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Research

Hypoglycemia requiring paramedic assistance among adults in southwestern Ontario, Canada: a population-based retrospective cohort study

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Abstract

Background: People with diabetes mellitus commonly experience hypoglycemia, but they may not necessarily present to hospital after severe hypoglycemia requiring paramedic assistance. We sought to describe the incidence and characteristics of calls for hypoglycemia requiring paramedic assistance among adults in southwestern Ontario, Canada, and to determine predictors of hospital transport.

Methods: This population-based retrospective cohort study used data extracted from ambulance call reports (ACRs) of 8 paramedic services of the Southwest Ontario Regional Base Hospital Program from January 2008 to June 2014. We described calls in which treatment for hypoglycemia was administered, summarized the incidence of hypoglycemia calls and performed logistic regression to determine predictors of hospital transport.

Results: Out of 470 467 ACRs during the study period, 9185 paramedic calls occurred in which hypoglycemia treatment was administered to an adult (mean age 60.2 yr, 56.8% male, 81.1% with documented diabetes). Refusal of hospital transport occurred in 2243 (24.4%) of calls. Documented diabetes diagnosis (adjusted odds ratio [OR] 0.82, 95% confidence interval [CI] 0.69–0.96), higher capillary blood glucose (adjusted OR 0.31, 95% CI 0.22–0.44) and overnight calls (adjusted OR 0.80, 95% CI 0.72–0.91) were associated with lower odds of hospital transport. Higher-acuity calls (adjusted OR 2.05, 95% CI 1.58–2.66) were associated with higher odds of transport. The estimated annual incidence rate of hypoglycemia requiring paramedic assistance was 108 per 10 000 people with diabetes per year.

Interpretation: Hypoglycemia requiring paramedic assistance in southwestern Ontario is common, and close to 25% of calls do not result in hospital transport. Physicians managing diabetes care may be unaware of patients' hypoglycemia requiring paramedic care, suggesting a potential gap in follow-up care; we suggest that paramedics play an important role in identifying those at high recurrence risk and communicating with their care providers.

Hypoglycemia is common in diabetes mellitus. It negatively affects many health-related outcomes.[1–10] Severe hypoglycemia, that is, hypoglycemia requiring third-party assistance,[11] is a major health concern. The incidence of severe hypoglycemia ranges from 0.8 to 3.2 events per person-year,[10,12–15] and annual prevalence ranges from 10% to 53% for type 1 diabetes[12] and from 4.4% to 6% for type 2 diabetes.[7,13]

Severe hypoglycemia is associated with increased cardiovascular events,[1,2] injury[3] and mortality;[1,2,4,5] it impairs quality of life[6,7] and discourages targeting tight glycemic control.[8,9] The economic costs are substantial in terms of the associated use of health care.[16] In Canada, 23% of people who presented to emergency departments with severe hypoglycemia were hospitalized (2008–2010).[3] Insulin and oral antihyperglycemic agents were the second and fourth medications, respectively, most frequently associated with emergency hospitalization among adults aged 65 years and older in the United States.[17] Despite serious consequences, it is probable that only some patients with severe hypoglycemia present to hospital, while others are treated only at the scene, by family or friends, or by emergency medical services; thus many episodes are "invisible" to the health care system.

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In Canada, paramedic scope of practice varies by province. Ontario ambulance crews include emergency medical assistants or paramedics. Emergency medical assistants have the narrowest scope of practice, followed by primary care paramedics, primary care paramedics with advanced training to administer intravenous medications, and then advanced care paramedics, who administer a wide variety of medications, including via intravenous administration. After an ambulance call, patients may decline hospital transport and hence may not have emergency department assessment. Thus, although reported rates of emergency department visits for hypoglycemia are high — a US study estimated more than 97 000 emergency department visits per year for insulin-related hypoglycemia[18] — the true burden of severe hypoglycemia is likely higher when considering events not leading to an emergency department visit.

