ABSTRACT

Objectives. To analyse the management of type 2 diabetes mellitus (T2DM) in Greenland in 2008.

Study design. Observational and cross-sectional study, including a review of medical records and databases.

Methods. Data on adult (>19 years old) T2DM patients were collected from each primary health care centre in Greenland. Information was collected about age, gender, HbA1c, blood pressure, blood lipids, and from eye, feet and urine examinations from 15 of the 17 health care districts in Greenland, which represent 90% of the whole adult population of Greenland. Three clinics were excluded because of too few patients (only 7). The management of T2DM patients is described and is based on 6 processes and 3 biological indicators.

Results. The 12 clinics together performed quite well looking at the monitoring of HbA1c (79%), blood pressure (69%) and blood lipids (83%). However, the screening rates were low within 2 years for microalbuminuria (47%), eye (50%) and foot examinations (29%). Great variation in the management of the treatment was observed among the clinics. No clinic achieved all the standards suggested in this paper. Screening for diabetic retinopathy seemed to be implemented, but the records were not fully updated, whereas screening for microalbuminuria and foot examinations clearly were not routine in most clinics.

Conclusions. The management of type 2 diabetes mellitus is a major task for the heath care system in Greenland. It is recommended that the implementation of a national strategy based on national guidelines, local diabetes registers and feedback to the clinics get underway as soon as possible.

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Keywords: Greenland, diabetes mellitus, care, quality
INTRODUCTION

Previously, the prevalence of diabetes mellitus type 2 (T2DM) was low in Greenland (1). New epidemiologic studies of the population in Greenland performed during the period 1998 to 2001 indicate a dramatic change in the prevalence of diabetes, suggesting an age-standardized prevalence of diabetes among men and women of 10.8% and 9.4%, respectively. Furthermore, 70% of those with diabetes had not previously been diagnosed (2). A high prevalence of diabetes has also been reported among Greenlander migrants living in Denmark (3). Furthermore, it has been predicted that the prevalence of T2DM will increase in Greenland (4).

The prevalence of patients aged at or above 40 years with diagnosed T2DM is only around 2% (5).

The prevalence of overweight and obese persons is also increasing rapidly (6–7), which supports the risk of a type 2 diabetes epidemic, which has been seen in other Westernized countries. T2DM thus seems to be a major challenge to the public health service in Greenland.

However, knowledge regarding the actual clinical management of the diabetes population is very limited. The population of Greenland is around 56,000 inhabitants, widely spread out geographically along the coast in a country with a total area of approximately 2,166,086 km² (8).

The public health care system is divided into 17 districts. Each district is composed of 1 town and a varying number of small settlements coupled with a primary health care centre, which also functions as a local hospital. The management of patients with T2DM is dealt with locally in each district, and the condition of a small group is monitored by the outpatients’ clinic at the Department of Internal Medicine, Queen Ingrid’s Hospital in Nuuk.

In 2 towns, Nuuk and Aasiaat, the primary health care centres have focused on the management of patients with T2DM. This provided the basis for the establishment of an electronic database, Fyns Diabetes Database (FDDB), which was implemented to improve the management of T2DM in November of 2006.

The health care system was able to start a 3-year project to improve the management of T2DM in Greenland based on a generous donation from Novo Nordisk A/S. The aim of this study is to describe the actual management of T2DM patients in Greenland and to compare the health care management in the 17 different districts.

MATERIAL AND METHODS

The 17 local districts were contacted and asked to make a list of patients with T2DM and to include related information regarding age and gender. The data were collected in a standard Microsoft excel spreadsheet after an introduction to the procedure was provided.

The clinical diagnosis in the medical records was used to classify the patients. Results of the latest examinations of blood pressure, blood lipids, microalbuminuria, eyes (performed by an ophthalmologist) and feet were collected from the database in Nuuk and Aasiaat and from health records in the other districts. Only districts with 10 or more T2DM patients were included. Analysis of venous blood for lipids and glycosylated haemoglobin and of urine (night sample) for excretion of albumin were performed at the Central Laboratory at Queen
Ingrid’s Hospital in Nuuk, using Architect 8000T from Abbott. The Central Laboratory is a member of the Danish quality control system for laboratories, DEKS. Some of the analysis for glycosylated haemoglobin was performed on capillary blood samples locally using a Nycocard Reader made by Axis-Shield PoC AS.

