Diabetes care pathways thematic data review

Summary of results from clinical commissioning group emergency diabetes admissions analysis

Introduction

The following is a summary of the methodology, results and conclusions from an analysis examining the relationships between certain demographic factors and emergency hospital admissions with a primary diagnosis of diabetes. After accounting for these demographic factors, we then looked for any remaining variation among clinical commissioning groups (CCGs) with respect to diabetes-related emergency hospital admissions.

This analysis was conducted to improve our understanding of the likelihood of having an emergency admission with a primary diagnosis of diabetes, in relation to different key demographic groups nationally; and to then use this understanding to create a CCG indicator comparing actual admissions for diabetes against what would be expected for those particular individuals given their demographic characteristics. Results for these CCG level comparisons were then compared with results for meeting of care processes and treatment targets in primary care taken from the 2011/12 National Diabetes Audit.

Methodology

Model

For this analysis we used a multivariate offset logistic regression model. This broadly involved a two-stage process; first, a baseline model calculating a measure of the likelihood of a given patient having a diabetes-related emergency admission (this measure is called a 'linear predictor'); and second, an offset model applying these to comparisons of CCGs to effectively standardise for the occurrence of these risk factors in the population.

The models use odds, which are the probability of an emergency diabetes admission divided by the probability of any other emergency admission. The models show the odds-ratios for a certain group when compared with another reference group. For the baseline model, the odds-ratios effectively indicate the likelihood of experiencing an emergency admission for diabetes compared to the likelihood of any non-diabetes-related emergency admission for that group (based on their characteristics in terms

of the other risk factors). An odds-ratio above one shows an increased likelihood of a diabetes admission while a ratio below one shows a decreased likelihood compared to a specified reference group. For the offset model, an odds-ratio is produced for each CCG. Ratios significantly higher than one indicate a CCG where people with diabetes are more likely to have an emergency diabetes admission, and odds ratios significantly lower than one indicate a CCG where this is less. As the outcome variable was an admission with a primary diagnosis of diabetes the analysis was applied to people identified as being diabetic only (identification was based on the appearance of any diabetes diagnostic code anywhere in their hospital records over the last 4 years).

The subsequent comparison with results from the National Diabetes Audit involved regression analysis using the log of the odds-ratio as the outcome variable and the following audit results as explanatory variables:

- Proportion of people with diabetes receiving all 8 care processes.
- Proportion of people with diabetes meeting HbA1c target (<=58mmol /mol).
- Proportion of people with diabetes meeting blood pressure target (<140/80).
- Proportion of people with diabetes meeting all treatment targets.
- Proportion of newly diagnosed people with diabetes being offered structured education.
- Proportion of newly diagnosed people with diabetes attending structured education.
- Proportion of newly diagnosed people with diabetes being offered or attending structured education.

Analysis was also performed looking at the relationships for audit results covering people with Type 1 diabetes only (outcome variable of insulin dependent, E10, admissions) and people with Type 2 diabetes only (outcome variable non-insulin dependent, E11, admissions) whilst bearing in mind limitations identified in the use of E10 and E11 coding to distinguish between people with Type 1 and 2 diabetes.

Outcome variable

The outcome variable for this analysis was emergency admissions with a primary diagnostic code of diabetes – i.e. E10-E14. The analysis was run for all of these admissions and then separately for E10 (insulin dependent) and E11 (non-insulin dependent) admissions. Models were run for each of the four full financial years from 2009/10 to 2012/13. Results are only discussed in detail for the two models looking at insulin dependent and non-insulin dependent admissions separately. This was due to substantial differences in these two groups, particularly in relation to age and ethnicity, creating the potential for misleading results when the two are grouped together.

Risk factors/variables

The identified risk factors used in this analysis were as follows. The reference groups were chosen because they had the highest count of admissions with a primary diagnosis of E10:

- Gender (reference group: female).
- Age – 00-09, 10-14, 15-24, 25-34, 35-44…85+ (reference group: 15-24 year olds).
- Ethnicity[1] – White, Asian, Black, Mixed and Other (reference group: White).
- Deprivation – 2010 IMD quintile groups (reference group: most deprived).
- Revised Charlson Index – Charlson score calculated excluding diabetes.
- Insulin Dependency Flag – this was applied to the models looking at all diabetes admissions and the E11 admissions.
- Financial Year –2010/11, 2011/12 and 2012/13 (reference group: 2009/10).

[1] Ethnicity used the definition from Hospital Episode Statistics and the 2001 census, with Chinese included in Other rather than Asian.

