Estimating and Examining the Costs of Inpatient Diabetes Care in an Irish Public Hospital

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RESEARCH ARTICLE

Estimating and examining the costs of inpatient diabetes care in an Irish Public Hospital

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Abstract

Aim: To estimate and examine hospitalisation costs of Type 1 and Type 2 diabetes in an Irish public hospital.

Methods: A retrospective audit of hospital inpatient admissions over a 5-year period was undertaken, and a wide range of admission-related data were collected for a sample of 7,548 admissions. Hospitalisations were costed using the diagnosis-related group methodology. A series of descriptive, univariate and multivariate regression analyses were undertaken.

Results: The mean hospitalisation cost for Type 1 diabetes was €4,027 and for Type 2 diabetes was €5,026 per admission. Sex, admission type and length of stay were significantly associated with hospitalisation costs for admissions with a primary diagnosis of Type 1 diabetes. Age, admission type, diagnosis status, complications status, discharge destination, length of stay and year were significantly associated with hospitalisation costs for admissions with a primary diagnosis of Type 2 diabetes. Length of stay was associated with higher mean costs, with each additional day increasing Type 1 diabetes costs by €260 ($p = 0.001$) and Type 2 diabetes by €216 ($p < 0.001$). Unscheduled admissions were associated with significantly lower costs than elective admissions; €1,578 ($p = 0.035$) lower for Type 1 diabetes and €2,108 ($p < 0.001$) lower for Type 2 diabetes.

Conclusions: This study presents estimates of the costs of diabetes care in the Irish public hospital system and identifies the factors which influence costs for Type 1 and Type 2 diabetes. These findings may be of interest to patients, the public, researchers and those with influence over diabetes policy and practice in Ireland and internationally.

KEYWORDS

costs, diabetes mellitus, economic impact, hospitalisation, inpatients, length of stay

1 | INTRODUCTION

Diabetes and its complications cause substantial economic impacts for those living with the condition and their families, for health systems and for economies through, for example, direct medical and healthcare costs, and indirect costs, such as the loss of work, wages and productivity.[1] There is a need to better understand the nature of the economic burden of diabetes on healthcare systems to better inform those charged with directing future policy and practice. The projected growth in diabetes poses a further significant risk to the operation and financing of the healthcare systems and requires an evidence base to inform the necessary policy response. A better understanding of the nature and drivers of diabetes costs may not only highlight the potential impact of rising prevalence levels but also form the economic basis for investment in preventive and clinical management strategies for Type 1 and Type 2 diabetes. Within this context, the role of hospital care is a key consideration, as it constitutes the major component of the healthcare burden of diabetes, and therefore, it has the greatest potential to benefit from the cost savings attributable to improvements in diabetes prevention and clinical management.

Limited evidence is available on the economics of diabetes care in Ireland. In the case of the Irish healthcare system, the estimated cost of managing diabetes is 12–14% (approximately €2billion) of the annual health budget.[2] Adopting a cost of illness approach, the CODEIRE study[3] demonstrated Type 2 diabetes to be a costly disease in Ireland in 2006, with annual total direct costs (hospitalisations, ambulatory and drug costs) estimated at €580 million for both diagnosed and undiagnosed diabetes. Notably, the study stated that hospitalisations were the main driver of costs, accounting for almost half of the overall cost estimate, which was primarily due to diabetes-related complications. In a more recent study based on a cross-sectional analysis of The Irish LongituDinal Study on Ageing (TILDA),[4] the incremental cost of the additional service use attributable to diabetes was estimated to be €89 million annually, with hospital admission accounting for 67% of these costs.[5] Importantly, these estimates were based on self-reported service use by study participants. Indeed, this reflects a historical paucity in the availability of healthcare resource use and cost data for Ireland, and the pragmatic approaches that researchers have had to take to address this problem. Notwithstanding this limited economic evidence base for Ireland, a particular area of concern given the projected growth in diabetes care is that of the already resource-constrained public hospital system. Moreover, with recent improvements in hospitalisation data availability in Ireland, there an onus on researchers to use these data to provide better evidence relating to hospitalisation costs, and in doing so, to better inform healthcare decision making process. In this paper, hospitalisation data obtained from an Irish public hospital, and costed using the diagnosis-related group methodology, was used to estimate and examine the costs of Type 1 diabetes and Type 2 diabetes in Ireland. The implications of the Covid-19 pandemic for diabetes care in public hospital systems is an important consideration as the impacts of delaying necessary hospital-based diabetes treatment because of Covid-19, will likely increase the future burden on public hospitals as they attempt to continue to meet ongoing healthcare needs in the future.