There have been limited studies describing prehospital hypoglycemia requiring paramedic assistance. We sought to describe the incidence and characteristics of hypoglycemia requiring paramedic assistance among adults in southwestern Ontario, Canada, over a period of 6.5 years, and to determine predictors of hospital transport.

Methods

Design and setting

We conducted a population-based retrospective cohort study in southwestern Ontario, Canada, using data from 2008 to 2014. We reported this study using the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement.[19]

Ontario is the most populous Canadian province. Southwestern Ontario has about 1.6 million residents,[20] making up about 12% of the provincial population.[21] In southwestern Ontario, emergency medical services (EMS) are provided by 11 paramedic services under the direction of the Southwest Ontario Regional Base Hospital Program (SWORBHP).

Data sources

Ontario paramedics are mandated to complete ambulance call reports (ACRs) for all calls attended.[22] In southwestern Ontario, each ambulance call is assigned a unique identifier, and data collected are stored in an electronic database housed at the SWORBHP. We used ACR data from 8 of 11 SWORBHP paramedic services; at the time of the study, ACRs for 3 services were not available electronically (Appendix 1, Supplementary Figure 1, available at www.cmajopen.ca/content/9/4/E1260/suppl/DC1).

Ambulance call and patient characteristics

All ambulance calls between Apr. 1, 2008, and June 30, 2014, for adults aged 18 and older were eligible for inclusion. As there is no ACR code for hypoglycemia, calls were considered for inclusion on the basis of documented paramedic hypoglycemia treatment. Two medical students manually reviewed ACRs for which capillary blood glucose level on paramedic arrival was either missing from the record or was 4 mmol/L or greater. We excluded those with duplicate call numbers or confirmed capillary blood glucose of 4 mmol/L or greater.

We extracted the following patient characteristics from each ACR: age, sex, diabetes diagnosis, use of insulin and oral antihyperglycemic agents, capillary blood glucose level (mmol/L) and Glasgow Coma Scale (GCS) score on paramedic arrival. We collected call characteristics as follows: call time, Canadian Triage and Acuity Scale (CTAS) level, crew type (emergency medical assistants, primary care paramedics, primary care paramedics with advanced training to administer intravenous medications, advanced care paramedics), hypoglycemia treatment (oral glucose, intravenous dextrose, intramuscular glucagon), final primary problem code (1 of 63 codes classified by organ system) and return priority code including disposition.

Statistical analysis

We summarized patient and call characteristics using means and standard deviations or proportions where appropriate. The characteristics of calls with and without transport refusal were compared using the independent *t* test (continuous variables) or the χ^2 or Fisher exact test (categorical variables) as appropriate.

To determine factors associated with hospital transport, we performed multivariable logistic regression. All variables were included in the multivariable model, with GCS score dichotomized as less than 9 versus 9 or greater; CTAS level dichotomized as 3 or less versus greater than 3; call time dichotomized to overnight (18:00–06:00) or daytime (06:01–17:59); final primary problem "diabetic emergency" dichotomized as yes or no; hypoglycemia treatment categorized as i) oral glucose alone, ii) intravenous dextrose (alone or with oral glucose), iii) any intramuscular glucagon (alone, with oral glucose or with intravenous dextrose), iv) all 3 (oral glucose, intravenous dextrose and intramuscular glucagon) with oral glucose alone as the referent group; and crew type categorized as i) emergency medical assistants or primary care paramedics, ii) primary care paramedics with advanced training to administer intravenous medications, and iii) advanced care paramedics. Missing data were not imputed.

The annual incidence of calls for hypoglycemia requiring paramedic assistance was estimated for 2009–2013 (partial years 2008 and 2014 not included) using diabetes prevalence figures reported by ICES, determined from provincial health administrative data from the Ontario Diabetes Database and the Registered Persons Database.[23] In 2011, there were an estimated 134 449 adults with diabetes in the SWORBHP area. [23]

We performed a sensitivity analysis for the annual incidence of calls, identifying calls using either paramedic treatment for hypoglycemia or the "diabetic emergency" ACR problem code.

A 5% level of significance was used for all tests. Statistical analyses were performed using SAS for Windows version 9.3 (SAS Institute).

