

Trends, length of stay, and mortality in people admitted to hospital for hypoglycaemia in England

A retrospective 10-year observational study

Francesco Zaccardi¹, MD

Prof Melanie J Davies¹, FRCP

Nafeesa N Dhalwani¹, PhD

David R Webb¹, MRCP

Gemma Housley²

Dominic Shaw^{2,3}, FRCP

James W Hatton²

Prof Kamlesh Khunti¹, FRCGP

¹ Diabetes Research Centre, University of Leicester, Leicester, England

² Nottingham University Hospitals & East Midlands Academic Health Science Network, Nottingham, England

³ Nottingham Respiratory Research Unit, University of Nottingham, Nottingham, England

Corresponding Author:

Dr Francesco Zaccardi

Leicester Diabetes Centre, Leicester General Hospital, LE5 4PW Leicester, England

Email: frazac@fastwebnet.it

Phone: +44 0116 258 4389 – Fax: +44 0116 258 4499

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ABSTRACT

Background

Previous studies in the US and Canada have reported increasing or stable trends of hospital admissions for hypoglycaemia. As few data from small studies are available for other countries, information on long-term trends of hospital admission for hypoglycaemia and subsequent outcomes in England is an important input to understand the global burden of hospitalisation for hypoglycaemia.

Methods

We collected data on all hospital admissions for hypoglycaemia between January 2005 and December 2014 using the Hospital Episode Statistics database to assess: trends of crude and adjusted (age, sex, ethnicity, social deprivation, and Charlson comorbidity score) admissions for hypoglycaemia; trends of hypoglycaemia admissions using total hospital admissions and diabetes prevalence as denominators; and trends of length of stay, in-hospital mortality, and one-month readmissions for hypoglycaemia

Findings

Between 2005 and 2014, 79,172 patients experienced 101,475 admissions for hypoglycaemia, of which 72% occurred in people aged ≥ 60 years old and 18% in people with a previous admission. The number of admissions increased steadily from 2005 until 2010, and stabilised after 2010 (39% overall increase, range 11% to 89% across England regions); the trend was similar when adjusted for risk factors, with a rate ratio of 1.53 (95% confidence interval: 1.29 to 1.81) comparing 2014 to 2005. Admissions for hypoglycaemia increased from 63 to 79 per 100,000 total hospital admissions between 2005/6 and 2010/11 and then declined to 72 per 100,000 in 2013/14 (14% overall increase). Accounting for diabetes prevalence, rates declined from 4.64 to 3.86 admissions/1000 person-years between 2010/11 and 2013/14. With some differences across regions, from 2005 to 2014 the adjusted proportion of same day discharge increased by 43.8% (18.9 to 27.1 per 100 admissions); in-hospital mortality decreased by 46.3% (4.2 to 2.3 per 100 admissions); and one-month readmissions decreased by 63.0% (48.1 to 17.8 per 100 readmissions)

Interpretation

Over 10 years, hospital admissions in England for hypoglycaemia increased by 39% in absolute terms and by 14% considering the general increase in hospitalisation; accounting for diabetes prevalence, however, there was a reduction of admission rates. Hospital length of stay, mortality, and one-month readmissions decreased progressively and consistently during the last 10 years. Given the continuous rise of diabetes prevalence, ageing population, and costs associated with hypoglycaemia, individual and national initiatives should be implemented to reduce the burden of hospital admissions for hypoglycaemia

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INTRODUCTION

In randomised control trials, intensive glucose control reduces long-term risk of microvascular and, to some extent, macrovascular diabetes complications.¹ Striving for intensive control may result in higher rates of hypoglycaemia.² As hypoglycaemia is associated with a deterioration in quality of life and possibly a higher risk of vascular events and mortality,³⁻⁹ clinicians often face a trade-off between the benefits of intensive glucose lowering and the drawbacks of hypoglycaemia.