Novelty statement

- Diabetes and its complications cause substantial economic impacts for those living with the condition and their families, for health systems and for economies. Our findings highlight the average costs of care for Type 1 and Type 2 diabetes, and thereby point to the potential cost savings that may be achievable through investment in effective diabetes prevention and clinical management strategies which reduce rates of hospitalisations. These data form part of the economic rationale to support international policy recommendations and investment in diabetes prevention and clinical management in primary and community care.

2 | RESEARCH DESIGN AND METHODS

2.1 | Data sources and sample characteristics

A retrospective audit of diabetes-related hospital admissions for the period 2013–2017 inclusively, was undertaken for an Irish public hospital in the west of the country. Ethical approval for the study was obtained from the hospital-based Clinical Research Ethics Committee on 11 June 2019 following which a request was made to the Hospital Inpatient Enquiry (HIPE) Department, the national agency responsible for public hospital data records in Ireland. Diabetes-related admissions in HIPE were identified using the International Statistical Classification of Diseases and Related Health Problems, 10th Revision (ICD-10 V. 8.0) categorisation and based on HIPE's quality reports (Appendix A).

Only those with a diabetes-related admission on their record were included in this data set, which comprised of 7,548 single hospital admissions and up to 16 diagnostic fields and five procedure fields. Data extracted included admission and discharge dates (i.e. length of hospital stay in days), primary diagnosis on hospital admission, diabetes complications ((no complications, one complication, two complications, three or more complications (Appendix A)), age, sex, admission type (elective and unscheduled), discharge destination (self, residence/home, nursing home, emergency and nonemergency transfer to other acute hospital, psychiatric hospital and decreased), insurance type (public or private) and Diagnoses Related Group (DRG) category and cost rate. As outlined in Table 1, of the sample, 427 (6%) were diagnosed with Type 1 diabetes and 7,121 (94%) with Type 2 diabetes. The sample was aged between 21 and 106 years (75 $\pm$ 14); with 4,473 men (59%) and 3,075 women (41%) included in this cohort.

2.2 | Cost analysis

Public hospitalisations in Ireland are categorised into DRGs, that are associated with cost and reimbursement rates using a method based on the Australian Diagnosis Related Groups (ARDRG) system.[6] The costs per DRG, which were presented in Euros in 2017 prices, and obtained from the Activity Based Funding price list for Ireland[7] were applied to estimate the cost of each hospitalisation in the data set.

2.3 | Statistical analysis

A series of descriptive, univariate and multivariate regression analyses, using a generalised linear model (GLM) technique, were undertaken. Means, medians, standard deviations and interquartile ranges were estimated to summarise hospitalisation costs for Type 1 diabetes and Type 2 diabetes. The univariate analysis consisted of independent *t*-tests, analysis of variance (ANOVA) for continuous variables and χ^2 tests for categorical variables to examine associations between participants and treatment-related factors, admissions and costs for Type 1 and Type 2 diabetes. A GLM regression assuming a distribution informed by a modified park test, and a log link function informed by a Pearson correlation test, a Pregibon link test and a Modified Hosmer and Lemeshow test, was adopted for the cost regression analysis. This approach has been shown to be appropriate for the analysis of cost data, which is often complicated in nature.[8,9] Separate cost regression models were estimated for Type 1 diabetes and Type 2 diabetes; in both cases, the models were estimated controlling for sex, age, admission type, primary diagnosis status, complications status, health insurance status, discharge destination and length of stay in days and year. Statistical significance was explored at the 0.05 level, model fit by the Akaike information criterion (AIC), and all analyses performed using SPSS version 26.0 software[10] and Stata version 15.0 software.[11]

3 | RESULTS

Summary statistics on the characteristics of study participants and a comparison for those with Type 1 and Type 2 diabetes are provided in Table 1. It is notable that statistically significant differences exist with respect to age, sex, primary diagnosis of diabetes on hospital admission, complications, discharge destination, discharge year and length of stay in days (Table S1*)* between Type 1 and Type 2 diabetes. For example, Type 2 diabetes admissions were more likely to be men, have a primary diagnosis on hospital admission other than diabetes, experience diabetes-related complications and have a longer length of hospital stay.