Ethics approval

The study was approved by the Western University Health Sciences Research Ethics Board.

Results

A total of 470 467 paramedic calls occurred over 6.5 years, including 9361 documenting paramedic hypoglycemia treatment in adults. In 688 (7.3%) calls, the capillary blood glucose level on paramedic arrival was either missing or was 4 mmol/L or greater; after review, 176 calls were excluded for a final number of 9185 calls (2.0% of total calls).

The number of hypoglycemia calls per complete year of data (2009–2013) by paramedic service is shown in Figure 1. The estimated incidence of calls for hypoglycemia requiring paramedic assistance from 2009 to 2013 was about 108 per 10 000 people with diabetes per year.

The patient and call characteristics are summarized in Table 1. Patients had a mean age of 60.2 years, 5197 (56.8%) were male and 7450 (81.1%) had a documented diagnosis of diabetes. As per CTAS, 7383 (95.5%) of calls were urgent acuity or higher. A total of 2181 (24.2%) patients had an initial GCS score of less than 9, and 2073 (23.0%) had an initial GCS score of 15.

Disposition data were available for 9173 (99.9%) calls, summarized in Table 2. Refusal of transport occurred in 2243 (24.4%) calls. The final primary problem was "diabetic emergency" in 6196 (67.5%) calls (Appendix 1, Supplementary Table 1).

After adjustment for the interaction between capillary blood glucose level and hypoglycemia treatment, glucagon treatment and CTAS level of 3 or lower were significantly associated with higher odds of hospital transport; higher capillary blood glucose (per mmol/L), documented diabetes and overnight call were associated with lower odds of transport (Table 3). There was no association between hospital transport and age, sex, insulin or oral antihyperglycemic agents use, GCS score or crew type.

In the sensitivity analysis using either paramedic treatment for hypoglycemia or "diabetic emergency" ACR problem code, we identified 1416 additional calls with initial capillary blood glucose levels of 4.0–14.0 mmol/L (or capillary blood glucose level not available).