The eye examinations were only included if done by an ophthalmologist (a travelling specialist from Denmark). The standard examination for retinopathy in Denmark is done by dilating the pupils. However, in this study, there was no effort to specify that the examination was done in this way. A foot examination was included in the investigation for neuropathy in Nuuk and Aasiaat, whereas any description of the foot in the medical records in the other clinics was included as a foot exam.

Six different process indicators were used to describe the management of T2DM in the clinics.

The following indicators were used for the analysis, with values designated as a percent of the total patients in each group:

1. The percentage of patients with T2DM in whom glycosylated haemoglobin was measured within the previous year.
2. The percentage of patients with T2DM in whom blood pressure was measured within the previous year.
3. The percentage of patients with T2DM in whom blood lipids were measured within the previous 2 years.
4. The percentage of patients with T2DM in whom urine was tested for microalbuminuria within the previous 2 years.
5. The percentage of patients with T2DM who had their eyes examined within the previous 2 years.
6. The percentage of patients with T2DM who had their feet examined within the previous 2 years.

Standards for acceptable monitoring levels based on the model adopted by the Danish National Indicator Project (9) were used. Furthermore, the quality of the treatment was described using biological indicators where medians and percentiles concerning glycosylated haemoglobin, blood pressure and serum cholesterol were calculated for each district (clinic).

Statistics

Q-Q plots were used to analyse for distribution of normality. Medians were compared with the Kruskal Wallis test. Chi-square tests were used to compare frequencies. Linear regression was used to analyse for dependency of clinic, age and gender. Statistical analyses were performed using SPSS 17.0.

RESULTS

Demographics

All 17 districts were contacted and asked to collect information about adult patients (above 19 years of age) with T2DM. The data received from 15 of the districts represented 90% of the adult population in Greenland. Two clinics were not able to deliver the results before the deadline. Three clinics were excluded because of the small combined total number of T2DM patients (7), leaving 12 clinics as the basis for further analysis, representing thus 88% of the adult population in Greenland (8).

Information about the latest examinations of blood pressure, blood lipids, microalbuminuria, eyes (as performed by an ophthalmolo-
gist) and feet was collected from the (FDDB) database in Nuuk and Aasiaat, and from health records in the other 10 districts. The number of patients registered in the 12 clinics totalled 440, of which 206 were women and 234 men. The number of patients in each clinic varied from 10 to 94. No significant variation difference in the distribution of males and females between the 12 clinics was observed (p=0.43).

However, the median age of the patients between each clinic was significantly different. Thus, the clinics are not fully comparable.

**Process indicators**

The process indicators of the management of type 2 diabetes mellitus in each of the 12 clinics and all clinics together are shown in Table I. Furthermore, a standard monitoring level is suggested.

The 12 clinics together perform quite well looking at the monitoring of glycosylated haemoglobin (79%), blood pressure (69%) and blood lipids (83%). However, the screening rates within 2 years for microalbuminuria (47%), eye (50%) and foot examinations (29%) are low.

Great variation among the clinics is demonstrated. Thus, the percentage of patients with T2DM in whom glycosylated haemoglobin was measured within the previous year varies from 39% to 100%. The percentage of patients with T2DM in whom hypertension was measured within the previous year varies from 20% to 100%, while the percentage of patients in whom blood lipids was measured within the previous 2 years varies from 36% to 100%.

The examination of feet and the screening for microalbuminuria were done very sporadically in many of the clinics. It was observed that 8 out of the 12 clinics performed these examinations on less than 50% of their patients.

In one of the clinics that maintained a database, the results of screening for microalbuminuria and foot examinations were not updated, resulting in an underestimation of the actual percentage of patients screened.

### Table I. The quality of the management of type 2 diabetes mellitus among the 12 clinics (1–12) in Greenland.

| Health Indicator | Number of clinic (number of patients) | 1 (94) | 2 (46) | 3 (42) | 4 (51) | 5 (17) | 6 (11) | 7 (46) | 8 (23) | 9 (24) | 10 (10) | 11 (22) | 12 (54) | All (440) |
|------------------|--------------------------------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| Metabolic | % of patients indicator with T2DM in whom/who had: | 98 | 91 | 98 | 39 | 88 | 91 | 70 | 57 | 83 | 100 | 82 | 63 | 79 | 95% | p<0.001 |
| Hypertension | % of patients indicator with T2DM in whom/who had: | 98 | 91 | 83 | 20 | 100 | 73 | 83 | 88 | 90 | 82 | 63 | 69 | 95% | p<0.001 |
| Blood lipids | % of patients indicator with T2DM in whom/who had: | 96 | 89 | 95 | 63 | 76 | 100 | 91 | 72 | 96 | 100 | 36 | 69 | 83 | 90% | p<0.001 |
| Microalbuminuria | % of patients indicator with T2DM in whom/who had: | 83 | 60 | 80 | 31 | 24 | 0 | 0 | 30 | 54 | 0 | 0 | 50 | 47 | 95% | p<0.001 |
| Eye examination | % of patients indicator with T2DM in whom/who had: | 30 | 37 | 74 | 43 | 41 | 0 | 85 | 22 | 79 | 0 | 23 | 50 | 45 | 90% | p<0.001 |
| Foot examination | % of patients indicator with T2DM in whom/who had: | 89 | 13 | 4 | 1 | 29 | 22 | 48 | 4 | 17 | 0 | 0 | 0 | 29 | 95% | p<0.001 |
The percentage of patients who had been given an eye examination within the last 2 years was also low. However, results from the screening for retinopathies were not updated in all clinics. More patients have actually been screened for retinopathy than what had indicated here.