Results

Part 1: Risk factors/variables

Table 1 below shows the odds-ratios for 2012/13 for each of the aforementioned risk factor groups compared with the chosen reference groups. By way of example, we have the odds ratio of 3.00 for E10 for the age band 0-9. This means that the odds of a patient with diabetes aged 0 to 9 having an emergency admission with a primary diagnosis of E10 are 3.00 times larger than the same odds for an otherwise-identical patient aged 15-24.

Values in black were significant at the 99.9% confidence level while those in blue were only significant at the 95% level, insignificant results have not been included in this table:

Table 1:

Risk factor	Group	All diabetes admissions (E10-E14)	Insulin dependent admissions (E10)	Non-insulin dependent admissions (E11)
Intercept		2.24	7.07	0.03
Gender	Male	1.22	1.08	1.16
Age	00-09	2.73	3.00	0.12
	10-14	3.56	2.84	0.58
	25-34	0.43	0.30	3.42
	35-44	0.26	0.10	8.39
	45-54	0.14	0.03	8.04
	55-64	0.08	0.01	5.93
	65-74	0.05	0.004	3.91
	75-84	0.04	0.002	3.26
	85+	0.04	0.002	2.75
Ethnicity	Asian	0.58	0.25	0.80
	Black	2.10	0.44	2.54
	Mixed	Not Sig	0.45	1.57
	Other	Not Sig	0.47	Not Sig
Deprivation	2	Not Sig	1.08	Not Sig
	3	Not Sig	1.11	Not Sig
	4	1.10	1.12	Not Sig
	5	1.13	1.20	1.07
Revised Charlson Index		0.992	0.979	1.005
Insulin dependent flag		4.18	Not used in model	0.62

The detailed descriptions below outline the findings for each of the identified risk factors and a brief interpretation of what this might mean in terms of the impact that each of the risk factors have on likelihood of experiencing an emergency admission with diabetes as the primary diagnosis.

Gender

Findings

1. Insulin dependent admissions: for all four years, the risk of experiencing an emergency hospital admission with E10 as a primary diagnosis, as opposed to any emergency admission, was significantly higher for males than females.
2. Non-insulin dependent admissions: for all four years, the risk of experiencing an emergency hospital admission with E11 as a primary diagnosis, as opposed to any emergency admission, was significantly higher for males than females.

Interpretation
Although the effect of gender was significant, it was also small. For males, the odds of an emergency E11 admission were just 16% higher than for females; and for E10 the difference was even smaller. As can be seen from the summary statistics, while for insulin dependent diabetes there was close to a 50/50 split in males and females admitted for non-insulin dependent diabetes, the split was closer to 60/40 with males making up the greater proportion of admissions.

Age

Findings

1. Insulin dependent admissions: for all four years the risk of experiencing an emergency hospital admission with insulin dependent diabetes as a primary diagnosis in comparison to the likelihood of experiencing any emergency admission for the age group is higher among younger groups and declines as people get older.
2. Non-insulin dependent admissions: younger age groups had a odds-ratio below one for experiencing an emergency admission with non-insulin dependent diabetes as a primary diagnosis in comparison to the likelihood of experiencing any emergency admission for the age group, the odds-ratios then became significantly above one for older groups, although the magnitudes peaked in the 35-54 age groups and then declined.

Interpretation
Results from the regression analysis show that while older age groups make up a large proportion of total admissions among people with diabetes (e.g. 21% of all emergency admissions in 2012/13 for a person flagged as having diabetes were for those aged 75-84) the effect on likelihood of the admission being specifically for diabetes is more pronounced in younger age groups with different patterns for insulin dependent and non-insulin dependent admissions.

For the insulin dependent admissions, the greatest effect is on younger age groups with increasingly small odds-ratios as people age (all below one for adult age groups). This is likely to be primarily due to the fact that as people get older the range of co-morbidities and reasons for admission to hospital increase, thereby lowering the prominence of emergency admissions with diabetes as the primary

diagnosis. It may also be due to a lack of awareness about diabetes symptoms such as Diabetic Ketoacidosis (DKA) in younger age groups, which, as highlighted in the most recent National Paediatric Diabetes Audit, is resulting in almost one in five children with diabetes developing DKA before they are officially diagnosed with the condition and high rates of DKA in young people even after diagnosis.

For non-insulin dependent admissions there was a reduced likelihood of emergency admission in the younger age groups. This indicates that while evidence exists of a growing incidence of Type 2 diabetes among younger people, there is still a lower likelihood of experiencing an emergency hospital admission as a result of Type 2 diabetes prior to adulthood. While the odds-ratios were above one for all of the older age groups (i.e. above the 15-24 reference group), the magnitudes were highest among the working-age population over 35. This is again likely to be due to the increasing likelihood of admission for other primary reasons in the 65+ age groups, but may also be due to working-age adults being less likely to realise that they have diabetes until they experience a diabetic crisis.