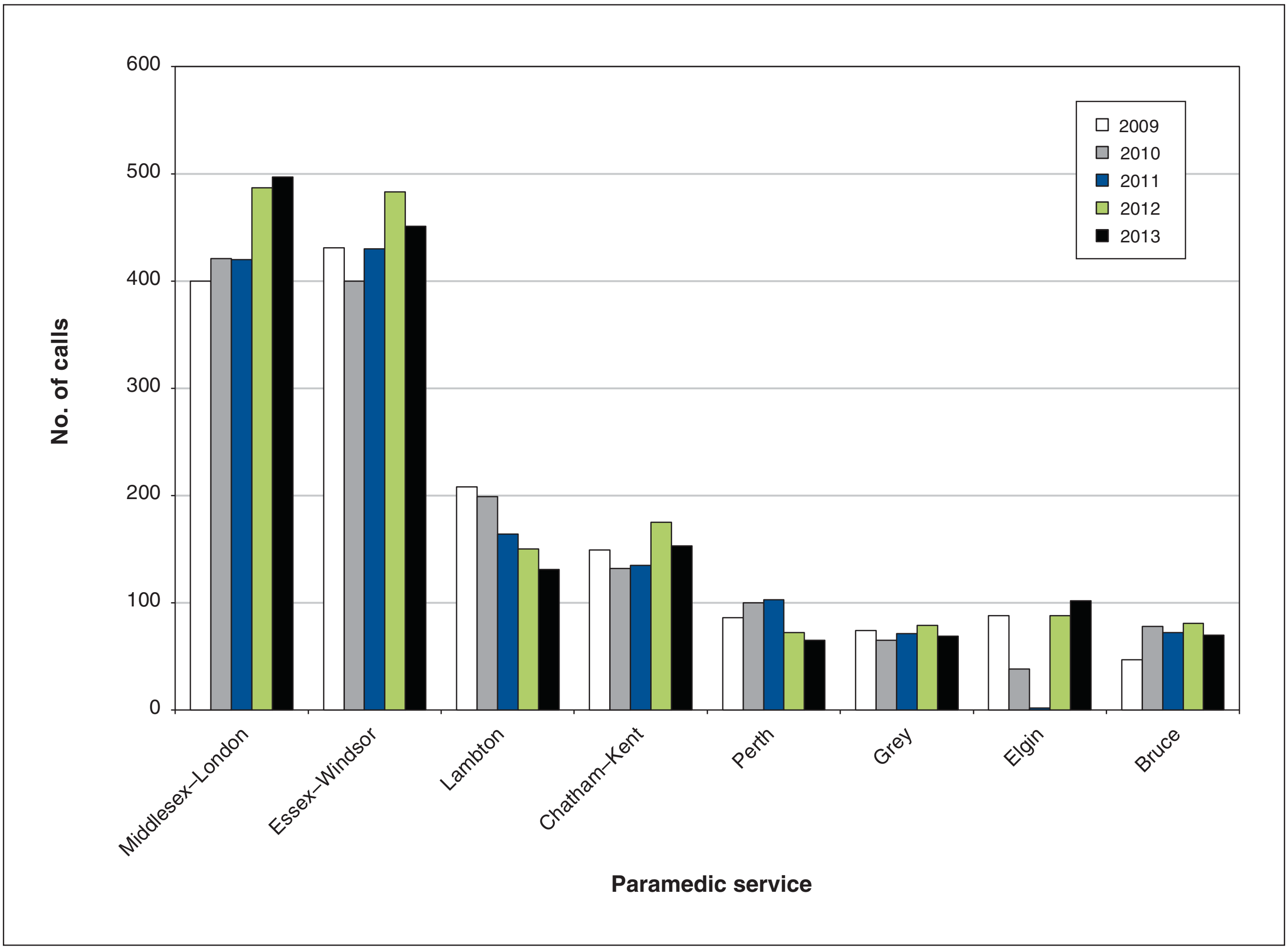

Figure 1: Calls for hypoglycemia requiring paramedic assistance per year, 2009–2013, by paramedic service (data for 2008 and 2014 were not included, as only partial data for these years were available [April to December 2008 and January to June 2014]).

Interpretation

We described more than 9000 calls for hypoglycemia requiring paramedic assistance among adults in southwestern Ontario over a period of 6.5 years and identified factors associated with hospital transport. The estimated annual incidence rate of calls was high at 108 per 10 000 people with diabetes per year. This study's results showed that, in our region, hypoglycemia requiring paramedic assistance is common, and transport refusal occurs in a substantial proportion (24%) of calls. Our results more accurately characterize prehospital severe hypoglycemia than studies using provincial health administrative data, as data from these patients would not be captured in administrative databases containing only emergency department visit information.

Comparing the frequency of hypoglycemia requiring paramedic assistance between studies is challenging. Prior studies are of shorter duration in varied populations,[16,24–32] with incidence ranging from 4.8 to 103 per 10 000 person-years in Victoria, Australia,[26] to 1150 per 10 000 person-years (type 1 diabetes) and 1180 per 10 000 person-years (type 2 diabetes) in Tayside, Scotland.[16] However, the Tayside study was more than 20 years ago, before the advent of newer insulins with less hypoglycemia risk and advanced glucose monitoring technology. There have been 2 Canadian studies with durations of

Table 1 (part 1 of 2): Patient and paramedic call characteristics (January 2008–June 2014), stratified by refusal of transport