There were significant differences between all indicators, and thus the health care management must vary between the clinics. Altogether, the most attention seems to have been placed on measuring blood lipids, glycosylated haemoglobin and causal blood pressure. No clinic achieved all the standards suggested in this paper.

**Biological indicators**

The biological characteristics of the patients are illustrated in Table II.

### Table II. Biological characteristics of patients with type 2 diabetes mellitus in 12 (of the 17) clinics in Greenland.

| Clinic | Percentiles (25–50) | Median (25–50) | Median (25–50) | Median (25–50) | Median (25–50) | Median (25–50) | Median (25–50) | Median (25–50) | Median (25–50) | Median (25–50) | Median (25–50) | Median (25–50) | Median (25–50) | Median (25–50) | Median (25–50) | Median (25–50) | Median (25–50) | Median (25–50) | Median (25-50) | Kruskal Wallis p |
|--------|---------------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|
| Age (years) | 60 (53-64) | 67 (60-75) | 60 (49-67) | 63 (57-71) | 65 (60-73) | 62 (62-68) | 61 (47-70) | 65 (63-72) | 70 (63-75) | 65 (62-71) | 61 (61-67) | 60 (53-68) | 63 (53-70) |
| HbA1C % | 6.9 (6.4-7.8) | 6.5 (5.7-7.3) | 6.4 (6.1-7.0) | 6.7 (6.1-7.5) | 7.7 (6.6-8.0) | 9.0 (6.7-10.8) | 7.4 (6.3-9.7) | 7.2 (6.3-9.4) | 6.8 (6.1-7.3) | 8.2 (6.3-10.1) | 7.5 (6.6-8.2) | 8.5 (7.1-11.1) | 7.0 (6.6-8.2) |
| Systolic blood pressure (mmHg) | 130 (122-140) | 120 (130-140) | 137 (129-153) | 140 (128-160) | 140 (132-146) | 149 (134-163) | 134 (120-142) | 150 (133-158) | 131 (130-146) | 140 (122-145) | 143 (121-140) | 143 (138-154) | 135 (125-150) |
| Diastolic blood pressure (mmHg) | 80 (74-87) | 70 (60-80) | 80 (73-89) | 80 (70-85) | 79 (70-80) | 82 (70-96) | 78 (73-83) | 80 (78-88) | 73 (65-80) | 80 (75-86) | 80 (80-85) | 83 (78-85) | 80 (70-85) |
| Total serum cholesterol (mmol/l) | 4.3 (3.4-5.1) | 4.6 (3.8-5.4) | 4.5 (3.7-5.6) | 5.0 (5.0-6.4) | 5.6 (4.2-6.3) | 4.8 (5.8-5.1) | 4.5 (4.2-6.4) | 4.5 (4.2-5.4) | 4.8 (4.1-6.0) | 4.3 (3.9-5.4) | 5.4 (4.2-6.1) | 4.6 (3.9-5.6) |
| Low Density Lipoprotein s-cholesterol (mmol/l) | 2.2 (1.8-3.0) | 2.8 (1.7-3.4) | 2.7 (1.6-3.5) | 2.6 (2.1-3.3) | 3.7 (2.2-4.5) | 3.3 (2.3-4.5) | 2.4 (1.9-3.0) | 4.6 (3.1-6.4) | 2.3 (2.0-3.1) | 2.6 (1.8-3.2) | 2.7 (1.8-3.7) | 2.6 (1.8-3.4) |

Distribution of normality was found for age, glycosylated haemoglobin, and systolic and diastolic blood pressure. Furthermore, the glycosylated haemoglobin along with systolic and diastolic blood pressure increased with age, as expected.