Ethnicity

Findings

1. Insulin dependent admissions: all four of the groups showed odds-ratios below one, with the magnitudes being largest for the Asian group.
2. Non-insulin dependent admissions: there were odds-ratios below one for the Asian group and above one for the Black group. There were also significant ratios above one for the Mixed group.

Interpretation
The odds-ratios below one for all four of the ethnic groups seen for insulin dependent diabetes indicate that emergency admissions for insulin dependent diabetes have a lower relative likelihood for ethnic minority groups than the majority White population. This may be due to a generally lower incidence of Type 1 diabetes in minority ethnic groups (for example as seen in the summary statistics while the White group made up 90% of insulin dependent admissions they only made up 83% of non-insulin dependent admissions) or higher rates of admissions for other reasons among insulin dependent ethnic minorities.

A more surprising result is the odds-ratio below one for non-insulin dependent admissions found for the Asian group, given that South Asians are known to have high prevalence of Type 2 diabetes. Possible reasons for this result may be higher rates of admission for other conditions, ethnic differences in pathogenesis of the condition, or differences in quality of care.

Deprivation

Findings

1. Insulin dependent admissions: these showed the most consistently significant results, with magnitudes of above one odds-ratios increasing as deprivation decreased.
2. Non-insulin dependent admissions: there were some significant results for the least deprived quintile, although the magnitudes were small, but not for the other quintiles.

Interpretation
As with gender, deprivation had a significant effect on the odds of an E10 emergency admission, but this effect was small. The odds ratio was 1.2 for the least deprived quintile compared with most deprived quintile, so the least deprived quintile had just 20% larger odds. The odds ratio was even closer to 1 for other quintiles.

It is a little surprising that the least deprived quintile had the higher odds, until we consider that the most deprived quintile is likely to have had more emergency admissions for conditions other than diabetes. As can be seen from the summary statistics, in terms of raw admissions across the five deprivation groups, proportions showed similar spreads for both insulin dependent and non-insulin dependent admissions (with both having higher proportions in the most deprived quintiles). The general lack of significant change in the likelihood of admission for non-insulin dependent diabetes across deprivation quintiles may therefore be due to the effect that deprivation has on wider health, resulting in people with diabetes from more deprived areas being admitted for conditions other than diabetes. While the pattern for insulin dependent admissions may be due to the relative lack of impact that social status has on insulin dependent admissions in comparison to hospital admissions for other reasons.

Revised Charlson Index

Findings and interpretation
The Charlson index is a standardly used measure of co-morbidity based around predicting the 10-year risk of mortality for an individual by assigning scores and aggregating these for 22 co-morbid conditions. A revised Charlson index score (i.e. one calculated excluding diabetes) was included in the model as part of the underlying process to calculate and account for the general risk of emergency admission for each group.

Because the odds ratios are so close to 1 for this index, they initially appear inconsequential. However, for the small number of patients with an index of 10 or more, who will have a smaller odds of an emergency E10 admission, this difference will not be negligible. Neither will such patients' **larger** odds of an emergency E11 admission.

Insulin dependency flag

Findings and interpretation
An insulin dependency flag was created in a similar way to the identification of patients with diabetes and based on an individual having had any hospital diagnosis of being insulin dependent in the last four years. As the flag was based on a hospital diagnosis, it could not be used as a variable for the insulin dependent admission group (all of these people would be flagged as insulin dependent). As can be seen from table 1 the flag showed a significant odds-ratio below one for non-insulin dependent admissions (i.e. if you are insulin dependent you are less likely to be admitted with a primary diagnosis of non-insulin dependent).

It was discovered in the analysis that some individuals received different codes for insulin dependency during different hospital spells. This suggests that a small number of Type 2 patients may be miscoded as insulin dependent (i.e. Type 1) although it does not suggest the opposite.

Financial year

Table 2

Financial year	Insulin dependent admissions (E10)	Non-insulin dependent admissions (E11)
2010/11	0.96	Not Sig
2011/12	0.94	0.96
2012/13	Not Sig	0.80

As can be seen from table 2 above, the only real discernable timeline trend identified was a slight decrease in likelihood of diabetes admission, particularly non-insulin dependent, over the most recent two complete financial years (data from the first few months of 2013/14 suggests that trend has continued).

