Comparison of co-morbidity and investigations for people with diabetes in Bermuda and the UK.

Final Report

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2 Executive summary

This is the first analysis comparing a sample of anonymised electronic health records data from the UK QResearch database with a sample of patient data based on insurance claims for Bermuda, both based on data recorded during 2016.

1. **Data sources**: There are similarities between the datasets since both datasets include information on age, sex, hospital procedures, major diagnoses, investigations and prescriptions. However, there are major differences in the populations covered by the datasets and how the electronic data are captured and coded, what data is available and the purpose for which is it collected.

    - The Bermuda dataset relies on data collected for medical insurance claims whereas the QResearch database is based on an electronic health record used for routine clinical care.
    - The UK data covers the general population. The Bermuda claims data is limited to people who have medical insurance and does not include those people without. It is biased towards those who are healthier, in work and under the age of 65 years. The elderly, uninsured and the under-insured are under-represented although they are likely to make up the majority of the health burden.
    - The claims codes used in the Bermuda dataset may be inaccurate since most providers in Bermuda do not have ubiquitous Electronic Health Record systems and will tend to bundle the reason for encounter, diagnosis and any procedures into higher level ICD9 codes used for billing purposes rather than clinical coding. This means that what may be claimed using a particular clinical code may not have been the specific reason for the visit. For example, a review for a chronic Illness is not necessarily on the diagnosis list for each claim, as often only the clinical service provided that day will be on the claim submitted. These inaccuracies in selecting clinical codes could result in this over-use of some codes and under-use of other codes.
    - There are also differences in the content of the datasets. For example, QResearch has the results of blood tests and clinical values such as blood pressure and body mass index. This is not available for Bermuda.

2. **Prevalence of disease**: We have found important similarities and differences in the recorded prevalence of several major diseases.

    - For example, the *recorded* prevalence of diabetes is similar in both countries. In Bermuda claims data, the prevalence of diabetes is slightly higher than that reported in the self reported Bermuda Census Data from 2010. However, it is highly probable that both are a gross under-estimate of the true prevalence of diabetes in Bermuda. The IDF Diabetes Atlas 2015 reported the diabetes prevalence as 15.7 % (20-79 years)
    - The prevalence of renal failure is substantially higher in Bermuda than in the UK although this is likely also to be an under-estimate because of the selected population.

3. **Investigations:** There are significant differences in investigations:
   - Whilst glucose monitoring among people with diabetes is similar between the two countries, the monitoring of kidney function and lipids among Bermudian patients appears to be less intensive than the UK. It is possible that this may contribute to the higher prevalence of complications such as renal failure in Bermuda. This could be related to the high 'co-pays' for people, who may have tests requested but no follow-through on testing, due to costs. This could also reflect a lack of test requests from the physician. However, it is not possible to tease these apart in the absence of care quality measures.

   - We have also found that Bermuda has much higher rates of MRI and CT scanning. These differences may reflect true differences in scanning rates or may reflect differences in how the information is recorded. It could also reflect patient demand or simple over-use by physicians in Bermuda or under-use in the UK. More detailed information as the clinical indication for the scan would need to be obtained to understand the differences.

4. **Possible implications**: If Bermuda were to develop an Electronic Health Record System which facilitated accurate clinical coding at the point of care and which included clinical values and results of blood tests, then it would be possible to
   - develop quality indicators similar to those used in the UK which could be used to monitor and improve health care for individuals in a systematic way
   - to use risk assessment tools to identify those at highest risk of developing complications for systematic targeted interventions with the aim of improving health outcomes.

   Even without the clinical values, the Bermuda insurance claims dataset already contains a substantial volume of useful clinical information on diagnoses, procedures, medication and investigations which could be used to drive improvement in health outcomes and health care. In particular, the existing data, if available in a clinical setting, could be used to prompt clinicians to undertake closer monitoring of conditions such as diabetes with the aim of reducing complications such as kidney failure.

3 Purpose of document

This is a report comparing the health care and characteristics of patients in Bermuda with the UK through the analysis of two sample anonymised datasets.

- The first dataset is health insurance claims dataset from 2016 which covers insurance claims for approximately one third of the population of Bermuda.
- The second is the QResearch database (version 42) which covers approximately 18% of the population in the UK and is derived from electronic health records from primary care linked to hospital episode statistics.

4 Objectives

Our objectives were to:

1. Compare the prevalence of six major morbidities in the general population for both datasets. This included diabetes, coronary heart disease, stroke, hypertension, heart failure and kidney failure.
2. Characterise the population of patients with diabetes. This included a description of the use of hypoglycaemic medication and the prevalence of diabetes related complications
3. To describe the uptake of blood tests and CT/MRI scanning imaging in the overall population and among those patients with diabetes.
4. Establish a baseline and assess the utility of insurance claims data through these exemplar analyses that could inform separate recommendations on the development of Electronic Health Record systems in Bermuda.

5 Summary of methods

- **Study period**: January 2016-Dec 2016.
- **Study design**: cross-sectional analysis.
- **Inclusion criteria**: all patients aged 0-100 years registered with each dataset during the calendar year of 2016.
- **Exclusion criteria**: none
- **Clinical codes for Insurance claims data**: We used ICD9 codes to identify diagnoses and procedures, searching on all four ICD4 fields. We also used the codes supplied by the insurer to identify procedures and investigations recorded in the 'procedures' fields.
- **Clinical codes for QResearch**: We used Read Codes and ICD10 codes to identify diagnoses and procedures recorded in the QResearch database linked to hospital data.
- **Analysis**: This report presents descriptive statistics in graphical and tabular form. The appendix contains two tables with the key results. A multivariate analysis, adjusting for age and sex was also undertaken and this confirmed all the differences highlighted in this report were statistically significant.