Most hypoglycaemic episodes are generally of mild severity and self-treated by patients. Severe episodes, which require third party assistance, are less common (1-2 episodes per year in insulin-treated patients) but represent a greater economic burden on healthcare systems.^{10,11} Some of these episodes require paramedic support, attendance at accident and emergency departments, or hospital admission. Precise estimates of the proportion of patients requiring these different services are not available in England, mainly because of a lack of nationally integrated electronic health record systems. Nevertheless, although hospital admissions for hypoglycaemia represent a small proportion of emergency department visits, they have significant resource implications.¹¹ The mean cost per admission for hypoglycaemia in England has been estimated to be slightly in excess of £1,000 (~1,300€), with a total annual direct cost of severe hypoglycaemic episodes around £13 million in the UK.^{12,13}

Older age, multimorbidity, and insulin therapy are well-recognised and interrelated risk factors for hypoglycaemia.¹⁴ Given the rise in diabetes prevalence and an ageing population,^{15,16} the number of admissions to hospital due to hypoglycaemia has possibly increased in recent years. This has recently been confirmed in a nationally representative sample of North Americans,¹⁷ while very few data are available for other countries and little is known on a global scale. Detailed analysis of contemporary trends for England can therefore contribute to understand the global burden of hospitalisation for hypoglycaemia.

The aim of this study was to characterise 10-year trend, from 2005 to 2014, of hospital admissions for hypoglycaemia and associated length of hospital stay, mortality, and readmissions using the Hospital Episode Statistics (HES) database, which includes data of hospital admissions for the entire population of England.

METHODS

Study design, setting, and source data

In this nationwide, retrospective observational study, we extracted data on people admitted to hospitals for hypoglycaemia from the HES database,¹⁸ which contains details of all admissions to English National Health Service hospital trusts. All hospital admissions due to hypoglycaemic episodes (unit of the study) were sought from 1/1/2005 to 31/12/2014. Criteria for data extraction are reported in detail in the appendix Table A1. We included all anonymised admission episodes reporting hypoglycaemia as primary reason of admission, i.e. the first ICD-10 (International Classification of Diseases, 10th revision) diagnosis field E160 (drug-induced hypoglycaemia without coma), E161 (other hypoglycaemia), or E162 (hypoglycaemia, unspecified) and E10+ (diabetes type 1) or E11+ (diabetes type 2) in any of the remaining ICD-10 fields (from 2nd to 20th). For all episodes, we collected data on age, sex, self-reported ethnicity, region of usual residence, start and end date of the episode, admission and discharge method, Index of Multiple Deprivation (IMD, an overall measure which combines information from several indicators and indicates deprivation experienced by people living in an area), and used ICD-10 fields to calculate the Charlson comorbidity score, an index measuring the effect of simultaneous conditions on mortality (Table A1–A3).¹⁹ Data on total hospital admissions and prevalence of diabetes were obtained from the publicly available reports of HES and Quality and Outcomes Framework (which contains data collected on a voluntary process for all surgeries in England), respectively.^{18,20}

Data analysis

Stata, version 14.1 (Stata Corp, College Station, Texas), was used for all analyses, and results are reported with 95% confidence intervals (CIs). To assess trends, for all analyses we used calendar time as a factor variable and considered the first calendar year as baseline.

We first reported region (East, East Midlands, London, North East, North West, South East, South West, West Midlands, and Yorkshire–Humber) and age-specific (<20 years old; 20–29; 30–39; 40–49; 50–59; 60–69; 70–79; ≥80) crude trends. Secondly, for each age-group, sex, and ethnicity (White, Caribbean, Indian, Pakistani, other, not available), we calculated the mean IMD-10 (deciles of IMD) and Charlson comorbidity score and the total number of admissions to estimate the trend of admissions adjusted for these risk factors with Poisson regression. Thirdly, we estimated trend of admissions for hypoglycaemia out of total hospital admissions with logistic regression; as total admissions were available from April 1 to March 31 (financial year), admissions for hypoglycaemia were estimated during the same interval. Lastly, we fit Poisson regressions to calculate trends in admission rates using the number of admissions for hypoglycaemia

(numerator) and the mid-point prevalence of diabetes (denominator/exposure) between two consecutive estimates (March 31). From 2010 onwards, data on diabetes prevalence were available only for subjects aged 17 or older. We therefore reported rates from 2010 to 2014 of subjects aged 17 or older to be consistent with prevalence data.