Part 2 – CCG comparisons

Offsetting for the risk factor effects and then comparing admissions for the 211 CCGs with a reference group CCG (selected on the basis of having a large population and results consistently close to the national median) yielded the following patterns in odds-ratios for 2012/13:

- Insulin dependent admissions (E10): 43 had a ratio significantly different to 1 (i.e. 95% confidence intervals did not cross 1) of these, 9 had a ratio of above 1 (with 5 above 1.5) and 34 had a ratio of less than 1 (with all below 0.75).
- Non-insulin dependent (E11): 42 had a ratio significantly different to 1, of these 34 were larger than 1 (with 19 greater than 1.5) and 8 were less than 1 (with 7 less than 0.75).

When interpreting odds-ratios it is important to look at both the statistical significance of the estimated ratio and its magnitude. An odds-ratio of 1 means the group has the same likelihood for the outcome as the reference group; values above 1 indicate a higher likelihood and below 1 a lower likelihood. For example, a CCG with a ratio of 10 means that people have tenfold greater odds of experiencing an emergency diabetes admission than would be expected given the population demographics, while a ratio of 0.1 would mean that they would have tenfold lower odds, in comparison to the reference group. The fact that there are over 40 CCG odds ratios (for both types of primary diagnosis) that are significantly different to one implies that there is significant variation across CCGs after accounting for demography. The only possible interpretation of this is that other factors that vary by CCG account for the remaining variation, and that some of those may relate to the quality of care provided. However, there may be other factors that do not relate to the quality of care provided, but we either did not consider them or could not obtain data for them.

Further analysis is still to be conducted to determine the most appropriate method for establishing bandings in order to present local authority indicators for emergency diabetes admissions. It is also worth noting that as CCG comparisons have been performed for each of the four financial years, further work will be done to explore how best to report variations over time with the potential for individual indicators for each year or an indicator showing trend.

Part 3 – Comparison with National Diabetes Audit results

Regression analysis did not find any statistically significant correlations between the CCG level audit results for 2011/12 and any of the four years of admissions data; R-squared values were all below 0.1. While some of this may be due to GP practice level variations within CCGs and the fact that the audit only covers 88% of practices (due to being voluntary), at this level of analysis it can be assumed that these deficiencies would not cause such low levels of significance. It can therefore be concluded that none of these National Audit results directly correlate with emergency admissions with a primary diagnosis of diabetes within a two-year timeframe. However, this does not mean that these process measures and targets are not

assessing important aspects of diabetes care in the community and it is likely that the lack of correlation is driven by the following two aspects:

- As noted in the National Diabetes Audit report, “There is a long lag time between improvements in diabetes care delivery and associated reductions in complications”. For example, high blood pressure or cholesterol may exist for a significant period before significantly affecting the risk of emergency hospital admission. This may mean that audit results have a lag period of many years before showing significant correlations with emergency admissions.

- While having national standards for diabetes care delivery and measuring compliance with these can provide a useful framework and reminder for those delivering primary care, this will not by itself ensure that people’s diabetes is being well managed. Ultimately successful management of the condition is dependent on the behaviour of individuals and how they are empowered to manage their condition. For example, a person may attend their GP surgery every six months and have their HbA1c measured, which may show to be above/below the target. But whatever the measure, this is not a guarantee that their sugar levels have remained at around this level in the intervening period. The way primary care staff use these screening results to frame care planning discussions with that individual will have a significant impact on the management of their diabetes, but it is not easy to measure via a national data set, particularly where we have only explored results for a single year (i.e. these more nuanced differences in quality of care may become more apparent in variations over many years of audit findings).

Conclusions

Results from this analysis show that there are substantially different patterns for diabetes admissions odds-ratios depending on whether the admission is for insulin dependent or non-insulin dependent diabetes (i.e. whether someone is insulin dependent or not). The difference is particularly noticeable in relation to age, with insulin dependent admissions being most prominent for younger age groups, but also showed noticeable effects in relation to ethnicity, gender and deprivation. Overall, being insulin dependent was shown to significantly increase the likelihood of experiencing an emergency admission for diabetes.

More surprising results were seen for ethnicity and deprivation with the Asian ethnic group showing a lower likelihood for non-insulin dependent admissions (despite their known higher prevalence of Type 2 diabetes) and deprivation having a less marked impact than might have been expected. These results may be due to a number of factors such as differences in admissions for other conditions in these groups, variations in quality of care, use of a broad quintile measure of deprivation, or other factors not accounted for in this modelling.

Once these demographic-based variables were accounted for, analysis showed that significant variations in diabetes admissions across CCGs remained, giving

indication of potential differences in the quality of care across the country. While no correlations were found with national audit results, this may have been due to the limitations of only using one year of audit results and the possibility that longitudinal studies covering many years may be required to accurately determine the effects that these processes and targets are having on people's likelihood of being admitted to hospital.