Diabet Med. Author manuscript; available in PMC 2014 October 31.

Published in final edited form as:
Diabet Med. 2011 December ; 28(12): 1514–1519. doi:10.1111/j.1464-5491.2011.03432.x.

Assessment of the under-reporting of diabetes in hospital admission data: a study from the Scottish Diabetes Research Network Epidemiology Group:

Under-reporting of diabetes in hospital admission data

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Summary

Aims—Good quality data are required to plan and evaluate diabetes services and to assess progress against targets for reducing hospital admissions and bed days. The aim of this study was to assess the completeness of recording of diabetes in hospital admissions using recent national data for Scotland.

Methods—Data derived from linkage of the Scottish national diabetes register and hospital admissions data were analysed to assess the completeness of coding of diabetes in hospital inpatient admissions between 2000 and 2007 for patients identified with diabetes prior to hospital admission.

Results—In 2007 only 59% of hospital inpatient admissions for people previously diagnosed with diabetes mentioned diabetes, whereas over 99% of people with a mention of diabetes on hospital records were included in the diabetes register. The completeness of diabetes recording varied from 44% to 82% among mainland NHS Boards and from 34% to 89% among large general hospitals. Completeness of recording of diabetes as a co-morbidity also varied by primary diagnosis: 70% and 41% of admissions with coronary heart disease and cancer as the primary diagnosis mentioned co-existing diabetes respectively.

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Conclusion—There is wide variation in the completeness of recording of diabetes in hospital admission data. Hospital data alone considerably underestimate the number of admissions and bed days but overestimate length of stay for people with diabetes. Linkage of diabetes register data to hospital admissions data provides a more accurate source for measuring hospital admissions among people diagnosed with diabetes than hospital admissions data.

Keywords

Diabetes; Hospital admissions; Linkage

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Introduction

Hospital admissions data are used for various purposes, including service planning and research. With the rise in prevalence of diabetes, reliable data on hospital admissions for people with diabetes are vital to help understand the burden of diabetes on secondary care and to evaluate the impact of initiatives to prevent diabetes and its complications. However it is acknowledged that diabetes is often not recognised or recorded as the underlying reason for hospital admission. Leslie et al [1] showed in 1992 that discharge statistics for a single hospital in Scotland considerably underestimated the importance of diabetes as a cause of hospital admission. It is not clear whether these results were typical or whether diabetes recording has improved since then.

Hospital admissions data are frequently used to compare performance and quality. For example, the Organisation for Economic Co-operation and Development (OECD) Health Care Quality Indicators (http://www.oecd.org/health/hcqi) use diabetes related lower extremity amputation as a measure of the quality of diabetes care. However, it is not known whether all amputations among people with diabetes can be identified by use of routine hospital data. Similarly, target 6 of the Scottish Health improvement, Efficiency, Access, and Treatment (HEAT) targets measures progress towards reductions in hospital admissions and bed days for patients with primary diagnoses of diabetes (and other chronic conditions). It is not clear what proportion of admissions attributable to diabetes is captured using this approach.

As a large proportion of the costs to the National Health Service related to diabetes arise from costs incurred in secondary care, it is clear that good quality data are needed in order to estimate the human and financial costs of diabetes accurately.

Hospital records allow the recording of a primary diagnosis and up to five secondary diagnoses and four procedures. Scottish clinical coding guidelines published in 1999 [2] advised that where present, chronic conditions (including diabetes) should be recorded on hospital discharge records as co-morbid conditions.

A linkage between the Scottish national electronic diabetes register (the Scottish Care Information - Diabetes Collaboration, SCI-DC, dataset) and hospital admissions data from the Scottish Morbidity Record (SMR01) allowed us to assess the coding of diabetes in hospital inpatient admissions for patients who were previously recorded as having diabetes on SCI-DC, to test the hypothesis that coding of diabetes as a co-morbidity has improved in

the last 20 years. We also investigated the completeness of the SCI-DC register by identifying numbers of cases in which diabetes was recorded as a hospital discharge diagnosis for people not previously registered on SCI-DC.