We also calculated the length of hospital stay, assessed whether the admission resulted in hospital death (all-cause mortality), and estimated time intervals between consecutive admissions occurring in the same year to calculate the proportion of one-month readmissions for hypoglycaemia out of total readmissions. We categorised the length of hospital stay in five ordered groups of similar size (same day discharge; day after discharge; two to three days; four to eight days; nine or more days) and performed an ordered logistic regression, adjusted for age, sex, ethnicity, IMD-10, and Charlson comorbidity score, to assess trend over time of hospital length of stay. Likewise, we fit logistic regressions with the same covariates to characterise trends for hospital mortality and one-month readmissions. All regressions were complete-case and included calendar year as a factor variable: the latter enabled the estimation of adjusted proportions with *margin* command for each region and overall. Odds ratios of risk factors were pooled across regions by random-effects meta-analyses and heterogeneity in the associations was estimated by the I^2 statistic.²¹

Ethics

Not required for this study.

Role of the funding source

The funding source had no role in study design, data collection, data analysis, data interpretation, or writing of the report. The corresponding author had full access to all of the data and the final responsibility to submit for publication.

RESULTS

Characteristics of admissions for hypoglycaemia

From 1/1/2005 to 31/12/2014, in England there were a total of 101,475 hospital admissions for hypoglycaemia in 79,172 people; 65,248 (82%) had a single episode (Table 1). Admissions occurred in males and females equally and the majority of cases were of White European ethnic origin. The median Charlson comorbidity score was 1 (Table 2). Admissions were more frequent in older people, with subjects aged 60 or older accounting for 72% of total cases (Figure 1). When adjusted for sex, ethnicity, IMD-10, and Charlson comorbidity score, age showed a J-shaped relationship with admissions: compared with people younger than 20 years old, we found a reduced risk in people between 20 to 49 and an increased risk in people aged 50 or older (appendix Figure A1). In 95% of all admissions, people attended "accident and emergency services" (87%) or were referred by a general practitioner (8%) (Table A4). Admissions were associated with at least three medical conditions in 50% of cases, of which the most common were essential hypertension, atrial fibrillation/flutter, urinary tract infection, chronic or acute renal failure, and chronic ischaemic heart disease (Figure A2).

Temporal trends

The overall number of admissions for hypoglycaemia increased progressively over time, from 7868 in 2005 to 11,756 in 2010 (49% increase), and then remained more stable until 2014 (10,977; 39% increase from baseline) (Figure A3 and Table A5). We found a similar overall trend after adjusting for risk factors, with a rate ratio of 1.53 (95% CI: 1.29 to 1.81) comparing 2014 to 2005 (Figure 2). Across regions, crude overall admissions increased by a minimum of 11% in East Midlands to a maximum of 89% in London (Table A5). When admissions for hypoglycaemia were estimated per total hospital admissions, we found an increase from 2005 for all the following years, with a peak in 2010/11 and a subsequent decline (Figure A4). Total admissions progressively increased from 12.7 million in 2005/6 to 15.5 million in 2013/14 (22% increase) while 63 admissions for hypoglycaemia per 100,000 total admissions were recorded in 2005/6, increasing to 79 per 100,000 in 2010/11 (24% increase), and then declining to 72 per 100,000 in 2013/14 (14% increase from baseline). Similarly, adjusting for diabetes prevalence, we found a decline between 2010/11 and 2013/14: diabetes prevalence in people aged 17 or older increased from 2.39 million in 2010/11 to 2.75 million in 2013/14 (16% increase) while admissions decreased from 11,133 to 10,653 (4% decrease), resulting in rates declining from 4.64 admissions for hypoglycaemia/1000 person-years with diabetes in 2010/11 to 3.86 in 2013/14 (rate ratio 2013/14 vs 2010/11: 0.83; 0.81 to 0.85) (Figure A5).

