally proven to substantially lower the incidence of diabetes-related complications and extend life-expectancy.[4] International treatment guidelines recommend glycaemic targets to preserve health and reduce the risk of complications[5-6] however, many young people with T1DM fail to achieve these targets.[7-10] This audit, comparing glycaemic control in individuals less than 16 years of age with T1DM in 2013 and 2014, is the first report of its kind in Malta. It is the first step to compile annual data about T1DM in children in Malta, and provides a facility for monitoring and benchmarking of services and an opportunity to develop more effective treatment strategies.

Aim

- To examine current levels of glycaemic control in young people with Type 1 Diabetes in Malta

and compare our results with similar European data.

- To calculate the proportion of young people with Type 1 Diabetes in Malta who are attaining HbA_{1c} goals of < 7.5% (< 58mmol/mol) as recommended by the International Society for Paediatric and Adolescent Diabetes (ISPAD) and the American Diabetes Association.[5-6]
- To identify any need for changing the way services are structured and delivered with the ultimate aim of improving quality of care, glycaemic control and outcomes for children and adolescents with T1DM in Malta.

Methods

Study design and population

An estimated 96% of children with T1DM in Malta are seen by the paediatric diabetes team on a regular basis at the main state hospital. Demographic and clinical data of all patients newly diagnosed with T1DM are collected on a Microsoft Excel® spreadsheet and up-dated annually with new information such as average annual HbA_{1c} and Body Mass Index. In 2013, a point of care HbA_{1c} analyser (Siemens DCA Vantage®) was made available to the paediatric diabetes team, so that HbA_{1c} could be measured at each clinic visit, every 3 months. These results were validated by annual laboratory measurements of HbA_{1c} from venous samples.

The average HbA_{1c} ±95% CI of all the measurements taken in 2013 and 2014 was used in this study to assess overall glycaemic control. Multiple HbA_{1c} measurements have been used on each patient to give a more accurate assessment of diabetes control over the entire year of care, and to bring the analysis in line with other international reporting audits and registries, making benchmarking more representative. HbA_{1c} values using the Diabetes Control and Complications Trial (DCCT) aligned measures of percentage (%) were converted to the newer IFCC-standardised measures in mmol/mol using the formula: IFCC (mmol/mol) = (10.93 x DCCT (%)) - 23.50.

Results

Participants

In 2013, there were 137 children with diabetes mellitus <16 years of age registered with the paediatric diabetes team. Two children in the partial remission phase and thus having a low total daily insulin dose of <0.5 units/kg/day, three children with Wolfram Syndrome and four children with Type 2 diabetes were excluded from this study. The two children in the partial remission phase had an HbA_{1c} of 6.0% and 5.6% respectively and were excluded so that they would not bias the results. Thus, 128 children with T1DM were included in 2013 study.

In 2014, there were 135 children with diabetes mellitus <16 years of age registered with the paediatric diabetes team. Three children with Wolfram Syndrome and five children with Type 2 diabetes were excluded from analysis of the 2014 data. Thus, 127 children with T1DM were included in 2014 study.

Table 1 outlines the number of patients on our database in 2013 and 2014 respectively. The children were divided into 3 age-groups: 0-4.9 years, 5.0-11.9 years, 12-15.9 years. For the purpose of comparing results with other published studies the cohort of patients were also analysed in 3 other age groups 0-10.9 years and 11-15.9 years (Table 2), 0-12.9 years and 13-15.9 years (Table 3) and less than 6 years.