Methods

Population-based data are available for people with diagnosed diabetes in Scotland (population 5.1 million people) from the SCI-DC database [3]. In brief, the database has existed at a national level since 2000, contains demographic and clinical data relevant to diabetes care and is populated by daily downloads from primary and secondary care databases across Scotland. Data are collated in this way from over 99.5% of people with a diagnosis of diabetes in Scotland because only 5 out of approximately 1000 general practices in Scotland do not contribute data [4].

Data were extracted from the SCI-DC database in May 2008, which were then linked to SMR01 hospital episodes by NHS National Services Scotland (NSS) Information Services Division using standard probability matching techniques. This linkage produced a dataset which contained no patient identifiable information, which was used for analysis. Approval for the generation and analysis of the linked dataset was obtained from the SCI-DC steering committee, the Scottish multi-centre research ethics committee, the NHS NSS Privacy Advisory Committee and Caldicott guardians of all 14 NHS Boards in Scotland.

The linked dataset was analysed to describe, among people recorded on the SCI-DC database as having diabetes, the proportion of hospital inpatient admissions where the SMR01 record mentioned diabetes. A hospital admission was defined as a continuous inpatient stay (CIS) in hospital, whether or not this involved transfer between hospitals or NHS Boards, where a CIS may contain one or more episodes of care within different clinical teams. The diagnosis of diabetes was based on inclusion in the SCI-DC database. Mention of diabetes was based on the presence of ICD10 codes E10-E14 (as a primary or secondary diagnosis) on any of the SMR01 episodes within the CIS. Admissions were excluded for people who did not have a date of diagnosis of diabetes available on SCI-DC, or where the hospital admission occurred before the date of diagnosis of diabetes on SCI-DC.

The completeness of the SCI-DC database was estimated by describing the number of Scottish residents who were not registered on SCI-DC but who had a hospital inpatient admission that mentioned diabetes. The analysis of hospital data completeness was stratified to investigate the effects of service related factors (NHS Board, hospital and specialty), year of hospital admission (between 2000 and 2007) and patient factors (age, sex, co-morbidity and socio-economic status measured by quintile of Scottish Index of Multiple Deprivation [5], an area measure of material deprivation). For people diagnosed with diabetes, the percentage of admissions coded with a co-morbidity of diabetes was calculated for selected primary diagnoses: cerebrovascular disease (defined by ICD-10 codes I60-I69 and G45), coronary heart disease (ICD-10 codes I20-I25), chronic kidney disease (ICD-10 code N18), circulatory disease (ICD-10 codes I00-I99), peripheral vascular disease (ICD-10 codes I70.2, I73) and malignant neoplasm excluding non-melanoma skin cancer and carcinoma in situ (ICD-10 codes C00-C43, C45-97). The proportion of admissions for lower extremity

amputation (defined by OPCS-4 codes X09-X11, excluding traumatic amputations) among people with a previous diagnosis of diabetes (based on inclusion in the SCI-DC database) that mentioned diabetes was also calculated.

Comparisons were made between average length of stay and occupied bed days for people diagnosed with diabetes using routine hospital admissions data and results from the linked dataset.

Results

Assessment of completeness of recording of diabetes on SCI-DC

In 2007 there were 1,517 people in Scotland that had at least one hospital admission that mentioned diabetes who were not included on SCI-DC before or after the time of their admission. This represents 0.6% of the 231,391 people with diagnosed diabetes in Scotland at 31st December 2007 in the SCI-DC database.

Assessment of completeness of recording of diabetes in hospital admission data

After excluding 753 admissions for 448 people for whom the date of diagnosis of diabetes was missing (1% of all admissions), there were 78,559 hospital inpatient admissions during 2007 for people registered on SCI-DC, of which only 59.3% mentioned diabetes as either a primary or secondary diagnosis. There was little change over time, with overall levels of recording of diabetes between 2000 and 2007 varying between 58 and 61%. Of those admissions which mentioned diabetes, 10% were coded with a primary diagnosis for Scotland as a whole, although this varied by NHS Board from 6% to 14% for mainland Boards.