The figures reported by the clinics concerning the level of glycosylated haemoglobin and systolic and diastolic blood pressure differed significantly, whereas no difference concerning total and LDL serum cholesterol was observed. The difference between the clinics remained highly significant when adjusted for age and gender.

No standards for the levels of biological parameters are suggested in this paper. However, the percentage of patients with available biological values in relation to some moderate target levels in the treatment for T2DM is shown in Table III.
Evaluating all clinics together, the metabolic regulation seems to be quite good, with a median of glycosylated haemoglobin of 7.0%. Five out of the 12 clinics registered below this level, indicating a possibility for improvement in some of the clinics.

The median systolic blood pressure for all clinics combined was 135 mmHg. Only 32% of the patients who had an available record of blood pressure had systolic blood pressure <130 mmHg. However, the median diastolic blood pressure was 80 mmHg, and 46% of the same patients had diastolic blood pressure below 80 mmHg.

The blood pressure levels were, in most cases, the last casual blood pressure recorded (measured in the clinic). However, frequent measurements of ambulatory blood pressure (based on 12 of 18 measurements made at home over 3 days) were implemented in 1 of the 12 clinics.

The percentage of patients with total and LDL serum cholesterol below the chosen target levels lay between 43% and 48%, and no significant difference between the clinics was observed.

Process indicators were not associated with the level of glycosylated haemoglobin, systolic and diastolic blood pressure in this study.

DISCUSSION

The quality of the management of T2DM in Greenland can be described based on both process and biological indicators. Great variation in the quality of the management was found. Monitoring the patient’s glycosylated haemoglobin, blood pressure and blood lipids was done routinely in most clinics. Screening for diabetic retinopathy seems to have been implemented, but the records were not updated, whereas screening for microalbuminuria and foot examinations clearly were not routinely done in most clinics. However, all process indicators and some biological indicators (glycosylated haemoglobin, systolic and diastolic blood pressure) showed significant differences.

The 12 clinics seen as a whole performed screening rates comparable to those reported in other Indigenous populations. Among older urban American Indians and Alaska Natives, screening rates within 12 months were for glycosylated haemoglobin (72%), lipid profile (84%), foot examination (72%) and urinalysis (23%) as reported in 2004 (10). Foot examination rates were better than reported in this study, whereas the opposite is the case for the urine analysis. In an older American study, the same trend reported high screening rates for blood pressure and annual laboratory tests, and low rates for eye, foot and dental examinations (11).
The monitoring found in the present study was of lesser quality than reported recently in the follow-up study after implementation of the Special Diabetes Program for Indians (12). Screening rates after implementation within 12 months were 85% (lipid profile), 67% (foot exam) and 56% (eye exam).

The screening rates were also lower than those reported for the diabetes population in the National Danish Indicator Project 2007 (13). The process indicators here are among the highest reported yet, with screening rates within 12–24 months for glycosylated haemoglobin (99%), blood pressure (97%), lipid profile (95%), foot examination (85%), urinalysis (86%) and ophthalmology examination (84%).

All patients with the diagnosis were included in the present study. Newly diagnosed patients may, of course, contribute to low screening rates. However, this may reflect a low number of patients, and it cannot explain the considerable differences in screening rates observed in this study. There is no reason to believe that this bias is more significant in one clinic than another.

The variability between the 12 clinics indicates that it is realistic to improve the general management of T2DM in Greenland. The variability may partly reflect the geographical differences and regional strategies in the health care system. Diabetes is a relatively new disease in Greenland, and focus may have been more intense on other major health issues, such as tuberculosis and other infections, sexually transmitted diseases, cancer, psychiatric diseases, high rates of suicide and acute medical conditions. However, shortage of medical staff, lack of a national diabetes program and lack of electronic diabetes registers definitely play a role in the great variability. Monitoring the quality of management for diabetes and the possibility of improving care as a result of better management have only been evident in 2 clinics.

A great deal of variability between the medical facilities has also been reported in the Alaska Area Diabetes Program (14). The best facilities were more likely to use an organized multidisciplinary team approach that included coordinated clinic appointments with multiple providers on the same day, maintenance of a diabetes registry, proactive preclinical preparation, flow sheet use, intensive individual nutritional counselling, a case manager coordinator system with standing orders and strong self-management support (14). Variability between rural and urban diabetes populations have also been reported in the U.S. Large rural towns provided the best diabetes care compared to small rural towns and urban areas (15). Local factors seemed to be important. Thus, only a few differences were found regarding the quality in the diabetes care among American Indians and Alaska Natives between urban and rural health care sites (16).