***Table 1**: Number of infants, children, and young people with T1DM by age band in 2013 and 2014*

	Age (years)							
	0-4.9		5-11.9		12-15.9		Total	
Year	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**
Male	1	3	43	40	29	31	73	73
Female	2	2	30	28	23	23	55	53
Total	3	5	73	68	52	54	128	127

***Table 2**: The mean HbA_{1c} ± 95% CI achieved in the whole cohort, in boys and girls, and in the 2 age groups 0-10.9 and 11-15.9 years*

Year	2013	2014
Mean HbA_{1c}(%) ± 95%CI	7.69±0.16	7.67±0.17
Boys	7.76±0.19	7.72±0.14
Girls	7.59±0.26	7.60±0.26
0-10.9 years	7.53 ±0.16	7.53±0.17
11-15.9 years	7.85±0.26	7.80±0.29

***Table 3**: The proportion of children with T1DM in Malta who achieved target HbA_{1c} <7.5% compared to international data*

Age group (years)	<13		13-15.9	
Year	2013	2014	2013	2014
Total number of Maltese T1DM patients	85	87	43	40
Proportion achieving HbA1c <7.5% in Malta	45%	51.7%	39.5%	45%
USA data (Wood et al 2013[10])	27%		23%	
Swedish data (Samualsson et al 2013[11])	60%		36%	
TEENs Study[12]	32%		29%	
TEENs Study[13] (European Data)	39.4%		36.5%	

Insulin regimen

Over the 2-year period, 68% of participants were on a basal bolus regimen using insulin glargine and mealtime bolus doses of short-acting insulin. 32% were on a twice-daily insulin regimen using isophane and soluble insulins. Insulin pump technology is not yet available in Malta. All patients check blood glucose levels at least 4 times daily with their own portable glucometer.

Glycaemic control

In 2013, the mean HbA_{1c} achieved in our cohort of patients was 7.69±0.16% (61±1.75 mmol/mol). The boys had a mean HbA_{1c} of 7.76±0.19% (61±2.07 mmol/mol) and the girls had a mean HbA_{1c} of 7.59±0.26% (59.4±2.84 mmol/mol). The mean HbA_{1c} in the 0-10.9 year age group in this period was 7.53±0.16% (59±1.75 mmol/mol) with a comparable mean HbA_{1c} in boys of 7.51±0.23% (58.6± 2.5 mmol/mol) and in girls of 7.55±0.28% (59±3.06 mmol/mol). The mean HbA_{1c} in the 11-16 year age group in 2013 was 7.85±0.26% (62.3±2.84 mmol/mol). The boys had a mean HbA_{1c} of 8.04±0.3% (64.4±3.28 mmol/mol) and the girls had a better mean HbA_{1c} of 7.63±0.44% (60± 4.81 mmol/mol).

In 2014, the mean HbA_{1c} achieved in our cohort of patients was 7.67±0.17% (60±1.75 mmol/mol). The boys had a mean HbA_{1c} of 7.72±0.14% (61±2.07 mmol/mol) and the girls had a mean HbA_{1c} of 7.60±0.26% (60±2.84 mmol/mol). The mean HbA_{1c} in the 0-10.9 year age group in this period was 7.53±0.17% (59±1.75 mmol/mol) with a comparable mean HbA_{1c} in boys of 7.54±0.18 % (59±2.5 mmol/mol) and in girls of 7.51±0.32% (58.5±3.06 mmol/mol). The mean HbA_{1c} in the 11-15.9 year age group in 2014 was 7.8±0.29% (61.7±2.84 mmol/mol). The boys had a mean HbA_{1c} of 7.9±0.39% (62.8±3.28 mmol/mol) and the girls had a better mean HbA_{1c} of 7.68±0.4% (60.4± 4.81 mmol/mol). Table 2 summarises the mean HbA_{1c} ± 95% CI achieved in the whole cohort, in boys and girls, and in the 2 age groups 0-10.9 and 11-15.9 years.

In 2013, 43.8% (95% CI 35-52%) of our patients achieved an HbA_{1c} of < 7.5% (< 58mmol/mol). 41% (95% CI 30-52%) of males and 47% (95% CI 34-60%) of females achieved

target HbA_{1c}. Another 25% (95% CI 15-35%) of males and 29% (95% CI 17-41%) of females achieved an HbA_{1c} of 7.5 - 8% (58-64mmol/mol). The percentage of patients with an HbA1c of > 9.5% (> 80mmol/mol) was 4.6% (95% CI 1-8%).

