

Inpatient hypoglycemia in the elderly is associated with a doubling in the increased length of stay compared to the younger population

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Key points (3-5):

- The incidence of hypoglycemia was slightly lower in the elderly inpatients with diabetes than in the younger counterparts.
- In all age groups, admissions with either level 1 or level 2 hypoglycemia were associated with an increased length of stay.
- In the elderly groups, the length of stay increments were much higher (double) than the younger counterparts.

Abstract

Background

Hypoglycemia during hospital admission is associated with poor outcomes including increased length of stay. In this study, we compared the incidence of inpatient hypoglycaemia and length of stays among people of three age groups: ≤ 65 years, 65-80 years and >80 years old.

Methods

The study was conducted using a four-year electronic patient record dataset from Oxford University Hospitals NHS Foundation Trust. The dataset contains hospital admission data for people with diabetes. We analyzed the blood glucose (BG) measurements and identified all level 1 (BG $<4\text{mmol/l}$) and level 2 (BG $<3\text{mmol/l}$) hypoglycemic episodes. We compared the length of stays between different age groups and with different levels of hypoglycemia.

Results

We analyzed data obtained from 17,658 inpatients with diabetes who underwent 32,758 hospital admissions. The length of stays for admissions with no hypoglycaemia were 3[1,6], 3[1,8] and 4[2,11] (median[interquartile range]) days for age groups ≤ 65 years, 65-80 years and >80 years, respectively. These were statistically significantly lower ($P < 0.01$ for all pairwise comparisons) than the length of stays for admissions with level 1 hypoglycemia which were 6[3,13], 10[5,20] and 12[6,22] days, and level 2 hypoglycemia which were 7[3,14], 11[5,24] and 13[6,24] days.

Conclusions

In all age groups, admissions with either level 1 or level 2 hypoglycemia were associated with an increased length of stay. However, in both of the elderly groups, the length of stay increments were much higher (double) than the younger counterparts. The clinical consequences of hypoglycaemia were more severe in the elderly compared to the younger population.

Introduction

Diabetes mellitus, is a common medical disorder, affecting the lives of 463 million people around the world [1]. The main characteristic feature of diabetes mellitus is prolonged high levels of blood glucose and it is associated with a range of long-term complications including retinopathy, neuropathy, cardiovascular disease, and nephropathy. Insulin is the medication of choice to treat people with Type 1 diabetes and many people with Type 2 diabetes as it is highly effective in controlling blood glucose levels. However, high doses of exogenous insulin may result in hypoglycemia which can be extremely dangerous particularly in the elderly [2]. As the number of people in the elderly population increases and life expectancy increases, diabetes care for the elderly population is becoming more important [3].

There is increasing evidence that in inpatients with diabetes, hypoglycaemia during a hospital admission is associated with poor outcomes including increased mortality and increased length of stay [4, 5]. However, an unanswered question is whether the burden of hypoglycaemia and its consequences are the same in different age groups, especially in the elderly population.

In this report, we retrospectively studied a four-year dataset obtained from the electronic patient record (EPR) system of a large teaching hospital and compared the incidence of inpatient hypoglycaemia and length of stays among people of three different ages groups: ≤ 65 years, 65-80 years and >80 years old.

Methods

The study was conducted using electronic patient record data from Oxford University Hospitals NHS Foundation Trust. This included the Cerner electronic patient record system, the laboratory information management system (LIMS) and the point-of-care testing (POCT) system. The dataset contains hospital admission data from 1st September 2014 to 30th June

2018 for people admitted to hospital with diabetes. Patients were included in the study if they fulfilled all of the following criteria: (1) being an inpatient as coded in the EPR; (2) having one diagnosis code among E10(insulin-dependent diabetes mellitus), E11(non-insulin-dependent diabetes mellitus), E13(other specified diabetes mellitus), E14(unspecified diabetes mellitus) or O24(diabetes mellitus in pregnancy) as defined in the World Health Organization International Classification of Diseases–10th Revision (ICD-10)[6]; (3) having at least one blood glucose test performed during the hospital admissions. A level 1 hypoglycemic episode was defined as any blood glucose measurement less than 4mmol/l and a level 2 hypoglycemic episode was defined as any blood glucose measurement less than 3mmol/l[7]. Any two or more than two consecutive low blood glucose measurements within a 2-hour time window were considered as one single hypoglycaemic episode. The age of an inpatient was calculated as the difference between the year of admission and the year of birth. The comparisons of length of stays between different age groups were performed using independent 2-group Mann-Whitney U test due to the non-normality of the dataset. All statistical analyses were performed using R version 3.3.