Geographical variation

The completeness of recording of diabetes varied notably at NHS Board and hospital level; for mainland NHS Boards it ranged from 44% to 82%, and for large general hospitals it ranged from 34% to 89%. There was also variation in completeness of recording of diabetes between different specialties, with higher levels of recording of diabetes for patients treated in medical than surgical specialties (see table 1). Improvements in recording of diabetes over time were made in the specialty of accident and emergency, with an increase from below 40% to 65% between 2000 and 2007. However, there were no other marked changes over time at specialty level.

Variation by primary diagnostic code

Among different primary diagnoses the highest levels of recording of diabetes were observed for admissions for cardiovascular and coronary heart disease, with 70.5% and 69.7% of admissions coded with a co-morbidity of diabetes, respectively. Chronic kidney disease had slightly lower levels of recording, with coding of diabetes as a co-morbidity in 66.4% of admissions. The levels of recording of diabetes for admissions for malignant neoplasm were much less complete at 41.4%. Over time these levels of recording showed very little variation. Among people diagnosed with diabetes on SCI-DC and who were

admitted for a lower extremity amputation, only 73.7% of admissions mentioned diabetes as the primary diagnosis (76.4% if any mention of diabetes were considered).

Variation by demographic factors

The percentage of admissions mentioning a diagnosis of diabetes was very similar for boys/men and girls/women (59.0% and 59.6% respectively). No association was found between the completeness of recording of diabetes and the level of area deprivation. However, analysis by age revealed evidence of an association, with proportions of records mentioning diabetes decreasing with age. For people aged 0-19 years diagnosed with diabetes, at least 90% of admissions included a diabetes code. This gradually decreased as age increased, falling below 60% for people aged 55 years and above. Levels of recording also varied with the number of co-morbidities recorded; the more co-morbidities recorded, the better the level of recording of diabetes.

Estimates of lengths of stay

For people diagnosed with diabetes on the SCI-DC database, the average length of stay was 1.7 times longer where diabetes was recorded than where diabetes was not recorded (10.5 days in comparison to 6.1 days respectively in 2007), suggesting that diabetes was more likely to be recorded in more complex cases. By comparison average length of stay for the whole of Scotland in 2007/08 was 5.4 days, although this does not adjust for differences in case mix. As a consequence average length of stay for people with diabetes is over-estimated if only records that mention diabetes are used for these estimates (see table 2). However the number of bed days occupied by people with diagnosed diabetes increases from 10.9% if only records mentioning diabetes are used, to 15.9% if all hospital admissions among people with diabetes are counted (see table 3).

Discussion

We have shown that the SCI-DC database includes over 99% of Scottish residents that have a diagnosis of diabetes recorded on a hospital admission, indicating that there is a very high level of completeness. The linked data can therefore provide an accurate picture of hospital admissions for people diagnosed with diabetes. We have used the linkage of population-based electronic diabetes database to hospital admission data to describe the completeness of recording of diabetes in hospital admission data.

Overall the quality of routine coding of the primary diagnosis in hospital admission data in Scotland is reasonably accurate. A review of coding quality [6] found that for discharges between 2004 and 2006, the overall accuracy of ‘Main Condition’ coding was 88%. This is similar to the results from four previous quality assurance assessments going back to 1992, and is close to the 90% target level. However, the accuracy rate for diagnoses coded in ‘Other Conditions’ in the sample of records included was much lower (72%), and for diabetes specifically the accuracy rate in this sample was 56%, (an under-recording of 44%). During this quality assessment the majority of recording errors found in ‘Other Conditions’ involved under-recording, where under-recording was due either to diabetes not being mentioned on the clinical discharge summary or coders not recording the diagnosis. The

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present study, using data for the whole population of people with diabetes rather than a sample, showed similar results. The diagnosis of diabetes as a co-morbidity was omitted in 41% of all admissions. Even for conditions in which diabetes is likely to play an important role the recording of diabetes on hospital admission data was incomplete, with over 30% of admission records for coronary heart disease among people with diabetes not mentioning diabetes. Overall this is an improvement in comparison to the results of the study by Leslie et al performed approximately 20 years ago[1], which found that diabetes was omitted in the coding of 61% of all diabetes admissions. With the introduction of payment by results in England, it may be argued that the underestimation of diabetes is now less of a problem than previously, as it would be expected that there would be an increase in the number of diagnoses that are coded [7]. However, this is not the same as having accurate codes. Although there may have been some improvements in accuracy in England, the DiabetesE fifth national report [8], which included 82% of Primary Care Trusts, reported that in 2009 over a third of hospital providers (39%) did not identify and code people with diabetes appropriately.Again, these results are very similar to those of our study.