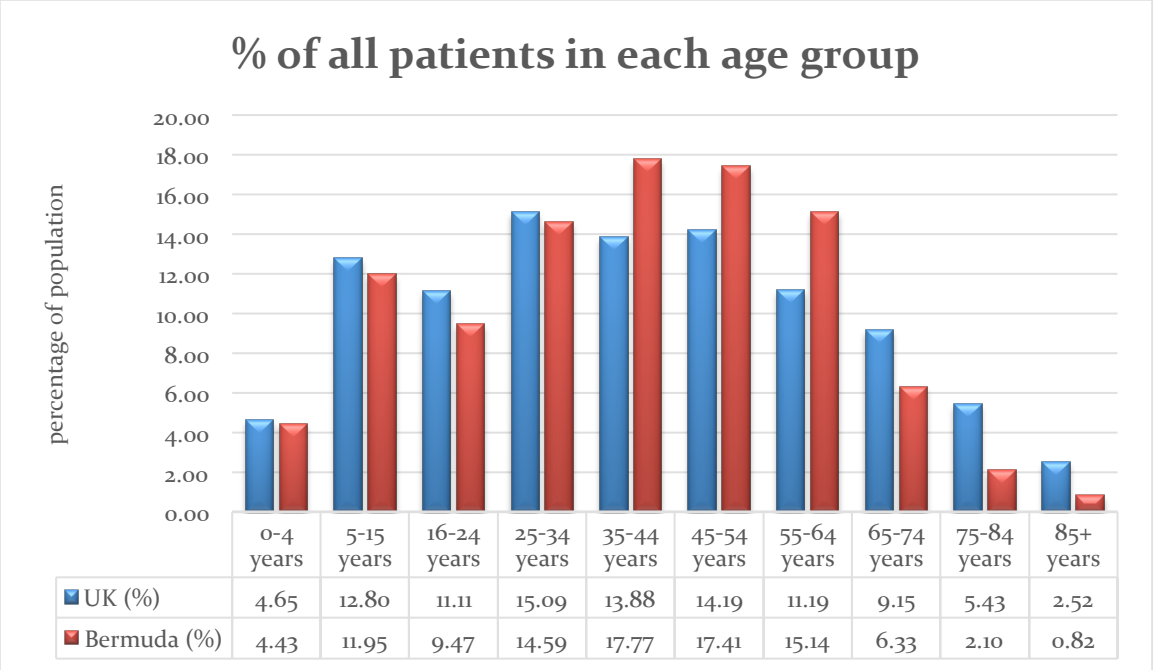
- **Interpretation**: Following discussions with clinicians, public health and IT personnel in Bermuda, caution is needed in the interpretation of coded data arising from Bermuda claims data. This is because most providers do not have Electronic Health Record systems so will tend to bundle the reason for encounter, diagnosis and any procedures diagnosis into the 'top 10' codes for billing purposes and not clinical care. This means that what may be billed/claimed using a particular clinical code may not have been the actual reason for the visit. This inaccuracy in selecting clinical codes could result in this over-use of some codes and under-use of other codes. Similarly, there are important differences in the populations covered which will affect the prevalence rates of disease.

6 Results

6.1 Characteristics of the overall population

Figure 1 shows the distribution of patients in both countries by age group. Bermudians were slightly younger than the UK population with a higher proportion in the middle-aged group. For example, 17% of Bermudans were in the 45-54 year-age group compared with 14% in the UK. There were also slightly fewer Bermudians in each of the age groups over 65 years. It is important to note that the Bermuda sample excludes the uninsured population and those over 65 years on either HIP or FutureCare causing bias towards a younger age range. In addition, the insured group tends to be white collar rather than blue-collar, as a broad generalisation, higher socioeconomic group and therefore lower risk for chronic disease. Also, this does not include any data from HIP/FutureCare/PCMH and GEHI sources.

Figure 1 Age structure of the population in Bermuda compared with the UK



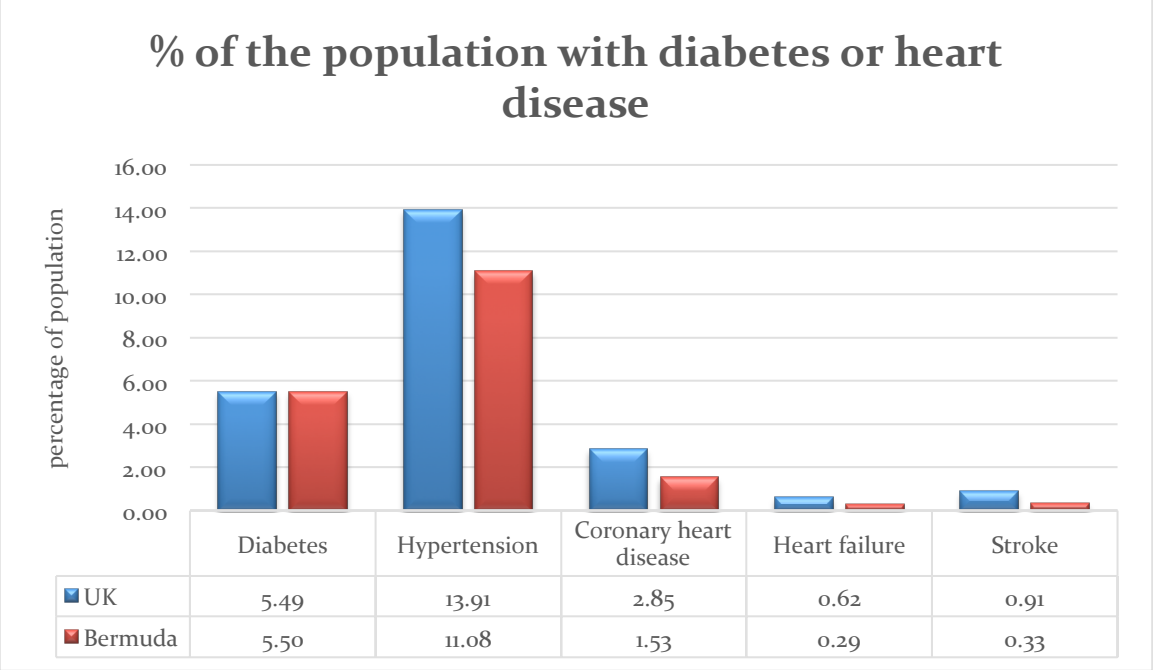
	0-4 years	5-15 years	16-24 years	25-34 years	35-44 years	45-54 years	55-64 years	65-74 years	75-84 years	85+ years
UK (%)	4.65	12.80	11.11	15.09	13.88	14.19	11.19	9.15	5.43	2.52
Bermuda (%)	4.43	11.95	9.47	14.59	17.77	17.41	15.14	6.33	2.10	0.82

6.1.1 Prevalence of diabetes and heart disease in the general population

The next figure shows the prevalence of diabetes , coronary heart disease, stroke and heart failure in the overall population. Hypertension, coronary heart disease, heart failure and stroke were all more common in the UK population than in Bermuda.The overall prevalence of diabetes is the same in both Bermuda and the UK as shown in the figure 2.

However, the known prevalence of diabetes in Bermuda is much higher than 6%. In 1996, an epidemiology study carried out by the Bermuda Diabetes Association in collaboration with McMaster University gave a prevalence of 11%. Other data available through the Department of Health, Bermuda Health Council and BHB (Bermuda Health Board) show that the prevalence of heart disease and other chronic disease risk factors in the Bermuda population is extremely high. Again, the insured population presented here is likely to be younger and healthier.