Results

We analyzed data obtained from 17,658 inpatients with diabetes who underwent 32,758 hospital admissions. We identified all the level 1 and level 2 hypoglycemic episodes during these admissions. The incidence of level 1 hypoglycemia during a hospital admission was 21.5% (24.7%, 19.5% and 19.3% in the age groups ≤ 65 years, 65-80 years and >80 years, respectively) and that of level 2 hypoglycemia was 9.6% (11.1%, 8.8% and 8.5% in the age groups ≤ 65 years, 65-80 years and >80 years, respectively).

A selection of the baseline characteristics, vital signs, laboratory test results, medication use and the glycemic outcomes for the total inpatient cohort and the other age groups are reported

in Table 1. The mean systolic blood pressure increased with increasing age groups but no difference was found in the eGFR levels. In the elderly (over 60 years and over 80 years old), most of the patients had type 2 diabetes and therefore were prescribed more sulfonylureas, but less rapid acting and long acting insulin analogues. The mean blood glucose levels were similar among the different age groups.

Figure 1 shows the boxplots of the length of stays for hospital admissions with inpatients of different age groups and with different levels of hypoglycaemia. The overall length of stay for people with diabetes with no hypoglycaemia, level 1 and level 2 were 3[1, 8], 8[4, 18] and 9[4, 20] days, respectively (median[interquartile range]). When split into age groups, the length of stays for people with no hypoglycaemia were 3[1,6], 3[1,8] and 4[2,11] days for age groups ≤ 65 years, 66-80 years and >80 years, respectively. These were statistically significantly lower ($P < 0.01$ for all pairwise comparisons) than the length of stays for admissions with level 1 hypoglycemia which were 6[3,13], 10[5,20] and 12[6,22] days, and level 2 hypoglycemia which were 7[3,14], 11[5,24] and 13[6,24] days.

Conclusion

In this study, we found that the incidence of both level 1 and level 2 hypoglycemia was slightly lower in the elderly inpatients with diabetes than in the younger population. In all age groups, admissions with either level 1 or level 2 hypoglycemia were associated with an increased length of stay. However, in both of the elderly groups, the length of stay increments were much higher (double) than the younger population. The greater increase in length of stay was seen in people experiencing both level 1 and level 2 hypoglycaemia. This is the first paper to define the additional adverse consequences of inpatient hypoglycaemia in the elderly population.

Other studies have shown that hypoglycaemia in hospitalized elderly patients is associated with increased stay in hospital and 3 month mortality, but that hypoglycaemia was not an independent predictor [8]. A previous study from Birmingham, UK examined over 6000 admissions of people with diabetes over a 4-year period. The age of patients increased slightly with the severity of hypoglycaemia with the median age of those without hypoglycaemia as 66 and the median age of those with severe hypoglycaemia was 72 [9]. The median length of stay of people who had experienced hypoglycaemia increased from 5.9 days (no hypoglycaemia) to 11.0 days to 17.0 days (blood glucose 2.3-3.9 and <2.2mmol/L respectively). This rise in length of stay with hypoglycaemia was consistent with the results of our study however the higher absolute length of stay may be due to changes in the practice of medicine over the last 10 years. The markedly higher length of stay for people with severe hypoglycaemia compared to our study may also be due to the difference in the cut off for severe hypoglycaemia (2.2mmol/L compared to 3.0mmol/L in our study).