Hospital length of stay and mortality

Around 24%, 47%, 68%, and 75% of all admissions resulted in a length of hospital stay ≤ 24 hours, ≤ 48 hours, ≤ 5 days, and ≤ 7 days, respectively (Figure A6). Female sex, older age, higher Charlson comorbidity score, and lower IMD-10 (i.e., more deprived) were significantly associated with a longer length of hospital stay, while Indian ethnicity was associated with a shorter stay (Figure A7). Heterogeneity across regions in the associations between the risk factors and length of stay was moderate to high (I^2 from 30% to 97%) (Figure A7 and A8). The crude proportion of same day discharge increased from 21.4% (1685 out of 7486 admissions) in 2005 to 24.9% (2730 out of 10,974) in 2014. In the analysis adjusted for risk factors, the proportion of patients being discharged on the same day of admission increased by 43.8% (95% CI: 33.9 to 53.6), from 18.9 (16.8 to 20.9) per 100 admissions in 2005 to 27.1 (25.1 to 29.1) in 2014 (Figure 3 and A9).

Three percent of all admissions resulted in hospital death (3109 all-cause deaths in 101,475 admissions; Table A4). Age and Charlson comorbidity score were independently associated with higher mortality (Figure A7), with moderate-high heterogeneity across regions (I^2 from 23% to 90%; Figure A7 and A8). The crude inpatient mortality decreased from 3.6% (280 out of 7860 admissions) in 2005 to 2.7% (296 out of 10,976) in 2014. Risk factor-adjusted inpatient death declined by 46.3% (95% CI: 40.4 to 52.2), from 4.2 (3.8 to 4.7) per 100 admissions in 2005 to 2.3 (2.0 to 2.5) in 2014 (Figure 3).

One-month readmission

During the study period, almost 18% of all admissions for hypoglycaemia occurred in people with a previous episode (Table 1); of these readmissions, around 23% occurred within one-month, without a clear difference across regions (Figure A10). One-month readmissions, however, decreased significantly over time, accounting for 48.1% of total readmission in 2005 and for 17.9% in 2014. Adjusted for risk factors, one-month readmissions declined by 63.0% (95% CI: 58.6 to 67.4), from 48.1% (43.6 to 52.5) per 100 readmissions in 2005 to 17.8% (16.5 to 19.1) in 2014 (Figure 3). None of the included risk factors was independently associated with one-month readmission (Figure A7 and A8).

Regional differences

During the study period, improved trends for the three outcomes were to some extent different across regions (Figure A11–A13). Comparing 2014 to 2005, we found substantial heterogeneity for same day discharge (I^2 63%; 95% CI: 24 to 82), with the highest and lowest changes for West and East Midlands, respectively (Figure 4). On the other hand, we found lower heterogeneity for both mortality (I^2 0%; 0 to 65; highest and lowest changes for West Midlands and Yorkshire-Humber, respectively) and one-month

readmission (I^2 36%; 0 to 70; highest and lowest changes for South East and Yorkshire-Humber, respectively) (Figure 4).

DISCUSSION

Using national hospital admissions data for England, we found an increasing trend of admissions for hypoglycaemia from 2005 to 2014. In particular, admissions increased steadily during the first five years, stabilising from 2010 onwards. We found a similar trend after adjusting for potential risk factors, including age, sex, and comorbidities. We evidenced an increase until 2010 followed by subsequent decline accounting for changes in total hospitalisation, and a decline in the same period accounting for changes in diabetes prevalence. In people admitted for hypoglycaemia, hospital length of stay, in-hospital mortality, and one-month readmission declined consistently over the 10-year study period, with some differences across regions.