In 2014, 49.6% (95% CI 41-58%) of our patients achieved an HbA_{1c} of <7.5% (<58mmol/mol). 44.6% (95% CI 33-56%) of males and 56.6% (95% CI 43-70%) of females achieved target HbA_{1c}. 18.9% (95%CI 12-26%) of our patients achieved an HbA_{1c} of 7.5 - 8% (58-64mmol/mol). The percentage of patients with an HbA_{1c} of > 9.5% (> 80mmol/mol) was 3.9% (95% CI 0.6-7.3%). These results are summarised in Figure 1. Figure 2 and 3 show the distribution of HbA_{1c} according to age group. Table 3 and 4 compare Maltese data with international data.

Figure 1: *Distribution of HbA_{1c} levels according to year*

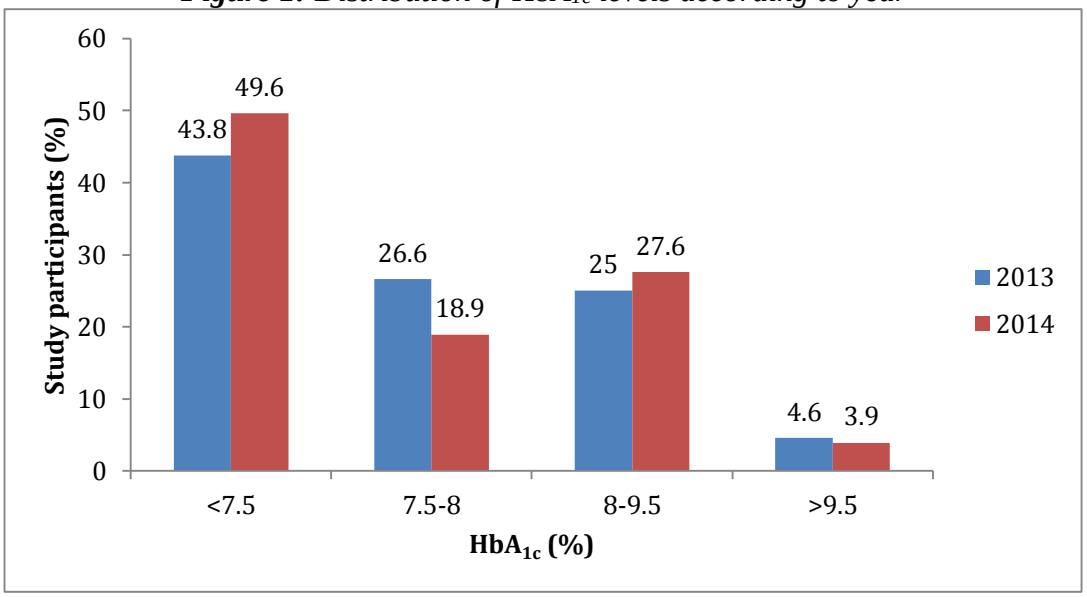


Figure 2: *Distribution of HbA_{1c} levels according to age group 2013*

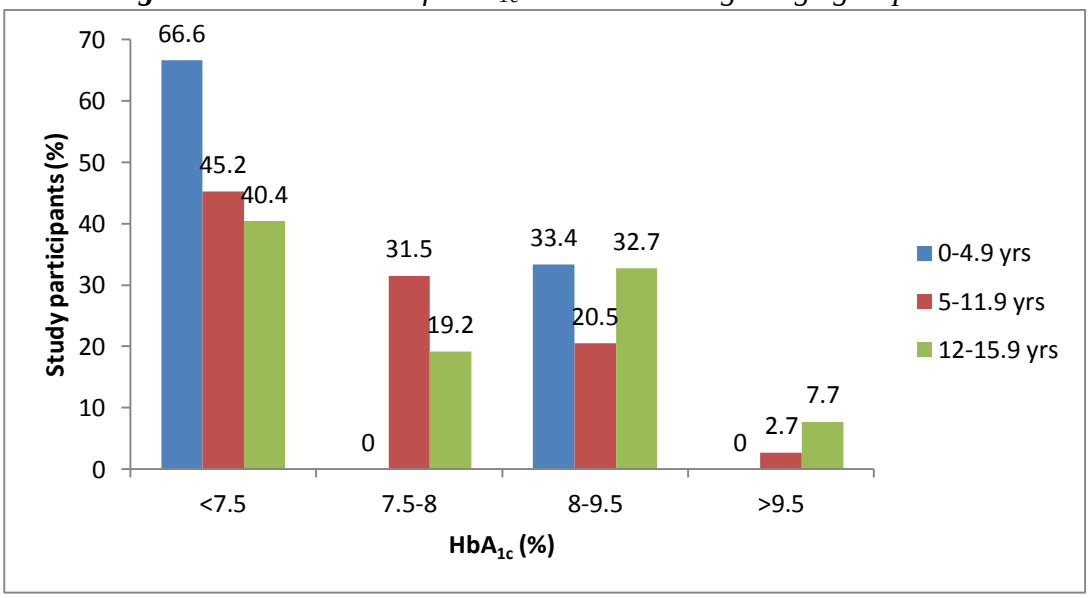
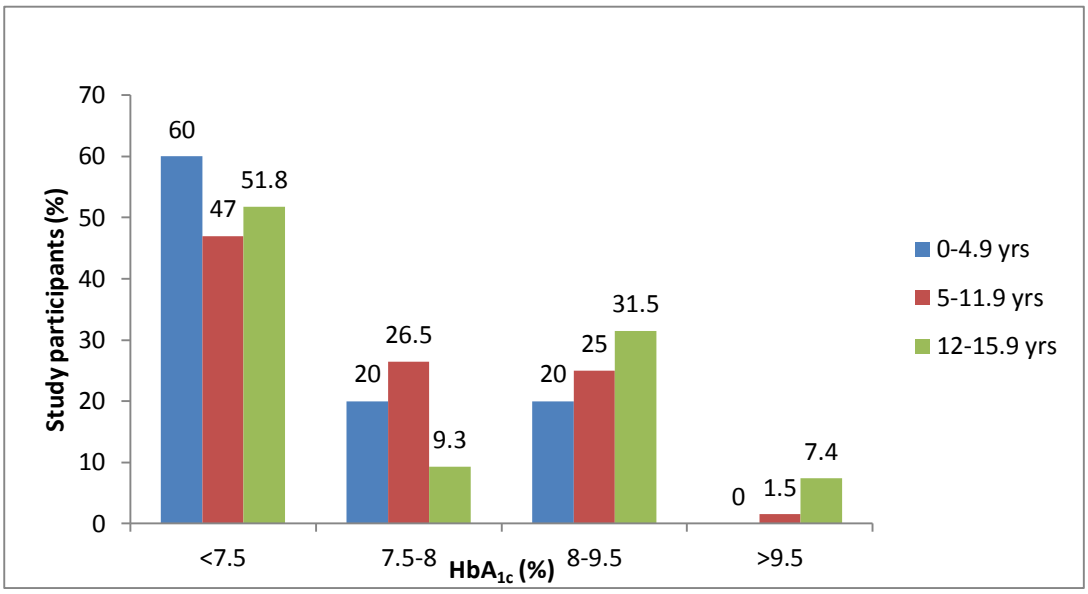


Figure 3: *Distribution of HbA_{1c} levels according to age group 2014*



Discussion

The National Paediatric Diabetes Audit Report carried out by the Royal College of Paediatrics and Child Health using data collected by diabetes units in England and Wales showed that the percentage of children and young people with T1DM achieving an HbA_{1c} of < 7.5% (< 58mmol/mol) was 15.8% in 2012-13 and 17.1% in 2013-14.[7-8] The percentage of children and young people with a very high HbA_{1c} (greater than 80 mmol/mol) putting them at high risk of developing diabetic complications has decreased from 25.8% in 2012/13 to 24.2% in 2013/14. There is significant variation in levels of HbA_{1c} across different units delivering care for infants and young people with diabetes in England and Wales with a mean HbA_{1c} ranging from 8.6 to 9% (70-75mmol/mol) in 2012-13 and from 8.5 to 8.9% (68.9-73.6mmol/mol) in 2013-14. The mean HbA1c for England and Wales was 8.8% (73mmol/mol) in 2012-13 and 8.7% (71.6mmol/mol) in 2013-14.[7-8] The mean HbA_{1c} achieved in our cohort of patients in 2013 was 7.69% (61mmol/mol) and in 2014 7.67% (60mmol/mol) (Table 4).