Figure 2 Prevalence of diabetes and heart disease



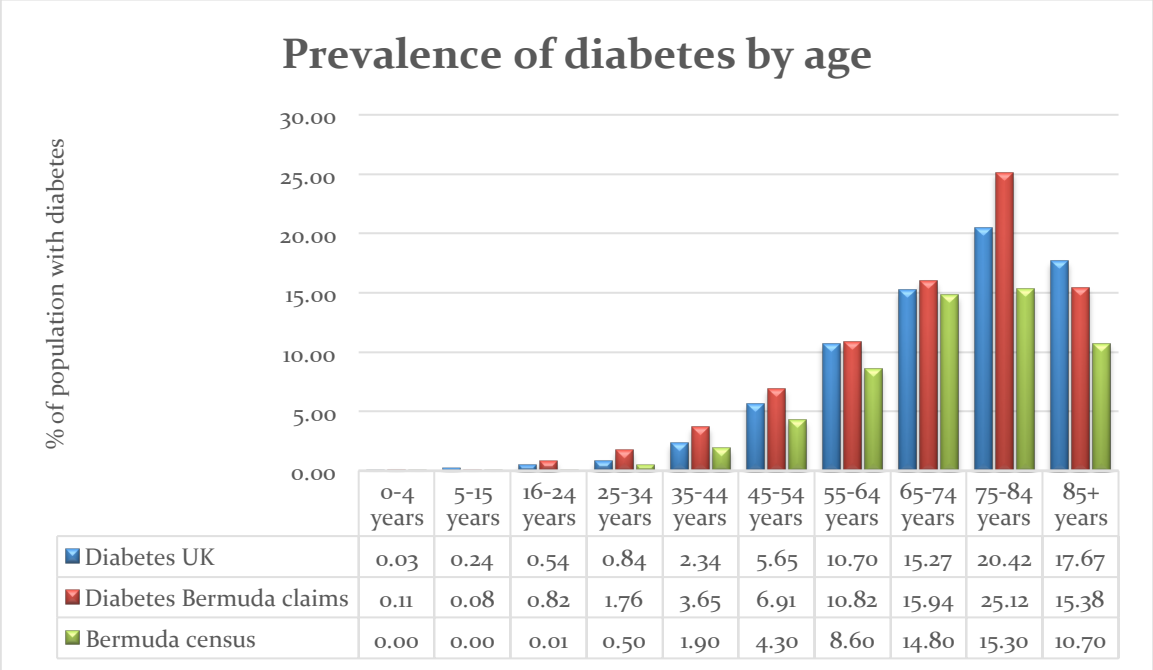
The next figure compares the prevalence of diabetes in the UK with that estimated from the Bermuda Claims data (shown in red) and the national prevalence figures issued by the Chief Medical Officer of Bermuda for 2010 (shown in green)[1].

The prevalence of diabetes increases steeply by age in all three datasets. For example, using the claims data, 25% of Bermudians aged 75-84 years had evidence of diabetes compared with 20% of those in the UK sample.

[1] https://www.gov.bm/bermuda-census

The prevalence of diabetes on the Bermuda claims data tended to be higher than the prevalence from the Bermuda Census, especially in the older age groups. However, this could reflect differences both in the time for the relevant estimates (2016 vs 2010) during which time the prevalence may have increased. Alternatively, it could reflect how the cases of diabetes are defined, identified and how the information is recorded between the claims and the census data. Also, many patients aged over 65 years will not be included in the claims insurance data so will not be represented in the analysis based on claims data.

Figure 3 Prevalence of diabetes by age in the UK (2016) compared with Bermuda claims data (2016) and Bermuda census data (2010)

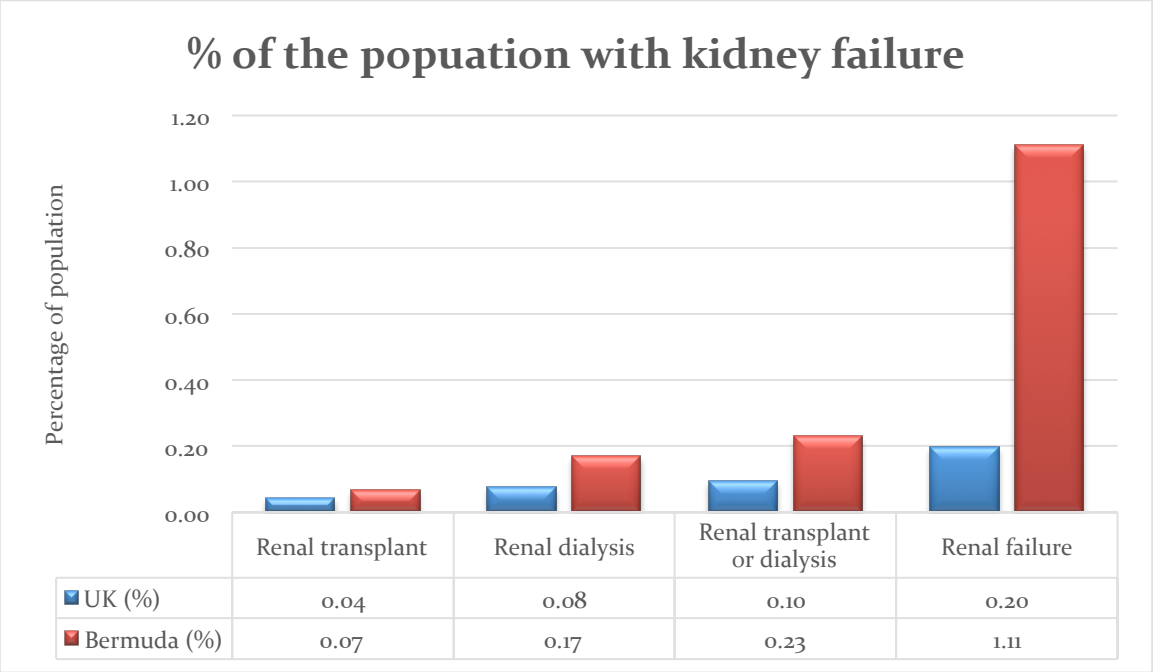


	0-4 years	5-15 years	16-24 years	25-34 years	35-44 years	45-54 years	55-64 years	65-74 years	75-84 years	85+ years
Diabetes UK	0.03	0.24	0.54	0.84	2.34	5.65	10.70	15.27	20.42	17.67
Diabetes Bermuda claims	0.11	0.08	0.82	1.76	3.65	6.91	10.82	15.94	25.12	15.38
Bermuda census	0.00	0.00	0.01	0.50	1.90	4.30	8.60	14.80	15.30	10.70