To our knowledge, this is the first report on all hospital admissions for hypoglycaemia in England. We reported data across different regions for 10 years and detailed demographical characteristics, associated comorbidities, and outcomes in subjects who experienced hospital admissions for hypoglycaemia. HES data further enabled us to assess trends over time adjusting for important confounders for admissions, particularly age and comorbidity. Moreover, while previous similar research reporting on the burden of hospital admissions for hypoglycaemia were performed at regional level or relied on data from representative samples to estimate trends at a national level (Table A6), in this study we used all hospital admissions data for England. Though not directly comparable, a recent study conducted in England assessed the risk of hospitalisation for hypoglycaemia using data from the Clinical Practice Research Datalink (which contains primary care records covering approximately 6% of the UK population²²) linked to HES (Table A6). Khalid et al. estimated rate of hospital admissions for hypoglycaemia as 30 per 10,000 person-years between 2006 and 2012 in ~100,000 patients with type 2 diabetes.²³ This study, however, did not assess trends over time. On the other hand, more comparable studies have been performed in the US. Lipska et al.,¹⁷ relying upon health insurance data to collect information on admissions for hypoglycaemia and national surveys to calculate diabetes prevalence, estimated trends of hospital admissions for hypoglycaemia in people aged 65 years or older at national level. From 1999 to 2011, they reported an absolute increase until 2007 and a subsequent decline, with a significant 11% increase of sex-, age-, and ethnicity-adjusted rate comparing 2011 to 1999. When admissions were adjusted for diabetes prevalence, however, they found a progressive decline during the entire study period. Interestingly, both results are in line with our findings, although we could estimate the prevalence-adjusted trend only from 2010 and in subjects aged 17 years or older. Further to this, they showed a reduction of one-month readmissions for all causes during the study. We limited the analysis to all-cause hospital mortality following the episode and readmissions due only to hypoglycaemia because our main goal was to assess the burden of hospital admissions rather than estimate how hypoglycaemia affects short- and long-term mortality. However, we used national-level data on diabetes

prevalence and total hospital admissions, reported more detailed information on length of hospital stay (that can be used to estimate costs), and extended the analysis to reflect contemporary diabetes management. Trends have been reported in three other studies in US and Canada, with slightly differing outcomes. Wang et al. showed an absolute and age-adjusted decline of US emergency department visits in adults with diabetes between 2006 and 2011,²⁴ while Pathak et al. reported no clinically meaningful age- and sex-adjusted trend of US emergency department visits or hospitalisation between 2005 and 2011 in people ≥ 20 years old.²⁵ Clemens et al.,²⁶ on the other hand, found in people ≥ 65 years old with diabetes an absolute increase in emergency department visits or hospitalisations for hypoglycaemia from 2002 to 2006 and then a decline until 2013; a continuous decline was found after accounting for the change in diabetes prevalence. A major strength of this research was the availability of all $\sim 100,000$ hospital admissions in England over a ten year period with information on several potential risk factors and residential location. Therefore, we were able to estimate accurately the burden of admissions at national as well as regional level. We found age and Charlson comorbidity score to be independently associated with both length of stay and mortality, while none of the included risk factors was associated with one-month readmission. We also found significant heterogeneity across regions in the impact of risk factors on the three outcomes: heterogeneity was lower for sex compared to age, social deprivation, and comorbidities, and was greater for length of stay and one-month readmissions than for mortality. These divergences, possibly due to a genuine clinical diversity of patients (attributable to factors other than those considered in the analysis) or to differences in nonclinical causes affecting the three outcomes (such as admission policies), could have influenced trends during the study period. Indeed, comparing 2014 to 2005 reductions in inpatient mortality and one-month readmissions and increase in same-day discharge were somewhat different across regions.

Along with strengths, our research had some limitations. First, data on diabetes prevalence were available for people aged 17 or older from 2010 and for all people before. Therefore, prevalence data were not comparable before and after 2010 and we could not estimate admission rates for the entire period of the study in the same population. Moreover, as available diabetes prevalence and total admissions data are not stratified by age, we could not detail trends by age groups. Second, we estimated trends for all-cause in-hospital mortality following the episode and not for short- or long-term mortality after discharge. However, previous research in England has already reported on the risk of all-cause and cardiovascular mortality in people who experienced episodes of severe hypoglycaemia.⁸ Third, frequent episodes of severe hypoglycaemia affect patient's functional status, mental performance, and risk of falls, important outcomes which could not be assessed here.⁹ Fourth, the Charlson comorbidity score is extensively used to assess comorbidity in epidemiological studies, yet it does not take into account disease severity. Fifth, our analyses were limited by the functionality of the health care database available. As HES data are collected for

administrative rather than research purposes, it is difficult to be absolutely sure of its imputation and coding accuracy. Sixth, although we adjusted for several potential confounders, secular trend changes of unmeasured factors (such as glucose-lowering therapy) could explain our findings. Lastly, using postcodes to identify regions, we assumed that people were admitted to hospitals in regions pertaining to their allotted postcode.