Improvements in diabetes care are realistic, even in small local facilities (12,17–22).

Both the process indicators (as described above) and the intermediate outcomes (biological indicators) improved during the period 1994–2004, following the implementation of the Special Diabetes Program for Indians in Alaska based on an accurate registry, standardized guidelines for care and annual evaluation and feedback to the clinics (12). Changes in the Indian Health Service also resulted in improved intermediate outcomes (17). Feedback to the clinics using achievable benchmarks significantly enhanced the quality in clinical care (23).
The percentage of patients with systolic blood pressure <130 mmHg is only 32%. This is somewhat higher than reported before the implementation of the Special Diabetes Program for Indians (28%) in 1994–1998, but lower than after the implementation (37%) in 2000–2004 (12). However, the median diastolic blood pressure was measured at 80mmHg, and 46% of the same patients had diastolic blood pressures below 80mmHg.

Blood pressure, in most cases, was the last casual blood pressure measured. However, frequent use of ambulatory blood pressure (based on 12 of 18 measurements made at home) was implemented in 1 of the 12 clinics. Casual blood pressure measurements are less reliable and, in general, are higher than ambulatory blood pressure measurements, which might influence the results (24). Treatment of hypertension is essential in the management of T2DM (25–28). Routine ambulatory blood pressure measurement should be implemented in all clinics.

Finally, the process indicators did not associate with the level of glycosylated haemoglobin, systolic and diastolic blood pressure. This may be due in part to the low number of patients in some clinics. However, in some clinics, a high percentage of patients have been followed in order to register glycosylated haemoglobin and blood pressure measurements, though the biological levels were high (see clinics 6 and 10). The opposite is seen in clinic 4. This may indicate problems in the clinical management of high glycosylated haemoglobin and blood pressure levels. National guidelines, education of the staff and telemedicine may prove to be part of the solution for this challenge.

Monitoring the process and biological indicators with feedback to the clinics may, over time, help to focus and adjust management at the local level. However, in some studies, implementation of guidelines and organizational improvement is primarily shown to improve the process indicators rather than the biological indicators (29).

This study demonstrates that it is possible to describe the quality of the management of type 2 diabetes in Greenland. However, process indicators alone do not satisfactorily describe the quality of the management and should be accompanied by biological indicators or other indicators reflecting the action in the treatment. The data in this study were drawn manually from the records of the patients in 10 clinics, whereas 2 clinics using a quality database were able to deliver the data electronically. In the daily running of a clinic, it is not realistic to collect these data manually on a frequent basis. Thus, some kind of database must be established in each clinic.

Screening for microalbuminuria, sensory neuropathy and diabetic foot problems (diagnosed through foot examinations) are areas that require attention since these have not been implemented in most clinics. Solutions to make this possible at the local level must be made a priority in the future. Recording the results of eye examinations with appropriate attention is also a task yet to be completed by many clinics. Diabetes care is also a matter of concern in small settlements.

In summary, diabetes care in Greenland is not optimal. In general, the blood pressure, glycosylated haemoglobin and blood lipids are monitored adequately but great
variation (in levels and record keeping) is demonstrated between the clinics. The management of systolic hypertension is a matter of concern, since only 32% of the patients have systolic blood pressure lower than 130mmHg.

Screening for microalbuminuria and foot examination is not conducted regularly and is a major task to be implemented as well. Screening for retinopathy and recording the results of those examinations also need attention.

The number of patients with T2DM in Greenland is expected to increase dramatically in the next few years.

The combination of an increasing prevalence of T2DM and the non-optimal diabetes care demonstrated in this study represents a major task for the public health system in Greenland. The many complications of the disease present a personal and socioeconomic threat to the whole of society. Efforts to homogenize and optimize diabetes care are very important. It is recommended that the implementation of a national strategy based on national guidelines, local diabetes registers and feedback to the clinics be started immediately.

Conclusions

In conclusion, the management of type 2 diabetes mellitus presents a major task for the health care system in Greenland. The management of T2DM in Greenland can be described using both process and biological indicators. In general, the blood pressure, glycosylated haemoglobin and blood lipids are adequately monitored but great variation (in levels and record keeping) is demonstrated between the clinics. The management of systolic hypertension is a matter of concern, since only 32% of the patients have systolic blood pressure lower than 130mmHg. Screening for microalbuminuria and foot examinations have hardly been implemented, and it will be a major task to have them implemented in the future. Screening for retinopathy and recording the results of those examinations also need attention.

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