6.1.2 Kidney failure in the general population

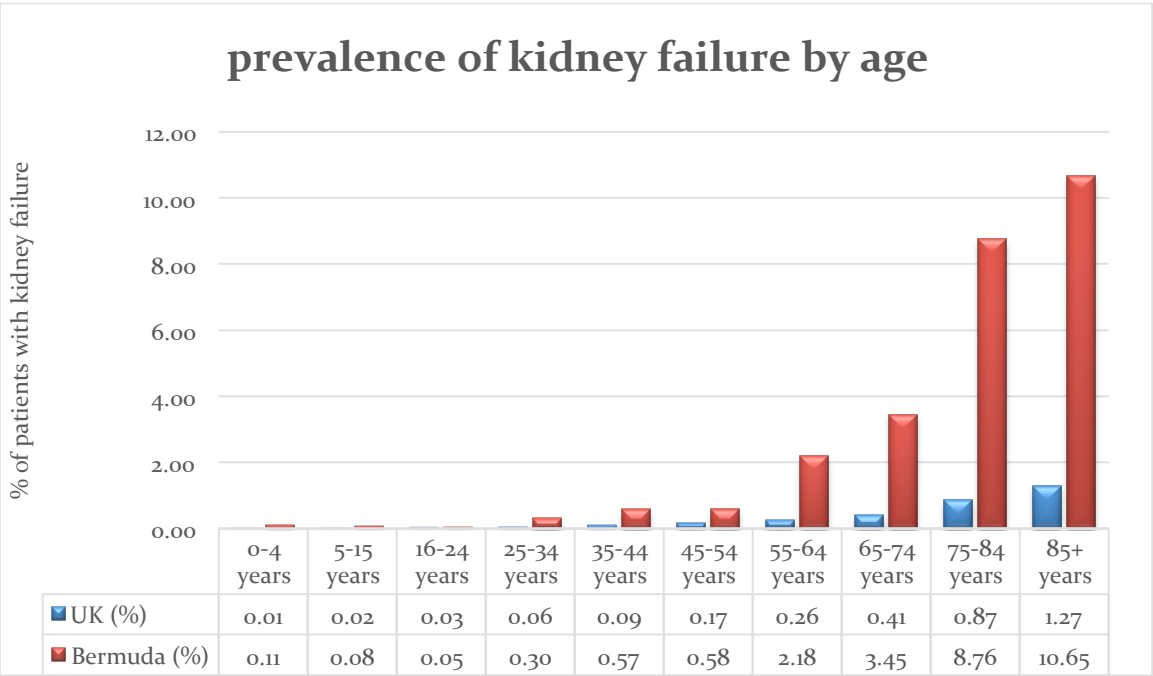
The next figure shows the percentage of patients who had kidney dialysis or underwent a kidney transplant during 2016 and the percentage with any evidence of kidney failure based on ICD9 diagnostic codes 584-586, kidney dialysis or kidney transplants. Whilst the difference in renal failure between the UK and Bermuda might reflect differences in clinical coding, the higher rate of renal transplant and dialysis in Bermuda suggests there is a true difference in the burden of kidney disease between the two countries. This is consistent with other reports that suggest that end stage kidney disease is substantially higher in Bermuda.

Figure 4 Prevalence of kidney failure



The next figure shows how the prevalence of kidney failure increases with age particularly in the Bermuda Population. This is expected given the age-related decline in glomerular filtration rate. Almost 10% of Bermudians over the age of 75 years have evidence of kidney failure.

Figure 5 Prevalence of kidney failure by age

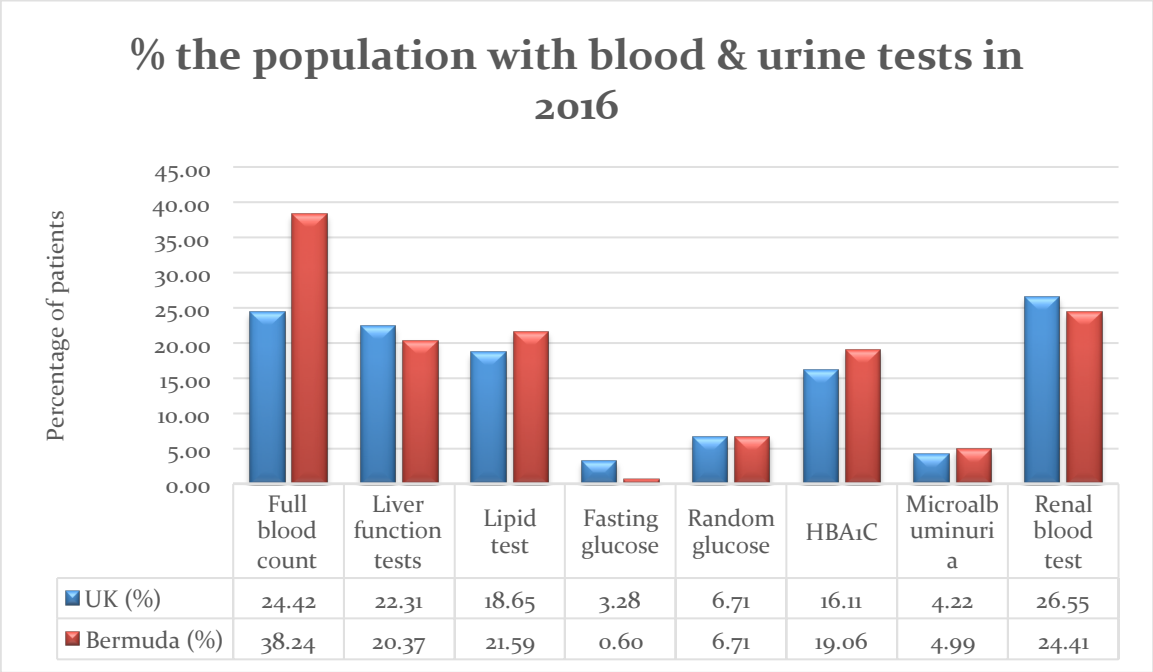


6.1.3 Laboratory investigations in the general population

The next figure shows the laboratory testing in the overall population recorded during 2016. The Bermuda dataset records whether the blood test was ordered whereas the UK dataset records both whether the test was ordered and the result of the blood test.