Implications for clinicians and policymakers

There appear to be two common characteristics amongst studies assessing emergency or hospital admissions for hypoglycaemia. First, in those investigating temporal trends, absolute admissions reach a peak (2007 in US;¹⁷ mid-2006 in Canada;²⁶ 2010 in our study) and then decline, or decline steadily over time (from 2006 in US²⁴). Second, older age is a significant risk factor for admissions. Given predicted population ageing, rise in diabetes and multimorbidity prevalence,^{27,28} and risk of potential overtreatment in older people,²⁹ these findings indicate that further measures will be required to keep stable or reduce the number of emergency department visits and hospital admissions for hypoglycaemia in the future.

Hypoglycaemia has gathered great attention in recent years, particularly after the publication of randomised controlled trials showing a nonsignificant reduction or even an increase in vascular risk in intensively treated subjects.³⁰ Glycaemic control targets may therefore have relaxed during the study period at the expense of higher rates of hyperglycaemia, as suggested in some but not all previous studies.^{17,24} This could potentially explain the declining trend in hospital admissions and readmissions for hypoglycaemia although we did not investigate admission trends for hyperglycaemia. On the other hand, the availability and use of drugs associated with a lower risk of hypoglycaemia and an improved outpatient care could further explain our findings.^{31,32} A precise estimate of the impact of modifiable risk factors such as glucose control on hospital admission rates for hypoglycaemia is difficult. However, an epidemiological analysis of the ACCORD trial suggests that the risk of hypoglycaemia resulting in emergency medical care or admission to hospital is progressively higher in type 2 diabetes participants with lower baseline HbA1c when comparing intensive vs standard glucose-lowering treatments (around 2-times for values $\geq 8.5\%$; 3-times for values between 7.5–8.4%; and 7-times for values $< 7.5\%$).³³ It is noteworthy that the individualised identification of HbA1c targets is just one of a number of approaches to the problem of hypoglycaemia.¹⁰ In observational studies, structured diabetes education reduce the burden of hypoglycaemia;¹⁰ yet, attendance at structured education programs remains very low (5.3%) and further effort should be put in place to identify and address local barriers.³²

The reduction of length of hospital stay and in-hospital mortality following admissions could be attributed to tighter glucose control during hospitalisation. Studies published in the last decade have indeed shown better hospital outcomes associated with better glucose control.^{34,35} The results of these studies could likewise have influenced glucose management in hospitalised patients, although a general improvement of hospital mortality and changes in admission policies may also explain these positive results.^{36,37}

Conclusion

In England, a rise in overall hospital admissions for hypoglycaemia has been counterbalanced by a decline of admissions accounting for the increase of diabetes prevalence, as well as a reduction of length of hospital stay, mortality, and readmissions over the 2005–2014 decade. A better picture of hypoglycaemia burden would require the availability of data for multiple stages of the admission process, from the episode to the hospital admission (i.e., episode–emergency calls–ambulance support–emergency admission–hospital admission). This information will clarify the best approach to reduce hospital admissions and identify at what stage resources should be allocated.

RESEARCH IN CONTEXT

Evidence before this study

We searched PubMed for manuscripts published in English between Jan 1, 1990, and Jan 20, 2016, using the terms “hospital”, “emergency”, and “hypoglyc(a)emia”. No specific inclusion or exclusion criteria were applied. Temporal trends of emergency department (ED) visits or hospital admissions for hypoglycaemia were reported in three studies published in US and one in Canada. Overall, these studies suggested no trends, a peak followed by a decline or a continuous decline over time of ED visits or hospital admissions for hypoglycaemia. While some studies have assessed ED visits or admissions for hypoglycaemia at regional/local level, no data at national level are to date available.