Table 2 (and Table S2) presents the results for the summary statistics for single hospitalisation costs and the univariate analysis. The mean hospitalisation cost for Type 1 diabetes was €4,027 and for Type 2 diabetes was €5,026 per admission. In the case of Type 1 diabetes, mean inpatient costs were higher for men, and for those aged 75 years and over, relative to those in younger age groups. For Type 2 diabetes, older age was associated with higher inpatient costs, with costs for those aged 75 years and over, generally higher than those for younger age groups. In addition, Type 2 diabetes costs were higher for elective admissions among those with diabetes complications and where diabetes was not their primary diagnosis on hospital admission. In respect of discharge destination, costs were found to vary significantly among those with Type 1 and Type 2 diabetes. For example, discharges to hospice and nursing care homes showed higher costs for those participants with Type 2 diabetes with significantly higher costs observed for those individuals who died while in hospital. Notably, costs of Type 2 diabetes appeared to be decreasing marginally from 2013 to 2017.

The results for the GLM analyses of hospitalisation costs are presented in Table 3 and are summarised below. In both cases, a GLM regression assuming an inverse Gaussian distribution and a 1.5 power link function was the preferred approach. The results for the following alternative model specifications are presented in the supplementary materials (Tables S3–S5): (S3) Family: inverse

TABLE 1 Sample characteristics

Variable	Total sample (n = 7548)	Type 1 diabetes (n = 427)	Type 2 diabetes (n = 7121)	*p*-value
Sex				
Men	4,473 (59)	228 (53)	4,245 (60)	
Women	3,075 (41)	199 (47)	2,876 (40)	0.011
Age (Years)	75 ± 14, 78 (69,86)	50 ± 20, 48 (31,67)	77 ± 12, 78 (70,86)	<0.001
Age group				
< 30 years	114 (1.5)	93 (22)	21 (0.3)	<0.001
30–44 years	203 (2.7)	108 (25)	95 (1.3)	
45–59 years	599 (7.9)	93 (22)	506 (7.1)	
60–74 years	2,053 (27)	61 (14)	1,992 (28)	
75+ years	4,578 (61)	71 (17)	4,507 (63)	
Admission type				
Elective	580 (7.7)	28 (6.6)	552 (7.8)	0.368
Unscheduled	6,968 (92)	399 (93)	6,569 (92)	
Primary diagnosis on hospital admission				
Not diabetes	6,941 (92)	242 (57)	6,699 (94)	<0.001
Diabetes	607 (8.0)	185 (43)	422 (5.9)	
Complications				
No diabetes complications	3,799 (50)	152 (36)	3,647 (51)	<0.001
1 diabetes complication	3,162 (42)	223 (52)	2,939 (41)	
2 diabetes complications	455 (6.0)	35 (8.2)	420 (6.0)	
3 or more complications	132 (1.7)	17 (4.0)	115 (1.6)	
Insurance				
Public	7,026 (93)	388 (91)	6,638 (93)	0.063
Private	522 (6.9)	39 (8.9)	483 (6.8)	
Discharge destination				
Self-discharged	52 (0.7)	11 (2.6)	41 (0.6)	<0.001
Residence (return home)	5,937 (79)	390 (91)	5,547 (78)	
Nursing/care home	902 (12)	15 (3.5)	887 (12)	
Emergency transfer	325 (4.3)	9 (1.9)	316 (4.4)	
Psychiatric hospital	45 (0.6)	0 (0.0)	45 (0.6)	
Hospice	47 (0.6)	0 (0.0)	47 (0.7)	
Died	240 (3.2)	2 (0.5)	238 (3.3)	
Discharge year				
2013	1177 (16)	80 (19)	1097 (15.4)	<0.001
2014	1267 (17)	103 (24)	1164 (16)	
2015	1582 (21)	74 (17)	1508 (21)	
2016	1679 (22)	84 (20)	1595 (22.4)	
2017	1843 (24)	86 (20)	1757 (25)	
Length of stay (days)	8 ± 13, 5 (2,10)	5 ± 8, 2 (1,5)	9 ± 13, 5 (2,10)	<0.001

Note: Statistical analysis consisted of t-test for continuous variables and χ^2 tests for categorical variables. Continuous data is displayed as mean ± SD, median (quartile 1, quartile 3); categorical data are reported as n (%).