Overall, based on procedure codes, blood and urine testing rates were broadly similar. For example, approximately one in four patients had a blood test designed to identify kidney failure with 27% in the UK and 24% in Bermuda. Similarly, rates of testing for diabetes (based on random glucose tests and HBA1C) were similar for both countries with Bermuda having slightly higher testing rates for HBA1C (19%) than the UK (16%). 21.6% of Bermudians had lipid tests recorded compared with 18.7% of those in the UK. Significantly more Bermudians had a full blood count recorded (38%) compared with 24% in the UK.

Figure 6 Laboratory testing in the general population during 2016



	Full blood count	Liver function tests	Lipid test	Fasting glucose	Random glucose	HBA1C	Microalbuminuria	Renal blood test
UK (%)	24.42	22.31	18.65	3.28	6.71	16.11	4.22	26.55
Bermuda (%)	38.24	20.37	21.59	0.60	6.71	19.06	4.99	24.41

From discussions with clinicians, public health and IT personnel in Bermuda, caution is needed in the interpretation of coded data arising from claims data. This is because most providers do not have Electronic Health Record systems so will tend to bundle the reason for encounter, diagnosis and any procedures diagnosis into the 'top 10' codes for billing purposes and not clinical care. This means that what may be claimed using a clinical code may not have been the actual reason for the visit. This inaccuracy in selecting clinical codes could result in this over-use of some codes and under-use of other codes.

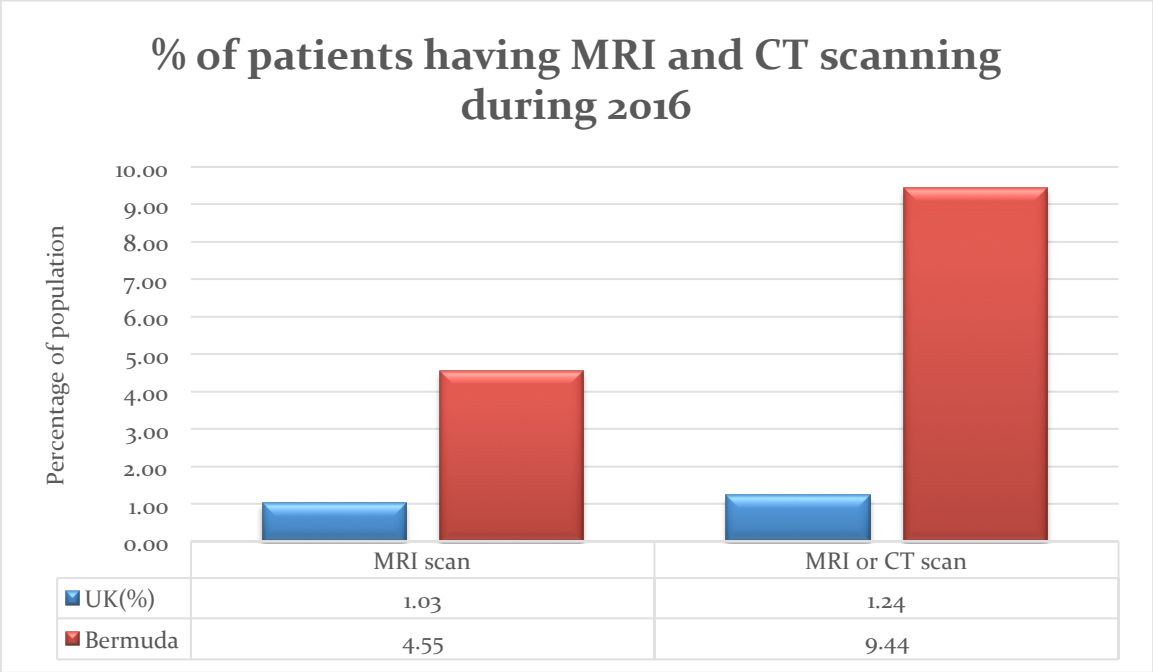
These results may reflect the opportunistic approach of the Bermuda Health System rather than the more proactive approach applied in the UK National Health Service. The Bermuda co-pay system may deter attendance for routine screening except for the worried well or

those who are significantly motivated or have sufficient funds. There will be many competing factors for an individual's funds, and screening for asymptomatic disease such as diabetes, hypertension and hypercholesterolaemia may not be a high priority.

6.1.4 MRI and CT scans

The next figure shows the percentage of patients who were recorded as having an MRI or CT scan during 2016. Neither the UK nor the Bermuda dataset records the results of the scan. The figure shows that over seven times as many Bermudians had a MRI or CT scan. These differences may reflect true differences in scanning rates or may reflect differences in how the information is recorded. It could also reflect patient demand or simple over-use by physicians in Bermuda or under-use in the UK. More detailed information as the clinical indication for the scan would need to be obtained to explain the differences.

Figure 7 Rates of MRI and CT scanning in the overall population during 2016



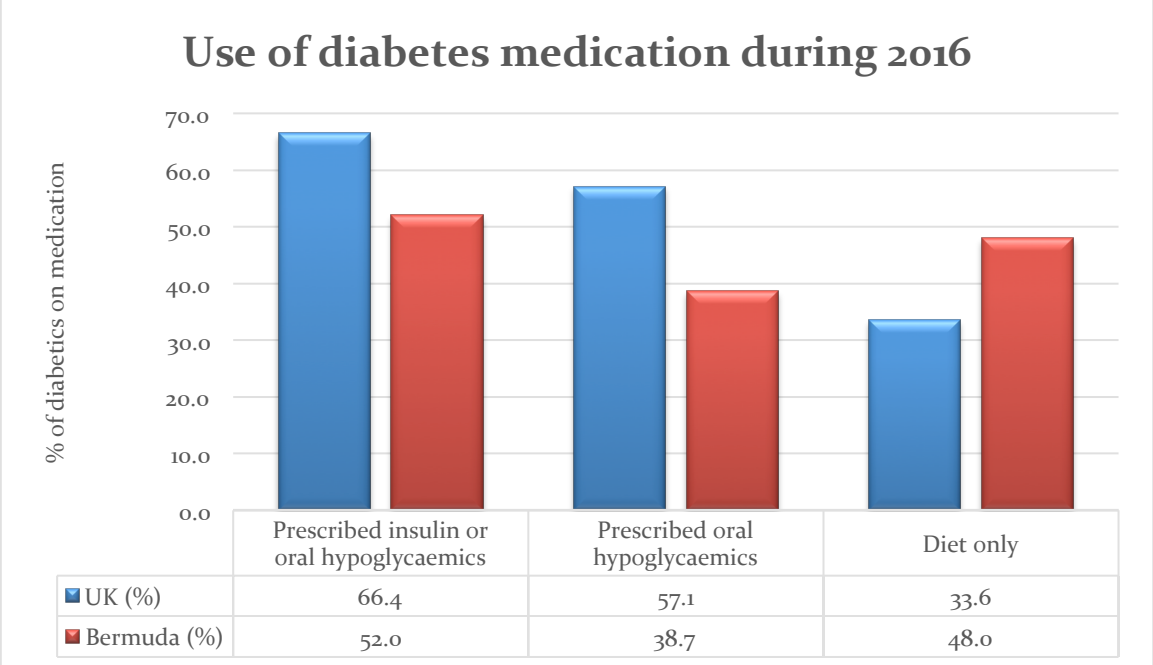
6.2 Characteristics of patients with diabetes