	No. (%) of calls*			
Characteristic	Total	Transport refusal	No refusal of transport†	*p* value‡
Calls	9185	2243 (24.4)	6942 (75.6)	
Patient characteristics				
Age, yr, mean ± SD (*n* = 9162)	60.2 ± 19.0	58.6 ± 19.7	60.8 ± 18.7	< 0.001
Sex, male (*n* = 9146)	5197 (56.8)	1333/2236 (59.6)	3864/6910 (55.9)	0.002
Documented diabetes diagnosis	7450 (81.1)	1746 (77.8)	5704 (82.2)	< 0.001
Insulin use	3883 (42.3)	963 (42.9)	2920 (42.1)	0.5
Oral antihyperglycemic agent use	1441 (15.7)	316 (14.1)	1125 (16.2)	0.02
Capillary blood glucose on paramedic arrival, mmol/L, mean ± SD (*n* = 9026)	2.5 ± 1.0	3.2 ± 1.1	2.3 ± 0.9	< 0.001
Capillary blood glucose on paramedic arrival < 2.5 mmol/L (*n* = 9026)	4931 (54.6)	504/2149 (23.5)	4427/6877 (64.4)	< 0.001
Initial Glasgow Coma Scale score < 9 (*n* = 9019)	2181 (24.2)	385/2190 (17.6)	1796/6829 (26.3)	< 0.001
Call characteristics				
Canadian Triage Acuity Scale level ≤ 3 (*n* = 7731)	7383 (95.5)	1561/1703 (91.7)	5822/6028 (96.6)	< 0.001
Time of calls (*n* = 9092)				0.007
00:00–05:59	1860 (20.5)	502/2222 (22.6)	1358/6870 (19.8)	
06:00–11:59	2084 (22.9)	493/2222 (22.2)	1591/6870 (23.2)	
12:00–17:59	2706 (29.8)	615/2222 (27.7)	2091/6870 (30.4)	
18:00–23:59	2442 (26.9)	612/2222 (27.5)	1830/6870 (26.6)	
Type of crew§ (*n* = 9168)				0.2
Emergency medical assistants	2 (0.02)	1/2237 (0.04)	1/6931 (0.01)	
Primary care paramedics	6717 (73.3)	1657/2237 (74.1)	5060/6931 (73.0)	
Primary care paramedics with advanced training to administer IV medications	159 (1.7)	29/2237 (1.3)	130/6931 (1.9)	
Advanced care paramedics	2290 (25.0)	550/2237 (24.6)	1740/6931 (25.1)	

Table 1 (part 2 of 2): Patient and paramedic call characteristics (January 2008–June 2014), stratified by refusal of transport				
	No. (%) of calls*			
Characteristic	Total	Transport refusal	No refusal of transport†	*p* value‡
Call characteristics cont'd				
Treatment				< 0.001
Oral glucose alone	2072 (22.6)	871 (38.8)	1201 (17.3)	
IV dextrose alone	3189 (34.7)	656 (29.2)	2533 (36.5)	
IM glucagon alone	1679 (18.3)	339 (15.1)	1340 (19.3)	
Oral glucose and IV dextrose	534 (5.8)	84 (3.7)	450 (6.5)	
Oral glucose and IM glucagon	1501 (16.3)	264 (11.8)	1237 (17.8)	
IV dextrose and IM glucagon	186 (2.0)	24 (1.1)	162 (2.3)	
Oral glucose, IV dextrose and IM glucagon	24 (0.3)	5 (0.2)	19 (0.3)	
Treatment (not mutually exclusive¶)				
Oral glucose	4131 (45.0)	1224 (54.6)	2907 (41.9)	< 0.001
IV dextrose	3933 (42.8)	769 (34.3)	3164 (45.6)	< 0.001
IM glucagon	3390 (36.9)	632 (28.2)	2758 (39.7)	< 0.001

Note: IM = intramuscular, IV = intravenous, SD = standard deviation.
*Unless stated otherwise.
†Includes calls where patients were transported to hospital (*n* = 6745) and those not transported for reasons other than refusal: transported by other ambulance (*n* = 147), deceased (*n* = 26), no patient found (*n* = 9), in police custody (*n* = 3) or with missing disposition (*n* = 12).
‡Comparison of those who refused transport and those who did not refuse transport using the independent *t* test (continuous variables) or the χ^2 or Fisher exact test (categorical variables) as appropriate.
§Ambulance crews can be composed of emergency medical assistants and paramedics, with different scopes of practices: emergency medical assistants have the narrowest scope, followed by primary care paramedics, primary care paramedics with advanced training administering IV medications, and then advanced care paramedics.
¶More than 1 type of treatment may have been administered (so the sum is greater than the total number of calls).