TABLE 2 Mean ± SD of inpatient costs (€) for Type 1 and Type 2 diabetes

Variable	Inpatient costs € Type 1 diabetes	*p*-value	Inpatient costs € Type 2 diabetes	*p*-value
Full sample	4027 ± 3604		5026 ± 5674	<0.001
Sex				
Men	4464 ± 4319	0.007	4983 ± 5498	0.436
Women	3528 ± 2456		5081 ± 5924	
Age				
< 30 years	3529 ± 2117	0.004	3483 ± 2988	<0.001
30–44 years	3162 ± 1637		3738 ± 2679	
45–59 years	4667 ± 5974		4935 ± 7822	
60–74 years	4341 ± 3102		4709 ± 5779	
75+ years	4884 ± 3276		5211 ± 5379	
Admission type				
Elective	5079 ± 2647	0.110	6570 ± 6078	<0.001
Unscheduled	3954 ± 3649		4896 ± 5619	
Primary diagnosis on hospital admission				
Not primary diagnosis	3995 ± 3200	0.837	5057 ± 5790	0.003
Primary diagnosis	4070 ± 4074		4533 ± 3274	
complications				
No diabetes complications	3628 ± 2355	0.350	4500 ± 4689	<0.001
1 diabetes complication	4183 ± 4401		5472 ± 6340	
2 diabetes complications	4543 ± 2502		5954 ± 5798	
3 or more complications	4492 ± 2841		6911 ± 11273	
Insurance				
Public	4021 ± 3725	0.904	4988 ± 5438	0.145
Private	4094 ± 2000		5545 ± 8246	
Discharge destination				
Self-discharged	4151 ± 3824	< 0.001	4100 (3214)	<0.001
Residence (return home)	3864 ± 3457		4528 (4317)	
Nursing/care home	5914 ± 2340		6165 (6551)	
Emergency transfer	4542 ± 3471		5640 (9075)	
Psychiatric hospital	n/a		6436 (8104)	
Hospice	n/a		6525 (2881)	
Died	18877 ± 7607		11169 (13977)	
Discharge year				
2013	3723 ± 1904	0.545	5570 ± 7620	<0.001
2014	4143 ± 2552		5456 ± 6622	
2015	4738 ± 7091		4893 ± 5729	
2016	3727 ± 2255		4908 ± 4466	
2017	3855 ± 2255		4662 ± 4305	

Note: Statistical analysis consisted of independent *t*-tests for binary predictors and ANOVA those categorical predictors with more than two levels. As both *t*-test and ANOVA involve comparison of group means, results for costs are displayed as mean ± SD.

Gaussian; Link: Identity; (S4) Family: Gamma; Link: Log; (S5) Family: Gaussian; Link: Identity.

Sex, admission type and length of stay were significantly associated with costs for admissions with a primary diagnosis of Type 1 diabetes. Women's admissions were less costly by €866 ($p < 0.001$) than men's admissions. Admissions with a primary diagnosis of diabetes were associated with higher costs of €654 ($p = 0.007$) relative to

TABLE 3 Marginal effects and standard errors for variables associated with in-patient diabetes costs, estimated using generalised linear models with an inverse Gaussian distribution and a 1.5 power link function

Variable	Type 1 diabetes		Type 2 diabetes	
	inpatient costs € marginal effects (standard errors)	*p*-value	inpatient costs € marginal effects (standard errors)	*p*-value
Sex				
Men (reference category (Ref))				
Women	−866 (205)	< 0.001	62 (52)	0.232
Age				
< 30 years (Ref)				
30–44 years	−449 (239)	0.060	121 (212)	0.568
45–59 years	86 (341)	0.800	452 (199)	0.023
60–74 years	54 (337)	0.872	697 (192)	< 0.001
75+ years	12 (322)	0.970	855 (191)	< 0.001
Admission type				
Elective (Ref)				
Unscheduled	−1578 (748)	0.035	−2108 (224)	< 0.001
Primary diagnosis				
Not primary diagnosis (Ref)				
Primary diagnosis	654 (242)	0.007	330 (133)	0.014
Complications				
No diabetes complications (Ref)				
1 diabetes complication	165 (218)	0.449	536 (68)	< 0.001
2 diabetes complications	390 (563)	0.489	719 (177)	< 0.001
3 or more complications	−216 (510)	0.672	848 (374)	0.023
Insurance				
Public (Ref)				
Private	416 (415)	0.317	176 (118)	0.134
Discharge destination				
Self-discharged	−20 (512)	0.969	−315 (194)	0.104
Residence (return home) (Ref)				
Nursing/care home	1307 (1307)	0.289	633 (133)	< 0.001
Emergency transfer	−1030 (1233)	0.289	533 (197)	0.007
Psychiatric hospital	n/a	n/a	766 (488)	0.117
Hospice	n/a	n/a	1946 (902)	0.031
Died	22968 (37891)	0.544	6795 (1050)	< 0.001
Length of stay (Days)	260 (48)	< 0.001	216 (9)	< 0.001
Year				
2013 (Ref)				
2014	38 (297)	0.897	99 (101)	0.329
2015	85 (285)	0.766	51 (91)	0.572
2016	120 (220)	0.584	449 (98)	< 0.001
2017	−171 (256)	0.505	191 (93)	0.041