We identified 1,135 Bermudian patients with diabetes that we compared with 489,471 UK patients with diabetes. Bermuda patients were on average 8 years younger than in the UK (57 years c.f. 65 years).

6.2.1 Use of Diabetic Medication

The next figure shows the use of hypoglycaemic medication in people with diabetes during 2016. One third of people with diabetes in the UK are managed on diet alone compared with nearly half of those in Bermuda. The high cost of medications in Bermuda may deter many from taking them, which may explain why a significant proportion of patients are not on any medications. Because there is no information on HbA1c levels associated with the Bermuda data, it is difficult to interpret whether this use/disuse of medications is appropriate or not.

Figure 8 Use of diabetic medication



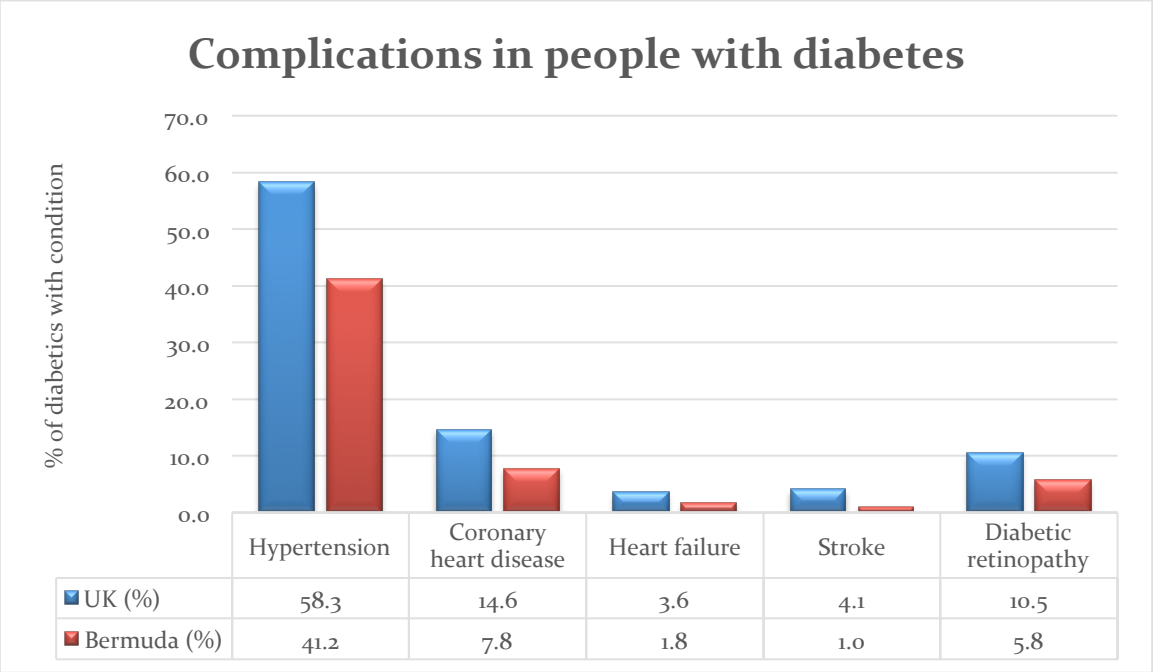
6.2.2 Complications in people with diabetes

The next figure shows levels of co-morbidity in people with diabetes. Hypertension, coronary heart disease, stroke, heart failure and diabetic retinopathy were all recorded more often among the UK population than in the Bermuda population. These differences could reflect differences in recording, ascertainment or true differences in prevalence between the two countries.

Of all the conditions, hypertension was the most common affecting 58% of people with diabetes in the UK and 41.2% of those in Bermuda.

There were too few patients with amputations or blindness in the Bermuda dataset for analysis. There are several reasons why the numbers of patients with amputation or blindness are lower in the Bermuda data. First, once patients go blind or have an amputation, they are likely to stop work and stop being included in the insured dataset. Second, there is no routine retinopathy screening service in Bermuda and no requirement for providers who undertake retinal photography to send the reports to the primary care physicians. This can mean that the primary care physician doesn't know the diagnosis and also doesn't have any relevant claim for the insurer.