This study has shown marked variation in completeness of coding between hospitals and clinical specialties, which is likely to be as a result of a combination of factors including: differences in the training and seniority of staff completing discharge summaries, variations in coding quality and local variations in the resources allocated to clinical coding. These variations inlevels of coding between NHS Boards, hospitals, specialties and diagnoses raise concerns about the comparability of data. This brings into question the validity of using hospital admissions data alone for diabetes-related performance and quality assessments, particularly at NHS Board or hospital level. Better quality data among the paediatric population could reflect a combination of a lower number of co-morbidities and a high proportion of insulin users, which may lead to better recording and coding of diabetes by clinical and coding staff than among older adults. It is not clear whether completeness of coding reflects differences in quality of diabetes care between hospitals and specialties. Audits of inpatient care are required to assess this issue.

Consequently using hospital data alone in Scotland will considerably underestimate the number of hospital admissions for people diagnosed with diabetes. This phenomenon was observed even when the primary diagnosis was likely to be diabetes related, for example cardiovascular disease. With diabetes coding levels of only 74% for lower extremity amputations (for which the majority are likely to be diabetes-related), it is evident that the OECD indicator will underestimate the rates of diabetes related lower extremity amputation. These findings are consistent with a previous study [9] that highlighted the underestimation of diabetes related lower extremity amputation rates in a large district general hospital in England due to the limitations of routine data. Although it is not known if this issue affects other countries, if this was the case it would seriously compromise the value of international comparisons.

In addition, a number of diabetes related research studies utilise hospital admissions data, and rely on the accurate coding of diabetes to ensure reliable results. Hart et al [10] investigated the association between being overweight in middle age and risk of developing diabetes in a Scottish cohort study. One of the weaknesses of this study was the use of

hospital discharge records to identify people that developed diabetes. However, the authors acknowledged that their approach would be likely to result in under-estimates of the true incidence of diabetes. In contrast, Bottle et al [11] compared 10-year trends in admissions among people with and without diabetes recorded, for myocardial infarction, angina, stroke, percutaneous coronary interventions (PCI) and coronary artery bypass graft (CABG) and dismissed the impact of coding inaccuracies, citing the study of Campbell [12]. However, Campbell's review of discharge coding accuracy focused on the coding of primary diagnosis and did not consider the coding of co-morbidities, which was the focus of the study by Bottle et al. Furthermore, Dixon et al [13], who carried out a retrospective audit aiming to assess the reproducibility of clinical coding in two National Health Service hospitals within North West Thames region between 1991 and 1993, concluded that co-morbidities may have been significantly under-coded. We argue that under-recording of secondary diagnoses may affect the conclusions of the study of Bottle et al.

In 1981 in East Anglia, 5.6% of hospital beds were identified as being occupied by people with diabetes [14]. It was concluded that the population of East Anglia with diabetes used, on average, 5.1 hospital bed days per person year compared with 1.1 days for the non-diabetic population. Our findings suggest that routine data over-estimate the mean length of stay associated with diabetes and under-estimate the proportion of bed days accounted for by people with diabetes. Hence the conclusions of this paper are likely to be based on an under-estimate of the proportion of beds occupied by people with diabetes, and an over-estimate of length of stay for people with diabetes.

Similarly, the results of a study of prolonged inpatient length of stay for diabetes patients in English acute hospitals by Sampson et al [15] in 2007, which found excess diabetes length of stay to be between 1 and 1.2 days, may be an overestimate due to the reliance on the coding of diabetes on the discharge summary. The National Diabetes Information Service recent analysis [16] which examined whether a patient's hospital stay was affected if they had diabetes also relies on hospital admissions data and may be misleading.

Our study found that the proportion of bed days occupied by patients with diabetes in Scotland in 2007 estimated using hospital admissions data only was 10.8% compared to 14.9% when estimated from the linked database. The latter estimate is similar to the results of a UK retrospective study carried out by Morgan et al to estimate acute hospital care costs of treating people with diabetes compared to those without, which also found that 15.9% of bed days were attributable to people with diabetes (based on 2004 data) [17]. In that study, patients with diabetes were identified from a combination of biochemistry test results, attendance at a diabetes-related clinic, as well as coding on routine data.