1 year or less, and neither estimated annual incidence.[33,34] Age and sex in our study were similar to those in prior reports.[24–29,31,32,34–37] A high proportion (81.1%) of patients included in our study had documented diabetes, with 42.3% taking insulin, a lower proportion than that found in prior studies[24,25,28,31] with insulin use ranging from 74.0%[31] to 75.9% (type 2 diabetes) and 99.5% (type 1 diabetes).[24]

We reported higher glucagon use either alone or in combination (36.9%) than other studies in which use ranged from 0.01%[36] to 17.8%.[34] A US EMS registry study also showed underuse of glucagon and postulated that crew type may be contributory, as about 75% of EMS providers in the US are not paramedics and cannot administer glucagon.[38] In Ontario, both primary care paramedics and advanced care paramedics may administer glucagon, but only primary care paramedics with specialized intravenous training and advanced care paramedics can administer intravenous dextrose. In our study, 73.3% of calls were attended by primary care paramedics, 25% by advanced care paramedics and 1.7% by primary care paramedics with specialized intravenous training; however, in a study by Sinclair and colleagues, 80% of calls in Ottawa, Ontario, were attended by advanced care paramedics.[34] This difference may explain higher glucagon use in our study (36.9% v. 17.8%) but does not explain the similar use of intravenous dextrose (42.8% v. 37.8%).[34] In our study, acuity may have been higher, necessitating glucagon use. Sinclair and colleagues excluded patients receiving palliative care and those with absent vital signs, and their proportion of patients with a GCS score of 15 on arrival was higher than in our study (42% v. 23%).[34] We did not have information on whether patients received treatment from others before paramedic arrival, and this may also have influenced subsequent paramedic treatment.

In our study, patients declined hospital transport in 1 in 4 calls. Refusal of transport has been commonly reported with similar rates of 17.7% to 29.7%.[27,29,34,36,38] We showed that, among calls with transport refusal, patients were younger and more often male, mean capillary blood glucose was higher, and more calls were overnight. A lower proportion of patients who declined transport had diabetes, had a GCS score of less than 9, had a CTAS level of 3 or lower, and used oral antihyperglycemic agents, similar to the findings of other studies reporting transport refusal by younger men and those less likely to be taking oral antihyperglycemic agents.[34,39] However, aside from capillary blood glucose level and GCS score, the differences between groups in our study were very small and not clinically relevant. The differences in the proportions with capillary blood glucose levels less than 2.5 mmol/L and GCS scores less than 9 between groups in our study were large, indicating that hypoglycemia was less severe in calls with transport refusal. Thus, those who declined transport may represent less severe hypoglycemia potentially related to more remediable causes, such as a missed meal or a miscalculation of insulin dose,

Table 2: Patient disposition as per return priority code*			
Disposition	No.	% of those transported or not transported†	% of total calls‡
Patient transported by paramedics		% of those transported	
Deceased patient	1	0.01	0.01
Scheduled call	8	0.1	0.09
Deferable call	66	1.0	0.7
Prompt call	4462	66.2	48.6
Urgent call	2208	32.7	24.1
Subtotal	6745		73.5
Patient not transported by paramedics		% of those not transported	
Patient in police custody	3	0.1	0.03
No patient found	9	0.4	0.1
Patient deceased	26	1.1	0.3
Transported by other ambulance	147	6.1	1.6
Patient refused	2243	92.4	24.5
Subtotal	2428		26.5

*Return priority code as assigned by paramedics that identifies the priority under which patients are transported, defined as (a) deceased patient — the transport of a deceased patient where no resuscitative measures are being performed, (b) scheduled call — non-emergency call which must be done at a specific time owing to the limited availability of special treatment or diagnostic or receiving facilities (scheduling not done because of patient preference or convenience), (c) deferrable call — non-emergency call that may be delayed without being physically detrimental to the patient, (d) prompt call — an emergency call that may be responded to with moderate delay (the patient is stable or under professional care and not in immediate danger, and (e) urgent — an emergency call requiring an immediate response (patient is life-, limb- or function-threatened and in immediate danger, and time is crucial).[22]
†Percentages may not add up to 100% because of rounding.
‡Total calls with disposition data available (n = 9173).