Added value of this study

To our knowledge, this is the first report of trends of admissions for hypoglycaemia at a national level. We investigated all hospital admissions in England showing a constant increase until 2010 and a stabilisation thereafter. Both our findings and previous studies, however, found a decline in admissions when accounting for diabetes prevalence and, although differently defined, a reduction of one-month readmissions and mortality. Moreover, we also found a steadily reduction over time of length of hospital stay. Taken together, the reduced risk of readmission and death and the shorter hospital stay would suggest an improved outpatient and inpatient care. Along with North American data, our results can contribute to a better understanding of the global burden of hospitalisation for hypoglycaemia.

Implications of all the available evidence

Given the rise in diabetes prevalence, population age, and the risk of potential overtreatment in older people, our findings indicated that further measures will be required to stabilise or reduce ED visits and hospital admissions for hypoglycaemia in the next years. More detailed data could inform the best approach to reduce hospital admissions and identify where resources should be allocated.

Contributors: Hospital episode statistics were made available by the NHS Health and Social Care Information Centre (copyright 2012, reused with the permission of the Health and Social Care Information Centre). All rights reserved. All authors provided substantial contributions to study conception, design, and interpretation of data. FZ performed all statistical analyses. GH extracted HES data. All authors were involved in drafting the article or revising it critically for important intellectual content, and approved the final version to be published. FZ is the study guarantor.

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Data access: FZ and GH had full access to the dataset under the terms of the Hospital Episode Statistics Data Re-Use Agreement.

Competing interests: All authors have completed the ICMJE uniform disclosure.

KK has acted as a consultant and speaker for Novartis, Novo Nordisk, Sanofi-Aventis, Lilly and Merck Sharp & Dohme. He has received grants in support of investigator and investigator initiated trials from Novartis, Novo Nordisk, Sanofi-Aventis, Lilly, Pfizer, Boehringer Ingelheim and Merck Sharp & Dohme. KK has received funds for research, honoraria for speaking at meetings and has served on advisory boards for Lilly, Sanofi-Aventis, Merck Sharp & Dohme and Novo Nordisk.

MJD has acted as consultant, advisory board member and speaker for Novo Nordisk, Sanofi-Aventis, Lilly, Merck Sharp & Dohme, Boehringer Ingelheim, AstraZeneca and Janssen and as a speaker for Mitsubishi Tanabe Pharma Corporation. She has received grants in support of investigator and investigator initiated trials from Novo Nordisk, Sanofi-Aventis and Lilly.

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Ethical approval: Not required for this study.

Data sharing: Statistical codes available from the corresponding author (FZ).

The lead author affirms that the manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.

Figure legends

Figure 1: Crude total hospital admissions for hypoglycaemia, England 2005–2014

Legend: From left to right, columns indicate calendar years 2005 to 2014. Difference indicates change 2014 *versus* 2005. Overall, there were 101,475 admissions

Figure 2: Adjusted rate ratios of hospital admissions for hypoglycaemia, England 2005–2014

Legend: Rate ratios, adjusted for age, sex, index of multiple deprivation, and Charlson comorbidity score, are compared to 2005 (reference year, black dotted line)

Figure 3: Trends of length of stay, inpatient mortality, and one-month readmission, England 2005–2014

Legend: Estimates adjusted for age, sex, ethnicity, IMD–10, and Charlson comorbidity score. Bars indicate 95%CI

Figure 4: Region-specific same day discharge, inpatient mortality, and one month readmission comparing 2014 vs 2005

Legend: Estimates, adjusted for age, sex, ethnicity, IMD–10, and Charlson comorbidity score, indicate absolute changes per 100 admissions comparing 2014 vs 2005. For example, in Yorkshire-Humber, 9.6 more admissions out of 100 (i.e., 9.6%) resulted in same day discharge comparing 2014 to 2005. Similarly, 1.3 less deaths per 100 admissions and 16.5 less one-month readmissions per 100 readmissions occurred in the same period and for the same area. Dotted lines and the 95%CI shadow areas indicate the national average for England.

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