Table 4*: Maltese data compared to data from National Paediatric Diabetes audit report (England/Wales) 2012-2013[7] and 2013-2014[8]*

	Maltese data		**Data (England/Wales)**	
	2013	**2014**	**2012-2013**	**2013-2014**
Mean HbA_{1c} (%)	7.69	7.67	8.8	8.7
Proportion achieving HbA_{1c} <7.5%	43.8%	49.6%	15.8%	17.1%
Proportion achieving HbA_{1c} 7.5-9.5%	51.6%	46.5%	58.4%	58.7%
Proportion achieving HbA_{1c} >9.5%	4.6%	3.9%	25.8%	24.2%

Data from the German/Austrian Prospective Diabetes Follow-up Registry (DPV) showed that an HbA_{1c} of < 7.5% (< 58mmol/mol) can frequently be achieved in children with Type 1 diabetes who are less than 6 years of age.[9] 56% of children less than 6 years of age met the recommended HbA_{1c} goals of <7.5%. In our cohort of patients there were 16 children less than 6 years of age in 2013. 10 out of these 16 i.e. 63% (95% CI 39-86%) achieved an HbA_{1c} < 7.5% (< 58mmol/mol), 2 out of 16 had an HbA1c of 7.5-8% (58-64mmol/mol) and 4 out of 16 had an HbA1c of > 8% (> 64mmol/mol). In 2014, there were 7 children less than 6 years of age. 5 had an HbA_{1c} < 7.5%. The other 2 had an HbA_{1c} of

7.6% and 8.8% respectively.

In the United States, only 27% of children younger than 13, and 23% of those between 13 and 19 years of age, meet the recommended HbA_{1c} goals of < 7.5% (< 58mmol/mol).[10] On the other hand, in Sweden, 60% of those younger than 13 and 36% of individuals between 13 and 18 years had an HbA_{1c} < 7.5% in 2013.[11] In Malta, 39 out of 85 (i.e. 45%) and 45 out of 87 (i.e. 51.7%) children with T1DM <13 years of age achieved an HbA_{1c} < 7.5% (< 58mmol/mol) in 2013 and 2014 respectively. 17 out of 43 (i.e. 39.5%) and 18 out of 40 (i.e. 45%) of young people with T1DM 13-16 years of age achieved the target HbA_{1c} in 2013 and 2014 respectively (Table 3).

The TEENs study, funded by Sanofi, is one of the largest ever to assess T1DM management and the factors that affect it, including psychosocial parameters. The data comes from 5960 individuals aged 8 to 25 years seen at 219 diabetes centers in 20 countries in the developed and the developing world, including Europe, the United States, Latin America, the Middle East, North and South Africa, and India. Results of the TEENs Registry Study were presented at the American Diabetes Association (ADA) 2014 Scientific Sessions by Professor Lori Laffel.[12] Average HbA_{1c} levels were 8.3% for the 1724 children aged 8 to 12 years and 8.6% for the 2854 adolescents aged 13 to 18 years. The proportions reaching the recommended targets were 32% of the younger children and 29% of the teens. Overall, 72% were not meeting the targets. 18%, nearly 1 in every 5 patients, had HbA_{1c} levels of 10% (86mmol/mol) or higher.[12] The 2943 European youths from 11 centers involved in the TEENs study had a mean HbA_{1c} of 8.1±1.6% (65.0±17.5 mmol/mol).[13] The mean HbA_{1c} varied by age: 7.9±1.4% (62.8±15.3 mmol/mol) in the 8-12-year age group, 8.2±1.7% (66.1±18.6 mmol/mol) in the 13-18 year age group. One-third of participants achieved HbA_{1c} targets (39.4% in the 8-12-year age group, 36.5% in the 13-18 year age group).