The limitations of the study include the differences in the populations across the age groups. Specifically there were fewer people with type 1 diabetes in the elderly groups and therefore a lower use of intravenous insulin and analogue insulin (both rapid and long acting). There was a slight increase in the use of human insulin in the elderly populations. However, despite these differences in the populations and the medications, there was no significant difference in mean glucose across the age groups. There was a noticeable reduction in the incidence of hypoglycaemia in the elderly which we attribute to the differences in the medications used across the age groups.

The results from this study suggest that the clinical consequences of hypoglycaemia are more severe in the elderly compared to the younger population. Whilst the management of inpatient hyperglycaemia is necessary, this study highlights the importance of avoiding inpatient hypoglycaemia especially in the elderly population. With the expanding population

of elderly inpatients with diabetes [10], the need to set individualized glycemic targets becomes all the more imperative in order reduce inpatient hypoglycaemia and its associated clinical outcomes.

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Data availability

The datasets analyzed during the current study are not publicly available due to data stored in a secured data management platform but may be available from the corresponding author on reasonable request.

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Duality of interest

The authors report no conflict of interest in the current study.

Contribution statement

YR had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. YR and RR co-designed the study analysis. YR carried out the data analysis. YR and RR drafted the manuscript. All authors contributed to the interpretation of the results and critical review of the report.

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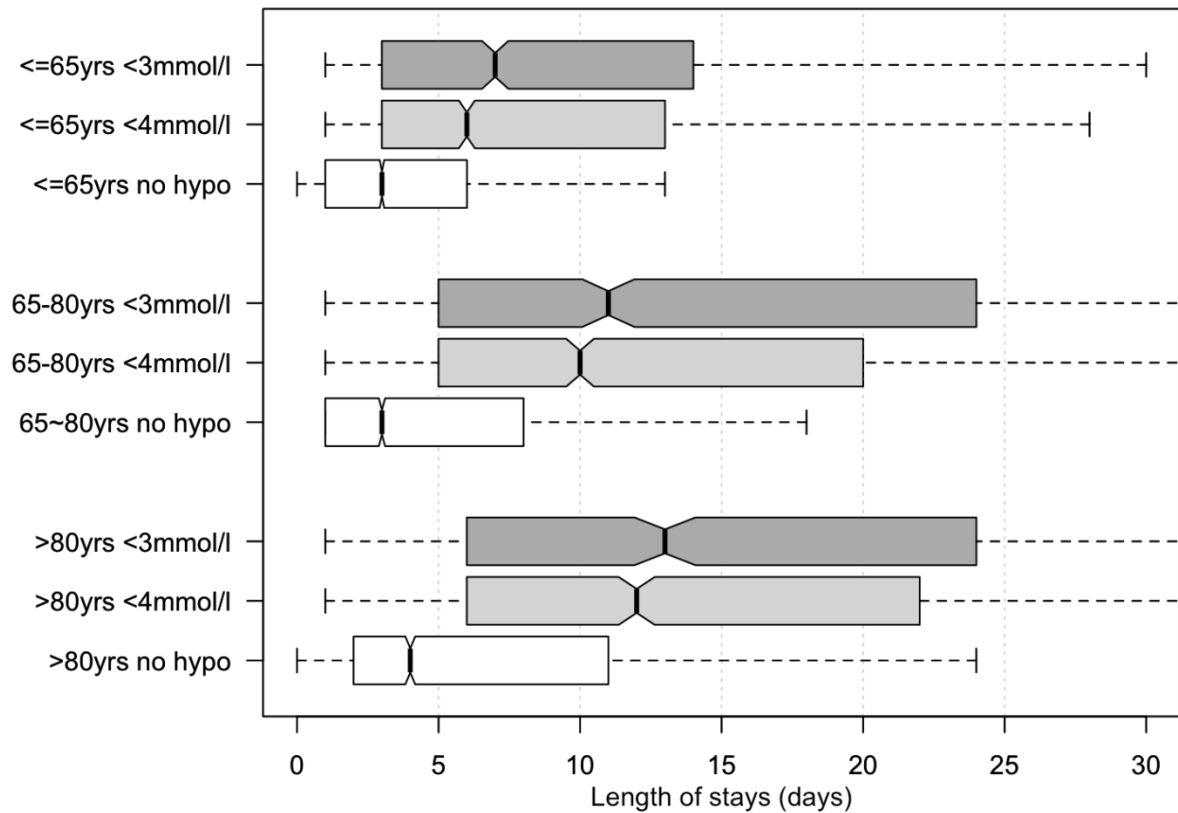


Figure 1. Influence of hypoglycemia on inpatient length of stay for age groups ≤65 years, 65-80 years and >80 years. The boxes depict median and interquartile range of the length of stay.