Finally, under-recording of diabetes on hospital admissions may also influence the Charlson index [18], a weighted index used to classify co-morbidity that takes into account the number and the seriousness of co-morbidities. If diabetes and other co-morbidities are not recorded then this index may provide inaccurate estimates. This is potential problem if data quality varies between centres and the Charlson index is used to adjust for case-mix.

Given low levels of recording, an alternative method of recording co-morbidities may have to be sought. Our results provide evidence that linkage to a diabetes register can provide a much more accurate source of data for measuring hospital admissions among people diagnosed with diabetes than hospital admissions data alone. The opportunity to link high quality routine data mean that it is possible to estimate the true cost of diabetes and plan and monitor health services more accurately than if hospital data of the current level of quality alone were used.

Acknowledgments

These data are available for analysis by members of the Scottish Diabetes Research Network epidemiology group thanks to the hard work of numerous NHS staff who enter the data and people and organisations (the Scottish Care Information –Diabetes Collaboration [SCI-DC] Steering Group, the Scottish Diabetes Group, the Scottish Diabetes Survey Monitoring Group, the managed clinical network managers and staff in each Health Board) involved in setting up, maintaining and overseeing SCI-DC. This work was supported by the Wellcome Trust through the Scottish Health Informatics Programme (SHIP) Grant (Ref WT086113). SHIP is collaboration between the Universities of Aberdeen, Dundee, Edinburgh, Glasgow and St Andrews and the Information Services Division of NHS Scotland. Funding for diabetes register linkage was provided by the Scottish Government. The Scottish Diabetes Research Network receives financial support from NHS Research Scotland (NRS)We are also very grateful to Karen Heatlie and Sophie Houston (NHS National Services Scotland Information Services Division) for their advice on data quality and clinical coding.

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Table 1

Percentage of admissions in 2007 after date of diagnosis of diabetes coded with a primary or secondary diagnosis of diabetes

Type of admission / Specialty	Total no. of admissions	% coded with a diagnosis of diabetes
Scotland	78,559	59.3
Elective	19,042	43.5
Non-elective	59,517	64.3
Paediatrics	959	93.8
Renal Medicine	1,544	76.6
General Medicine	29,625	69.6
Geriatric Medicine	6,779	68.3
Cardiology	3,732	66.7
Accident & Emergency	740	64.6
Respiratory Medicine	2,014	58.4
Cardiac Surgery	555	55.9
GP Other Than Obstetrics	2,588	52.8
Haematology	556	51.3
Trauma & Orthopaedic Surgery	4,524	49.6
General Surgery	11,605	46.2
Ophthalmology	1,117	42.6
Gynaecology	1,236	39.3
Ear, Nose & Throat	1,171	37.6
Urology	3,642	33.8
Clinical Oncology	982	28.3

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Table 2

Average length of stay for hospital admissions recording diabetes and hospital admissions not recording diabetes among people with diabetes and known date of diagnosis

Year	Average length of stay in days for people diagnosed with diabetes (diabetes recorded)	Average length of stay in days for people diagnosed with diabetes (diabetes not recorded)
2000	11.6	6.7
2001	11.9	6.7
2002	11.4	6.6
2003	11.1	6.5
2004	10.8	6.2
2005	10.5	6.0
2006	10.1	5.8
2007	10.5	6.1

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Table 3

Total bed days occupied by patients in which diabetes is coded during the admission and comparison with total bed days occupied by people registered as having diabetes

Year	Total number of bed days (based on hospital data along)	% of total bed days	Total number of bed days (based on linked register data)	% of total bed days
2000	377,635	7.9	513,757	10.8
2001	386,479	8.4	542,283	11.8
2002	387,702	8.7	554,489	12.4
2003	394,992	9.1	563,055	13.0
2004	408,220	9.7	580,678	13.8
2005	418,242	10.1	593,995	14.4
2006	419,915	10.3	609,226	15.0
2007	439,478	10.9	639,557	15.9