rather than serious underlying illness. Although paramedic treatment was required, after recovery, patients may have been less willing to seek further care. Although we found no difference in insulin use, other studies have shown higher insulin use among patients who declined transport.[34,39] On multiple regression, odds of transport were higher with glucagon treatment and a CTAS level of 3 or lower, and odds of transport were lower with higher capillary blood glucose, documented diabetes and an overnight call. However, since the baseline rate of transport was high, we note that the odds ratios cannot be interpreted as approximations of relative risk.

Given the substantial proportion of calls with transport refusal, many patients may not receive appropriate follow-up care. Strategies have been assessed to facilitate timely access to care after hypoglycemia requiring paramedic assistance, including early education referral[40] and phone calls or reminder cards to contact diabetes care providers.[41] Although patients perceived these programs positively,[40,41] follow-up diabetes care attendance did not improve.[41] Another study evaluated an "opt-out" referral pathway, which lead to delivery of follow-up hypoglycemia education in 72.1% of the first 2000 referrals.[42]

In our region, follow-up for patients with hypoglycemia presenting to the emergency department is individualized (i.e., family physician, endocrinologist or diabetes educator assessments), but this is not possible if patients do not present to the emergency department. Since we showed that this group may represent a sizable proportion of cases, we implemented a pilot referral program in which direct electronic referrals were sent at the time of paramedic assessment for patients with hypoglycemia to receive follow-up focused hypoglycemia education. More studies are needed to evaluate other approaches to improve communication of the occurrence of severe hypoglycemia between patients, EMS and physicians, and to elucidate patient-important barriers to hospital transport for hypoglycemia.

Study strengths include the large call number and use of a comprehensive ACR database from a geographically defined region. To ensure data validity, we manually reviewed capillary blood glucose levels in 7.3% of calls.

Limitations

We could not identify unique individuals, as date of birth is redacted in the SWORBHP database (only age available) and health card number is not a mandatory ACR field. Hence, we could not identify repeat calls per patient. However, the repeat hypoglycemia call rate was 26% over 6 months in 2014 in the Middlesex-London Paramedic Service (the largest SWORBHP service) (Dr. Michael Peddle, SWORBHP, London, Ont.: unpublished data, 2015), similar to the rates in other studies with repeat call rates 13.5% to 25.9%.[33–35]

We also could not use ACR codes to identify hypoglycemia calls, as there is no specific code for hypoglycemia (only for "diabetic emergency," including both hypoglycemia and hyperglycemia). Thus, we used paramedic hypoglycemia treatment as an inclusion criterion, excluding calls in which hypoglycemia

Table 3: Association between patient and call characteristics and hospital transport