Figure 9 Complications in people with diabetes

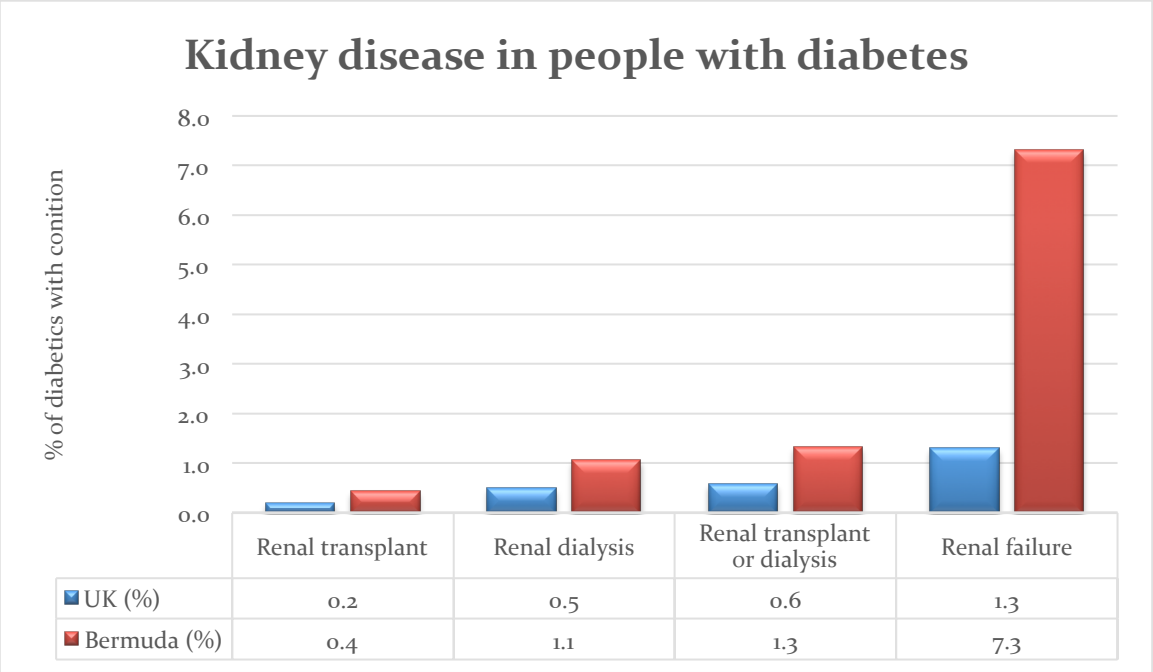


	Hypertension	Coronary heart disease	Heart failure	Stroke	Diabetic retinopathy
UK (%)	58.3	14.6	3.6	4.1	10.5
Bermuda (%)	41.2	7.8	1.8	1.0	5.8

6.2.3 Kidney disease in people with diabetes

The next figure shows the recorded prevalence of kidney disease in people with diabetes. Kidney failure includes renal transplant, renal dialysis or a ICD9 code for renal failure. Five times as many patients with kidney failure in Bermuda compared with the UK (7.3% compared with 1.3%) and over twice as many Bermudians had kidney dialysis or transplants during 2016. The true figure in Bermuda may be even higher since patients with end stage renal failure are likely to stop work and not be included in the insurance dataset.

Figure 10 Kidney failure in people with diabetes



6.2.4 Blood and urine tests in people with diabetes

UK patients with diabetes were much more likely to have blood tests compared with the Bermuda sample. Information on the results of the blood tests is not available for the Bermuda data.

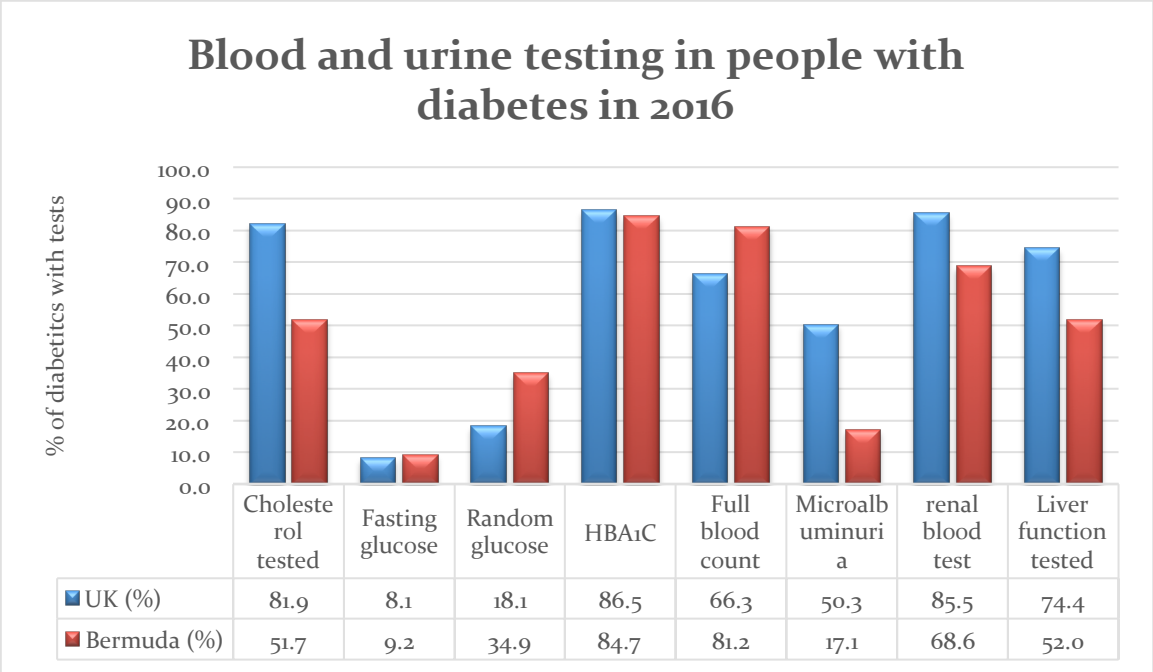
Testing for HBA1C was similar however with 85% of Bermudians having a glycosylated haemoglobin (HBA1C) recorded compared with 87% in the UK. More Bermudians had a random glucose measurement and more have a full blood count than in the UK.

However

- Fewer Bermudians (67%) had a kidney blood test during 2016 compared than in the UK (86%).

- Fewer Bermudians (17%) had the urine test for micro-albuminuria (which is designed to identify early signs of kidney disease) compared with 50.3% of those in the UK.
- Fewer Bermudians had lipids recorded (52%) compared with the UK (82%).
- Fewer Bermudians had liver function tests recorded (52%) compared with the UK (74%).