Note: Abbreviation: Ref, reference category; IG, inverse Gaussian; AIC, Akaike Information Criterion.

an alternative diagnosis. Unscheduled admissions were associated with lower costs of €1578 ($p = 0.035$) relative to elective admissions. Length of stay was associated with higher mean costs, with each additional day increasing costs by €260 ($p = 0.001$). Admissions for women aged between 30 and 44 years were less costly than those aged less

than 30 years while discharge destination, and, if a patient died in hospital were associated with a cost increase relative to the reference category of residence, however, no association was observed in the multivariable analysis. In 2017, costs decreased per admission relative to previous years; however, these differences were also not found to be significant.

Age, admission type, diagnosis status, complications status, discharge destination, length of stay and year were significantly associated with costs for admissions with a primary diagnosis of Type 2 diabetes. Relative to those aged under 30 years, older age cohorts of 45–59, 60–74 and 75 and over were associated with additional costs of €452 ($p = 0.023$), €697 ($p < 0.001$), and €855 ($p < 0.001$) respectively. Admissions with a primary diagnosis of diabetes were associated wither higher costs of €330 ($p = 0.014$). Unscheduled admissions were associated with lower costs of €2,108 ($p < 0.001$) relative to elective admissions. Complications were associated with higher costs, with one, two and three or more complications associated with additional costs of €536 ($p < 0.001$), €719 ($p < 0.001$), and €848 ($p = 0.023$), respectively. Discharge destination for Type 2 diabetes were higher for those discharged to further care and those who died, relative to those discharged home. Length of stay was associated with higher mean inpatient costs, with each additional day increasing costs by €216 ($p < 0.001$). Notably, year was statistically significant, with 2016 and 2017 differing from the reference year of 2013.

4 | DISCUSSION

Given the significant burden that diabetes places on healthcare systems in Ireland and internationally, and the role that hospital care plays in this context, this study estimated and examined the costs of Type 1 and Type 2 diabetes in an Irish public hospital setting. Considering projected increasing prevalence levels and competing calls for investment on already resource constrained health budgets, our findings highlight the average costs of care for Type 1 and Type 2 diabetes, and thereby point to the potential cost savings that may be achievable through investment in effective diabetes prevention and clinical management strategies, which reduce rates of hospitalisations. That said, evidence on the clinical and cost effectiveness of such interventions would be required to inform decisions on their reimbursement and implementation in clinical practice.

In this study, the factors associated with variations in hospitalisation costs were also considered. Although some factors are unlikely to be changed by policy intervention, length of hospital stay and risk factors for complications of diabetes are certainly modifiable. An increase in costs up to €6,911 was associated with Type 2 diabetes with complications and substantiates the investigation by O'Neill et al.[5] that Type 2 diabetes hospitalisations due to diabetes-related complications are a key driver of costs. Each additional day in hospital increases approximately 3 percentage points to basic costs for those with Type 1 diabetes and 2 percentage points for those with Type 2 diabetes. This is a significant cost driver considering the unwarranted extended length of hospital stay for those with diabetes.[12] Length of stay for those transitioning to a nursing home is up to 14 days so a decrease here could lessen costs, but it is unclear from the data whether this pertains to the patient's illness or if awaiting suitable accommodation.