Table 1. Baseline characteristics and glycemic outcomes of the total, ≤ 65 years 65-80 years and >80 years inpatients cohorts.

Characteristics	Total inpatients with diabetes (N = 17,658) Number of hospital admissions (n = 32,758)	Inpatients ≤ 65 years (N = 7,252) Number of admissions (n = 12,588)	Inpatients 65-80 years (N = 6,545) Number of admissions (n = 12,002)	Inpatients >80 years (N = 4,175) Number of admissions (n = 8,168)
Sex, N(%)				
	Female	8,381(47)	3,784(52)	2,572(39)
	Male	9,277(53)	3,468(48)	2,013(48)
Age, mean(SD)	66(18)	48(14)	73(4)	86(4)
Ethnicity, N(%)				
	White British	12,511(70.8)	4,534(62.5)	4,825(73.7)
	African	116(0.7)	88(1.2)	24(0.4)
	Pakistani	331(1.9)	214(3.0)	95(1.5)
	Chinese	53(0.3)	28(0.4)	18(0.3)
	Indian	254(1.4)	152(2.1)	76(1.2)
	Not stated	2,869(16.2)	1,396(19.2)	1,031(15.8)
	Other	1,524(8.6)	840(11.6)	476(7.3)
Type of diabetes, N(%)				
	Type 1 diabetes	1,696(9.6)	1,401(19.3)	241(3.7)
	Type 2 diabetes	14,006(79.3)	4,249(58.6)	3,979(95.3)
	Other forms (including GDM)	1,956(11.1)	1,602(22.1)	237(3.6)
Systolic blood pressure, mean(SD)	132.5(18.2)	130.6(17.3)	133.7(17.7)	135.3(18.2)
eGFR, mean(SD)	29.8(6.4)	29.7(6.3)	29.8(6.3)	30.0(6.3)
Hemoglobin, mean(SD)	29.9(6.4)	30.0(6.4)	29.9(6.4)	30.0(6.4)
Medication use				
Sulfonylurea, n(%)	6,435(19.6)	1,743(13.7)	2,687(23.9)	1,832(22.4)
DPP-4, n(%)	1,415(4.3)	407(3.2)	641(5.3)	367(4.5)
GLP-1, n(%)	349(1.1)	215(1.7)	130(1.1)	4(0.1)
Metformin, n(%)	10,756(32.8)	3,561(28.3)	4,693(39.1)	2,502(30.6)
Insulin, n(%)				
	Intravenous insulin	4,678(14.3)	2,443(19.4)	1,441(12.0)
	Rapid acting analogue	3,954(12.1)	2,659(21.1)	975(8.1)
	Mixed acting analogue	1,553(4.7)	489(3.9)	770(6.4)
	Long acting analogue	5,118(15.6)	2,745(21.8)	1,457(12.1)
	Short acting human	3,561(10.9)	1,141(9.1)	1,391(11.6)
	Mixed acting human	1,388(4.2)	475(3.8)	581(4.8)
	Intermediate acting human	2,394(7.3)	838(6.7)	980(8.2)
Procedures, n(%)	22,931(70.0)	9,097(72.3)	8,683(72.3)	5,151(63.1)
Glycemic outcomes				
Hypoglycemia, n(%)				
	Level 1 (<4mmol/l)	7,030(21.5)	3,114(24.7)	2,338(19.5)
	Level 2 (<3mmol/l)	3,154(9.6)	1,403(11.1)	1,054(8.8)
Blood glucose level, mean(SD)	10.1(4.7)	10.1(5.0)	10.1(4.7)	10.2(4.9)

N(%), number of patients and percentage over the total number of patients; n(%), number of admissions and percentage over the total number of admissions