Conclusions and recommendations

This audit report shows that glycaemic control achieved in Malta in infants, children and young people with T1DM was stable over the 2 years analysed. Our results are comparable, or better, to that achieved in other European countries and the United States of America. However, there is always room for improvement as the Swedish data[11] have shown, and we should continue to strive to increase the proportion of our patients achieving the recommended target HbA_{1c} < 7.5% (< 58mmol/mol). Recently, the National Institute of Clinical Excellence (NICE) has set even lower HbA1c targets of 6.5% (48mmol/mol) for young people with T1DM.[14]

The TEENs study has identified many modifiable factors which significantly predict HbA_{1c} target achievement.[12] These have been summarized in Table 5. Up to the middle of 2015, protocols by the Maltese Department of Health mandated that only isophane and soluble insulins could be funded for patients at the outset of T1DM diagnosis. Insulin analogues would only be funded after a minimum period of 6 months from initial diagnosis, and only if a number of strict clinical criteria were met. Since 2015, we have been allowed to start patients on insulin analogues from diagnosis. Over the last few years in our clinical practice, there has been a move towards intensification of insulin therapy including the use of multiple daily insulin regimens and the introduction of insulin dose adjustment for carbohydrate intake which, however, is still in its infancy in Malta as more input by dietitians is required.

All patients are advised to check capillary blood glucose at least 4 times every day, and the overwhelming majority of our patients comply with this advice. Since September 2014, the number of blood glucose strips provided free-of-charge, for individuals under 18 years of age with T1DM in Malta, was increased to 4 per day. This reduced the financial burden of this essential practice and also served as an incentive for regular monitoring of capillary blood glucose levels. All of our patients are taught how to adjust insulin doses according to capillary blood glucose results so that persistent dysglycaemia is avoided at most times. Patients are also advised to contact our diabetes team if they do not feel confident in making any necessary adjustments themselves. Clinic visits are frequent, every 2-3 months depending on need. The significance of HbA_{1c} results is explained to patients and treatment goals are clearly defined as target-setting has been shown to improve metabolic outcome.[15] Patients with unacceptably high HbA_{1c} levels are admitted to hospital for a short period to stabilise their blood glucose. During their in-patient

stay they meet with the diabetes multidisciplinary team to re-inforce diabetes education. A clinical guideline on how to treat patients with a high HbA_{1c} will be formulated and put into practice.

***Table 5**: Factors significantly predicting HbA_{1c} target achieved from TEENs study*[12]

Demographic factors	***p*<0.001**
Absence of financial burden related to T1DM management	
Shorter T1DM duration	
Age <12 years	
Treatment factors	***p*≤0.005**
Pump therapy	
Blood glucose monitoring >3 times daily	
CHO counting	
Exercise >30 minutes/week	
No history of DKA in the past 3 months	
Family factors	***p*<0.019**
Parental involvement in T1DM care	
Absence of diabetes specific family conflict	
Living with 2 parents in the home	

In the coming year, we would wish to start organising multidisciplinary team (MDT) meetings to discuss patients who are not achieving the recommended treatment goals on an individual basis. The aim of these meetings is to come up with an individual care plan to help such patients improve glycaemic control: changing the insulin regimen, reinforcing structured diabetes education, offering support to the family/patient to help them in self-management tasks, telephone contact in between clinic visits, psychological help, identifying psychosocial dysfunction within families and enrolling the help of psychologist/social worker to work through the issues. We do not have these MDT meetings regularly as yet because of a significant lack in human resources, especially with regard to diabetes nursing staff. This shortage in human resources needs to be addressed by the Department of Health and our hospital's administration.

We need to set up a formal annual review so that all of the seven key processes of diabetes care: HbA_{1c}, BMI, blood pressure, urinary albumin, lipid screening, eye screening, and foot examination are done regularly and systematically as stipulated by international guidelines.[5,14] The audit data, including also acute complications such as diabetic ketoacidosis and severe hypoglycaemia, will be collected and analysed annually to assess whether the changes implemented have resulted in an improvement in outcome for children and adolescents with T1DM in Malta.

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