More needs to be done to keep people living well with diabetes. Treating patients with long-term conditions as close to home as possible with quality care from a dedicated team of experienced professionals could be a more efficient system in the management of diabetes and prevention of its complications. New developments in technology, clinical practice and the integration of health and social care, primary and secondary care are facilitating a transformation in health service provision. The National Model of Integrated Care for Patients with Type 2 Diabetes[13] aims to prevent the onset of Type 2 diabetes and improve the delivery of diabetes care to those living with the condition. This is particularly important for our aging population who are at increased risk of comorbidities, increased prevalence of long-term conditions and ultimately healthcare utilisation.[14] Given the healthcare utilisation impacts reported here, and the projected increased prevalence of diabetes in the future, there is likely to be a reciprocal impact on healthcare costs with current figures demonstrating that diabetes accounts for up to 14% of the Irish health budget[2] and costs of service provision estimated to be €89 million annually.[5] Similar costs are noted in NHS England, Wales (£14billion)[12] and Scotland (£1billion).[15] Direct costs of hospital complications constitute a large cost component of managing and treating diabetes.[16-18] Not only does diabetes increase medical expenditures, but the effect grows over time with the condition increasing the likelihood of hospitalisation by two to six times.[19] The costs generated in this paper correspond to other national healthcare settings with complications contributing factors in increased costs and length of hospital stay.

This study provides estimates of inpatient hospitalisation costs related to Type 1 and Type 2 diabetes in the Irish public hospital system, using the DRG costing methodology. The analysis identifies the factors which influence inpatient costs for Type 1 and Type 2 diabetes and

provides estimates of the potential inpatient cost savings that could accrue to health systems through the prevention and reduction of diabetes-related complications and admissions. Together, these findings provide additional weight behind the economic argument for further investment in diabetes prevention and disease management strategies.[20,21] That is, the prevention of diabetes-related inpatient admissions has the potential to generate substantial savings in health budgets, and such savings could be reallocated to invest in diabetes prevention and disease management programmes. As the study is specific to the Irish context, it supports the economic evidence review of the National Clinical Guideline for adults with Type 1 diabetes mellitus that highlights an evidential lack of literature that is specific to the Irish healthcare setting[22] and further embraces the National Model of Integrated Care for Patients with Type 2 Diabetes.[13] Considering the projected growth in diabetes prevalence in Ireland and internationally, these findings should be of interest to patients, the public, researchers and those with influence over diabetes care policy and practice in Ireland and internationally.

This paper has several limitations that need to be considered. Only those admissions with a diagnosis of diabetes were requested for this analysis. As a result, we are unable to make cost comparisons with non-diabetes admissions or identify several hospitalisations for the same patient. A further limitation of the paper is the data itself wherein risk factors such as previous history of conditions, duration of diabetes, treatments received and biomarkers were not available. Another possible caveat is that many DRG codes distinguish between conditions where another complication is present, for example, this data set coded diabetes as a secondary diagnosis where the condition will require treatment and monitoring during hospital stay. Furthermore, primary and outpatient care costs are likely to be significant in these populations but were not included. This study used data from hospital coding practice, were variations and inaccuracies may exist. Studies show that barriers to clinical coding quality include the data generated particularly at the level of documentation completed by healthcare providers, incomplete and unorganised chart documentation, and lack of communication for clarification. Furthermore, clinical coding quality suffered because of limited resources such as staffing and budget, variability in the documents used for coding and illegibility of handwriting when coding on paper.[23-25] Finally, although appropriate regression approaches were employed and the preferred models adopted, the Pregibon link test result for the Type 2 diabetes analysis raises questions over the link function adopted. This reflects the complexity in analysing cost data and should be considered in the interpretation of the findings presented.

5 | CONCLUSIONS

The estimates in this study provide a measure of the burden on public hospital systems that is associated with the care of diabetes, the factors influencing diabetes-related hospitalisation costs, and the potential cost savings to health systems through the prevention of hospital admissions. The analysis provides information that will be useful to future research that seeks to examine questions of the cost and cost effectiveness of diabetes care. In particular, these data form part of the economic rationale to support international policy recommendations and investment in diabetes prevention and clinical management in primary and community care.

CONFLICT OF INTERESTS

The authors declared no potential conflicts of interest with respect to the research, authorship and/or publication of this article.

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SUPPORTING INFORMATION

Additional supporting information may be found in the online version of the article at the publisher's website.

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APPENDIX A

List of ICD-10 codes used to identify Type 1 and Type 2 diabetes.

