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## Original research

# Severe hypoglycaemia requiring emergency medical assistance by ambulance services in the East Midlands: A retrospective study

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## ABSTRACT

**Aims:** To report the characteristics and treatment of individuals requiring emergency ambulance services for severe hypoglycaemia and estimate associated provider costs.

**Methods:** Retrospective analysis of routinely collected data collected by the East Midlands Ambulance Trust, UK, of episodes of severe hypoglycaemia attended by emergency ambulance services during a four-month period. Standard clinical measures, response time, on-site treatment and transportation were recorded and ambulance services costs calculated.

**Results:** 90,435 emergency calls were recorded, 523 (0.6%) for severe hypoglycaemia, equating to an incidence of to 2.76 per 100 patient years; 74% of individuals were insulin-treated, 28% of events occurred nocturnally (00:00–07:59), and 32% were transported to hospital. Higher respiratory rate was a positive predictor ( $p=0.03$ ), whereas higher post treatment blood glucose ( $p=0.05$ ) and insulin treatment ( $p<0.01$ ) were negative predictors of transport to hospital. Median treatment costs for individuals transported and not transported to hospital were £92 and £176 respectively.

**Conclusions:** Most cases of severe hypoglycaemia requiring assistance from emergency ambulance services are successfully treated at the scene. Individuals not responding to treatment or were non insulin-treated were more likely to be transported to hospital. Further studies are needed to evaluate the effect of prehospital ambulance care by treatment and diabetes type on subsequent outcomes.

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Abbreviations: UK, United Kingdom; NICE, National Institute for Clinical Excellence.

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## 1. Introduction

Hypoglycemia is a known consequence of intensive therapy in people with diabetes [1,2]. Mild hypoglycaemia triggers unpleasant symptoms and disturbs daily activities. Repeated episodes increase the risk of severe hypoglycaemia [3] and hypoglycaemia unawareness [4]. The clinical consequences of severe hypoglycaemia are important and include provoking major vascular events and causing major neurological disability. Most episodes of severe hypoglycaemia do not require the assistance of the emergency medical services and are treated effectively at home or work by friends, relatives, and colleagues [5].

Globally the epidemiology of hypoglycaemia is thought to be changing as a result of guidelines recommending lower blood glucose targets, an aging population, and more frequent use of insulin for treatment of type 2 diabetes [6]. Approximately one-third of people with type 1 diabetes are exposed to one or more episodes of severe hypoglycaemia annually [7]. The frequency of severe hypoglycaemia in individuals with insulin-treated type 2 diabetes, although currently unknown, has previously been reported similar to individuals with type 1 diabetes [8].

Emergency ambulance services most frequently provide medical assistance for severe hypoglycaemia in comparison to other healthcare providers [8]. Incidence and costs of severe hypoglycaemia to emergency ambulance services have recently been reported elsewhere [9]. However, associated clinical characteristics and time spent by emergency ambulance staff for calls related to severe hypoglycaemia were not reported.

In view of the changing epidemiology and the clinical and economic consequences of severe hypoglycaemia, the aim of this study was to report the characteristics and treatment of individuals experiencing severe hypoglycaemia that required emergency ambulance services using routinely collected data. An additional objective was to provide associated ambulance related health service costs of hypoglycaemia.

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## 2. Methods

The East Midlands Ambulance Service NHS Trust, UK, routinely collects data on individuals requiring emergency ambulance services as part of the electronic call and dispatch system (recorded during calls to the ambulance service) and the electronic clinical record (recorded by clinicians attending patients). For the purposes of this study, cases of severe hypoglycaemia were defined as according to the definition used by the Diabetes Control and Complications Trial [1], defining episodes of 'severe' hypoglycaemia as any episode in which external assistance is required for recovery and is not confined to the development of coma or reduced consciousness level [10].

In this retrospective, population-based study, all episodes with a documented blood glucose measurement of <4.0 mmol/l occurring during a four month period (1st November 2010 to 28th February 2011) attended to by the emergency ambulance services in Nottinghamshire and

Derbyshire, UK, were retrieved using a computerized search. Nottinghamshire and Derbyshire have a population of 770,000 and 760,000, respectively.

Demographic data (including date of birth and sex), clinical information (pre and post treatment blood glucose, heart rate, respiratory rate, systolic and diastolic blood pressure, Glasgow Coma Scale score, treatment administered) and individuals' outcome (transported to hospital or left at scene) were extracted from electronic clinical records. In addition, timing of episode (call to emergency personnel, arrival and departure time of ambulance crew from individual) was extracted from the call and dispatch system in order to calculate time spent with individual by emergency ambulance service staff. Information on diabetic medications was obtained by the following categories: 'insulin treated', 'insulin plus oral hypoglycaemic agent', 'oral hypoglycaemic agent' and 'diet controlled'. Information on initial treatment administered was obtained as follows: 'food (carbohydrate/sweet)', 'oral glucose', 'glucose 10% (i.v.)' and 'other'.

Individuals without a confirmed diagnosis of diabetes were included in this study. Ambulance clinicians' classification of diabetes type was uncertain. To avoid potential misclassification by diabetes type, individuals were categorized as insulin-treated or non insulin-treated. All data were recorded in an anonymous form and age was calculated by year of birth only.

The Business Intelligence Unit at East Midlands Ambulance Service NHS Trust provided average costs of attending a call for a diabetes related problem as £141 per hour. Publicly available data sources were accessed to utilize total and diabetes population estimates of the study population.

### 2.1. Statistical analysis

The summary statistics were presented using *n* (%) or mean (SD or confidence intervals) or median (IQR), as appropriate. Non-parametric tests were used to compare the distributions of categorical and continuous study variables by diabetes treatment type and individual outcome (transportation to hospital or left at scene). Univariate and multivariate logistic regression models were developed to identify independent predictors of transportation to hospital. Complete case analysis was used, excluding missing responses from the analysis. The coefficients associated with individual predictors were presented with odds ratios (OR) and their 95% confidence intervals.

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## 3. Results

In 2009/10, the combined total population estimate of Nottinghamshire and Derbyshire was 1,530,000 [11], of whom 75,603 had a recorded diagnosis of diabetes [12]. The overall prevalence of diabetes in the study population was 4.94%. During the study period (1st November 2010 to 28th February 2011), a total of 90,435 emergency calls were received, of which 523 (0.6%) were recorded as severe hypoglycaemia comprising 521 individuals. The incidence of severe hypoglycaemia requiring emergency ambulance services in the diabetes population equates to 2.76 per 100 person-years. We were unable to obtain

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