Variable	Unadjusted* OR (95% CI)	Adjusted† OR (95% CI)
Age (years)	1.00 (1.00–1.01)	1.00 (1.00–1.01)
Sex, male	0.89 (0.79–1.01)	0.89 (0.79–1.01)
Documented diabetes diagnosis	0.82 (0.69–0.96)	0.82 (0.69–0.96)
Insulin use	0.95 (0.82–1.09)	0.95 (0.82–1.09)
Oral antihyperglycemic agent use	1.06 (0.89–1.25)	1.06 (0.89–1.26)
Glasgow Coma Scale score < 9	1.13 (0.97–1.32)	1.12 (0.65–1.31)
Canadian Triage Acuity Scale level ≤ 3	2.09 (1.61–2.71)	2.05 (1.58–2.66)
Overnight call (18:00–06:00)	0.81 (0.72–0.91)	0.80 (0.72–0.91)
“Diabetic emergency” as final primary problem code	1.10 (0.97–1.25)	1.10 (0.97–1.25)
Crew type		
Advanced care paramedics (referent group)	1.00	1.00
Emergency medical assistants or primary care paramedics	0.94 (0.80–1.10)	0.94 (0.81–1.10)
Primary care paramedics with advanced training to administer IV medications	1.34 (0.83–2.17)	1.31 (0.82–2.11)
CBG (per mmol/L)	0.26 (0.24–0.29)	0.31 (0.22–0.44)
Treatment		
Oral glucose alone (referent group)	1.00	1.00
IV dextrose alone or with oral glucose	1.11 (0.92–1.30)	1.63 (0.70–3.80)
Any IM glucagon (alone, with oral glucose or with IV dextrose)	1.14 (0.97–1.34)	3.89 (1.64–9.20)
All 3 (oral glucose + IV dextrose + IM glucagon)	0.45 (0.14–1.37)	0.21 (0.02–2.18)
Interaction of CBG and treatment		
CBG (per mmol/L), oral glucose (referent group)	–	1.00
CBG (per mmol/L), IV dextrose alone or with oral glucose	–	0.90 (0.63–1.28)
CBG (per mmol/L), any IM glucagon (alone, with oral glucose or with IV dextrose)	–	0.67 (0.47–0.95)
CBG (per mmol/L), all 3 (oral glucose + IV dextrose + IM glucagon)	–	1.52 (0.56–4.12)

Note: CBG = capillary blood glucose, CI = confidence interval, IM = intramuscular, IV = intravenous, OR = odds ratio.
*Main effects model.
†Adjusted for interaction between CBG and treatment.

was treated by others before paramedic arrival and subsequently not treated by paramedics. We determined the number of diabetic emergency calls with no paramedic treatment (Appendix 1, Supplementary Table 2): 276 with capillary blood glucose less than 4.0 mmol/L and 1416 with capillary blood glucose 4.0 mmol/L or greater, or not documented or not available. For the latter group, there was no way to distinguish between a hyperglycemia call or a hypoglycemia call with patient treatment before paramedic arrival. If we assumed all 1416 were cases of true hypoglycemia and included them, these would be only about 13% of total study calls and unlikely to change the results substantially.

Other limitations related to ACR data are the inability to distinguish diabetes type, as differences in incidence of hypoglycemia requiring paramedic assistance by diabetes type has been reported,[16,27–30] lack of information on whether hypoglycemia was diabetes related or nondiabetes related (e.g., sepsis or severe liver failure), and absence of information on patient marital status or living arrangements, as social context may influence transport refusal.

Further limitations are that capillary blood glucose levels were validated but not other data (though paramedics enter ACR data in real time and complete biannual training on ACR completion), and the data used are older and may not reflect the contemporary incidence and characteristics of hypoglycemia requiring paramedic assistance.

Finally, although our study encompassed a large geographic area served by the SWORBHP, the results may not be generalizable to other populations. The diabetes prevalence in the area served by 3 of the paramedic services in this study is higher (7.7 per 100 000 population) than the prevalence in the rest of Ontario (6.8 per 100 000) and Canada (6.2 per 100 000), though the prevalence in the area served by the other 5 services is the same as that of Canada (6.2 per 100 000).[43] In southwestern Ontario, disparities in social determinants of health exist that may affect hypoglycemia requiring paramedic assistance, including a higher dependency ratio for older people than the provincial and national ratios (30% v. 24%), lower median income than that of Ontario (though higher than the national median) and a higher rate of individuals with either no formal schooling or only high school diploma compared with Ontario and Canada (53% v. 49%).[43]

Conclusion

This large population-based study shows not only the high incidence of hypoglycemia requiring paramedic assistance in southwestern Ontario, but also the high rate of transport refusal in paramedic-treated hypoglycemia. Physicians managing diabetes care may be unaware of the occurrence of paramedic assistance for hypoglycemia in their patients. This is an important care gap as it represents missed opportunities to intervene with strategies to prevent recurrent severe hypoglycemia. We suggest that paramedics play an important role in identifying patients at high risk of recurrence and communicating severe hypoglycemia occurrence to patients' diabetes care providers.

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