Data were received for hospital acquired diagnosis 1–16 and procedures 1–5 that included all diagnoses (ICD-10-AM) between e10 (Type 1 diabetes mellitus) and e149 (unspecified DM without complication) and all diagnoses between e16 (other disorders of pancreatic internal secretion) and e162 (hypoglycaemia unspecified). The complete list is provided below:

E10.01 Type 1 diabetes mellitus with hyperosmolarity without nonketotic hyperglycaemic-hyperosmolar coma (NKHHC)
E10.11 Type 1 diabetes mellitus with ketoacidosis, without coma
E10.29 Type 1 diabetes mellitus with other specified kidney complication
E10.31 Type 1 diabetes mellitus with background retinopathy
E10.64 Type 1 diabetes mellitus with hypoglycaemia
E10.65 Type 1 diabetes mellitus with poor control
E10.69 Type 1 diabetes mellitus with other specified complication
E10.73 Type 1 diabetes mellitus with foot ulcer due to multiple causes
E10.9 Type 1 diabetes mellitus without complication
E11.01 Type 2 diabetes mellitus with hyperosmolarity without nonketotic hyperglycaemic-hyperosmolar coma [NKHHC]
E11.02 Type 2 diabetes mellitus with hyperosmolarity with coma
E11.11 Type 2 diabetes mellitus with ketoacidosis, without coma
E11.22 Type 2 diabetes mellitus with established diabetic nephropathy
E11.29 Type 2 diabetes mellitus with other specified kidney complication
E11.33 Type 2 diabetes mellitus with proliferative retinopathy
E11.34 Type 2 diabetes mellitus with other retinopathy
E11.42 Type 2 diabetes mellitus with diabetic polyneuropathy
E11.43 Type 2 diabetes mellitus with diabetic autonomic neuropathy
E11.52 Type 2 diabetes mellitus with peripheral angiopathy, with gangrene
E11.64 Type 2 diabetes mellitus with hypoglycaemia
E11.65 Type 2 diabetes mellitus with poor control
E11.69 Type 2 diabetes mellitus with other specified complication
E11.71 Type 2 diabetes mellitus with multiple microvascular and other specified nonvascular complications
E11.72 Type 2 diabetes mellitus with features of insulin resistance
E11.73 Type 2 diabetes mellitus with foot ulcer due to multiple causes
E11.9 Type 2 diabetes mellitus without complication
E13.61 Other specified diabetes mellitus with specified diabetic musculoskeletal and connective tissue complication
E13.65 Other specified diabetes mellitus with poor control
E13.69 Other specified diabetes mellitus with other specified complication
E13.9 Other specified diabetes mellitus without complication

APPENDIX B

Diagnosis ascertaining the presence of complications.

With complication(s)	Without complication(s)
E11.01 Type 2 diabetes mellitus with hyperosmolarity without nonketotic hyperglycaemic-hyperosmolar coma [NKHHC]	E10.9 Type 1 diabetes mellitus without complication
E11.02 Type 2 diabetes mellitus with hyperosmolarity with coma	E11.9 Type 2 diabetes mellitus without complication
E11.11 Type 2 diabetes mellitus with ketoacidosis, without coma	E13.9 Other specified diabetes mellitus without complication
E11.22 Type 2 diabetes mellitus with established diabetic nephropathy	
E11.29 Type 2 diabetes mellitus with other specified kidney complication	
E11.33 Type 2 diabetes mellitus with proliferative retinopathy	
E11.34 Type 2 diabetes mellitus with other retinopathy	
E11.42 Type 2 diabetes mellitus with diabetic polyneuropathy	
E11.43 Type 2 diabetes mellitus with diabetic autonomic neuropathy	
E11.52 Type 2 diabetes mellitus with peripheral angiopathy, with gangrene	
E11.64 Type 2 diabetes mellitus with hypoglycaemia	
E11.65 Type 2 diabetes mellitus with poor control	
E11.69 Type 2 diabetes mellitus with other specified complication	
E11.71 Type 2 diabetes mellitus with multiple microvascular and other specified nonvascular complications	
E11.72 Type 2 diabetes mellitus with features of insulin resistance	
E11.73 Type 2 diabetes mellitus with foot ulcer due to multiple causes	
E13.61 Other specified diabetes mellitus with specified diabetic musculoskeletal and connective tissue complication	
E13.65 Other specified diabetes mellitus with poor control	
E13.69 Other specified diabetes mellitus with other specified complication	