Figure 11 Blood and urine testing in people with diabetes

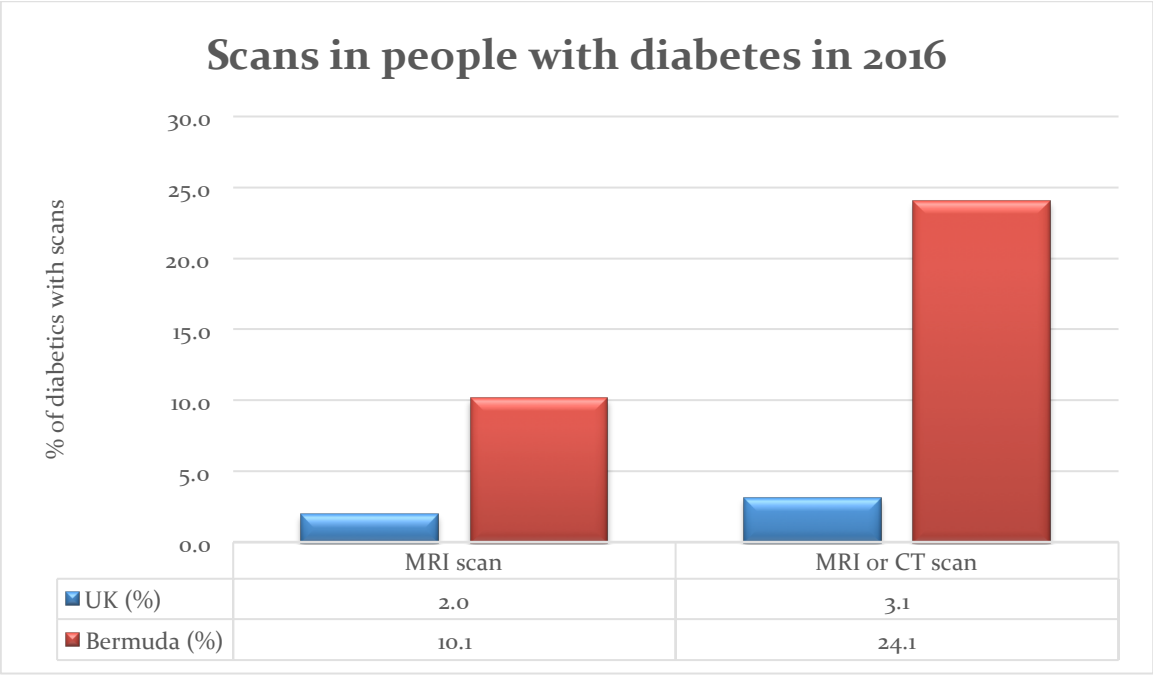


These findings suggest that whilst HBA1C monitoring is similar between the two countries, the monitoring of kidney function and lipids among Bermudian patients with diabetes is less intensive than the UK. It is possible that this may contribute to the higher prevalence of complications such as renal failure in Bermuda. This could be related to the high co-pays for people who may have tests requested but no follow-through on testing, due to costs. This could also reflect a lack of test requests from the physician. However, it is not possible to tease these apart in the absence of care quality measures.

6.2.5 MRI and CT scans in people with diabetes

Bermudian patients with diabetes were 8 times more likely to have a MRI or CT scan compared with UK patients with diabetes as shown in the figure below. Almost one in five Bermudians with diabetes had a MRI or CT scan (24.1%) compared with 3.1% of UK patients.

Figure 12 MRI and CT scans in people with diabetes



7 Acknowledgements

We acknowledge the contribution of EMIS practices who contribute to QResearch® and EMIS Health and the University of Nottingham for expertise in establishing, developing and supporting the QResearch database. The Hospital Episode Statistics data used in this analysis are re-used by permission from the NHS Digital who retain the copyright in the raw data. We thank Sean and Jenny Riddell for funding this work, and the public health, clinical, insurance company and IT personnel from Bermuda who provided valuable comments on the interpretation of the data.

8 Appendix 1

Table 1 shows the characteristics of the overall population in QResearch in the UK and Bermuda

	QResearch (column %)	Bermuda (column %)
Total patients in sample	8910307	20632
Men	4452920 (50.0)	9881 (47.9)
0-4 years	413940 (4.6)	915 (4.4)
5-15 years	1140895 (12.8)	2465 (11.9)
16-24 years	989581 (11.1)	1953 (9.5)
25-34 years	1344554 (15.1)	3010 (14.6)
35-44 years	1236575 (13.9)	3667 (17.8)
45-54 years	1264580 (14.2)	3591 (17.4)
55-64 years	996657 (11.2)	3123 (15.1)
65-74 years	815521 (9.2)	1305 (6.3)
75-84 years	483547 (5.4)	434 (2.1)
85+ years	224457 (2.5)	169 (0.8)
Diabetes	489471 (5.5)	1135 (5.5)
Hypertension	1239592 (13.9)	2287 (11.1)
Coronary heart disease	253861 (2.8)	316 (1.5)
Heart failure	55549 (0.6)	59 (0.3)
Stroke	80825 (0.9)	69 (0.3)
Diabetic retinopathy	51970 (0.6)	220 (1.1)
Blindness	946 (0.0)	18 (0.1)
Amputation	8513 (0.1)	8 (0.0)
Kidney transplant	3788 (0.0)	14 (0.1)
Kidney dialysis	6831 (0.1)	32 (0.2)
Kidney transplant or dialysis	8498 (0.1)	43 (0.2)
Kidney failure	17641 (0.2)	224 (1.1)
Cholesterol tested	1661613 (18.6)	4455 (21.6)
Fasting glucose	291930 (3.3)	123 (0.6)
Random glucose	597684 (6.7)	1385 (6.7)
HBA1C	1435160 (16.1)	3932 (19.1)
Full blood count	2176330 (24.4)	7889 (38.2)
Micro-albuminuria	376259 (4.2)	1030 (5.0)
Kidney function blood test	2365585 (26.5)	5037 (24.4)
Liver function tested	1987971 (22.3)	4203 (20.4)
MRI scan	91414 (1.0)	938 (4.5)
MRI or CT scan	110778 (1.2)	1947 (9.4)

Table 2 Characteristics of patients with diabetes in the UK compared with Bermuda

	QResearch (column %)	Bermuda (column %)
Total patients with diabetes	489471	1135
Prescribed insulin or oral hypoglycaemics	325060 (66.4)	590 (52.0)
Prescribed oral hypoglycaemics	279565 (57.1)	439 (38.7)
Men	272992 (55.8)	567 (50.0)
Mean age(SD)	64.5 (15.5)	57.2 (14.4)
Hypertension	285526 (58.3)	468 (41.2)
Coronary heart disease	71465 (14.6)	88 (7.8)
Heart failure	17745 (3.6)	20 (1.8)
Stroke	19944 (4.1)	11 (1.0)
Diabetic retinopathy	51601 (10.5)	66 (5.8)
Blindness	168 (0.0)	<5
Amputation	3774 (0.8)	<5
Kidney transplant	972 (0.2)	5 (0.4)
Kidney dialysis	2470 (0.5)	12 (1.1)
Kidney transplant or dialysis	2854 (0.6)	15 (1.3)
Kidney failure	6369 (1.3)	83 (7.3)
Cholesterol tested	400993 (81.9)	587 (51.7)
Fasting glucose	39530 (8.1)	104 (9.2)
Random glucose	88818 (18.1)	396 (34.9)
HBA1C	423165 (86.5)	961 (84.7)
Full blood count	324688 (66.3)	921 (81.1)
Micro-albuminuria	246048 (50.3)	194 (17.1)
Kidney function blood test	418569 (85.5)	779 (68.6)
Liver function tested	364341 (74.4)	590 (52.0)
MRI scan	9622 (2.0)	115 (10.1)
MRI or CT scan	15365 (3.1)	273 (24.1)