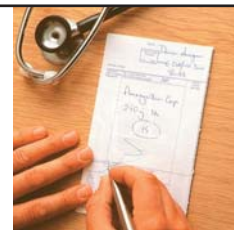


Motor vehicle accidents during episodes of hypoglycaemia



Case reports and lessons to be learnt

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BACKGROUND

Hypoglycaemia is a common adverse effect of insulin treatment in individuals with diabetes, potentially leading to cognitive impairment, altered levels of consciousness and delayed reactions. If this happens while driving a motor vehicle, a disastrous accident may ensue.

OBJECTIVE

This article describes the clinical scenarios of five men with type 1 diabetes who were involved in motor vehicle accidents due to severe hypoglycaemia and discusses the potential risk factors for hypoglycaemia.

DISCUSSION

Reference is made to the specific management guidelines set out by the Australian Driver Licensing Authorities for individuals with diabetes. Sometimes, important ethical decisions can be difficult when managing diabetic individuals who fail to comply with therapy or who suffer hypoglycaemia related events and continue to drive a motor vehicle.

Hypoglycaemia is not an uncommon occurrence in individuals with type 1 diabetes. Following the results of The Diabetes Complication and Control Trial, the American Diabetes Association has recommended strict glycaemic control in individuals with type 1 diabetes so as to prevent long term complications. Achieving HbA1C measurements of less than 7.2% and average blood glucose levels of approximately 8.0–8.5 mmol/L are now considered the gold standard of care.¹ This practice, however, is not without risk and has the potential to result in more frequent and catastrophic hypoglycaemia.²

Case reports

There were five men with type 1 diabetes aged 18–66 years involved in motor vehicle accidents due to severe hypoglycaemia. Their clinical data and factors potentially responsible for their driving accidents are outlined in *Table 1*. These men were randomly selected from a group currently attending education courses at the St George Hospital Diabetes Centre (New South Wales). All motor vehicle acci-

dents were reported to the police and were found to be due to documented hypoglycaemia with plasma glucose values less than 2.5 mmol/L; none were related to poor visual acuity. All men required paramedical resuscitation with intravenous glucose at the scene of the accident. While all men volunteered the classic symptoms such as sweating, palpitations and agitation with the onset of the hypoglycaemia, only two (patients 3 and 5) reported taking a few jellybeans before their accident. There was no case fatalities reported from the accident scenes.

The motor vehicle accident involving patient 1 may have been related to fat hypertrophy at injection sites. Failure to rotate insulin injection sites may result in a localised anabolic effect of insulin on subcutaneous fat cells leading to a potential 'depot' for insulin storage. Erratic insulin release may have led to the hypoglycaemic event. Patient 2 was known to suffer from longstanding, poorly compliant coeliac disease with malabsorption. Patient 3 drove a 17 ton truck. On the day of his accident, he was unexpectedly called out

to work an unrostered shift and failed to consume sufficient carbohydrate. Interestingly, he covered a distance of approximately 3 km in a hypoglycaemic stupor before crashing his truck into a fire hydrant (after avoiding several pedestrians). Patient 4 missed his lunch on the day of the accident, despite having administered his long acting insulin that morning. Patient 5 suffered from suboptimal, glycaemia control with infrequent self monitoring of blood glucose and poor clinic attendance. The accident occurred mid morning before his usual snacking.

Discussion

Diabetic drivers are potentially at increased risk for motor vehicle accidents as a result of

both their therapy (insulin induced hypoglycaemia) or diabetic complications (retinopathy with visual disturbances).³ Currently there are no published statistics regarding the number of motor vehicle accidents involving individuals with type 1 diabetes living in Australia. A report from Belfast suggested the prevalence of motor vehicle accidents did not differ between insulin requiring diabetic and nondiabetic drivers.⁴ On the other hand, a report from the USA suggests that drivers with type 1 diabetes experience more frequent driving related hypoglycaemic mishaps such as crashes, violations, and hypoglycaemic stupor than drivers with type 2 diabetes.⁵ These differences, however, may be related

to global variations (USA compared to Ireland), methodology of recording driving mishap (self as opposed to police reported) and the under reporting of incidents by individuals who may be fearful of losing their drivers licence.

Hypoglycaemic events are common in type 1 diabetes. Asymptomatic hypoglycaemia with plasma glucose levels between 2.8–3.3 mmol/L occurs in individuals with type 1 diabetes as frequently as twice a week and may result in potentially thousands of episodes over a lifetime.³ Severe, temporarily disabling hypoglycaemia on the other hand, occurs approximately once a year. Data from the Diabetes Control and Complications Trial suggest that individuals

Table 1. Clinical data of the patients involved in serious motor vehicle accidents

	Patient 1	Patient 2	Patient 3	Patient 4	Patient 5
Sex	Male	Male	Male	Male	Male
Age (years)	39	59	47	18	66
Weight (kg)	72.6	70	98	80	82.7
Duration of diabetes (years)	20	50	30	1.3	1.6
Previous severe hypoglycaemia	>5 (in 1 month)	0	2	1	0
Retinopathy	+	+	+	–	–
Polyneuropathy	–	+	+	–	–
Macrovascular disease	–	+	CABG	–	–
Hypoglycaemic unawareness	–	–	–	–	–
Fat hypertrophy	+	–	–	–	–
Serum creatinine (mmol/L)	0.07	0.07	0.10	0.08	0.12
Urine microalbumin (mg/mmol creat)	0.9	0.8	5.7	1.7	0.3
HbA1C (%)	7.8	7.5	6.1	6.6	6.6
Mean SMBG (mmol/L)	8.9	6.8	5.8	6.5	6.8
Subcutaneous insulin regimen	Mixtard 30:70 twice daily	Actrapid 3 times daily and bedtime protophane	Actrapid 3 times daily and bedtime protophane	Actrapid 3 times daily and bedtime protophane	Mixtard 30:70 twice daily
Other therapy					
Beta blocker	Atenolol	Carvedilol	–	–	–
ACE inhibitor	–	Perindopril	Ramapril	–	Enalapril
Type of vehicle driven	Car	Car	Heavy duty truck	Car	Car
Presumed cause of accident	Erratic insulin release	Coeliac disease with malabsorption	Missed snack with limited food intake	Increased exercise	Missed snack

SMBG = self monitoring blood glucose, CABG = coronary artery bypass grafting

treated with intensive insulin regimens experienced a three-fold increased risk of severe hypoglycaemia than those treated with standard therapy (with three deaths occurring from hypoglycaemia related motor vehicle accidents).⁶ A recent postal survey conducted in Australia on 570 individuals with type 1 diabetes revealed 22 hypoglycaemic events per person over a 6 month period.⁷

Identifying high risk individuals and specific factors which may predispose to hypoglycaemia is therefore essential. The onset of hypoglycaemia in individuals with type 1 diabetes may occur as a result of a number of inter-related factors (*Table 2*) and is usually not due to a single abnormality.³ In nondiabetic individuals, a decrease in plasma glucose concentration usually results in glucose counterregulation so as to increase hepatic glucose output and correct neuroglycopenic symptoms. In type 1 diabetes, individuals may suffer from compromised glucose counterregulation mechanisms.³

In our report, identifiable risk factors included infrequent self monitoring of blood glucose, overinsulinisation with inappropriately administered exogenous insulin or erratic release from 'depot' insulin stores in

fat hypertrophied sites, suboptimal glucose intake, and malabsorption. In a recent report using an anonymous driving questionnaire, the driving mishaps of individuals with type 1 and type 2 diabetes were compared with controls.⁵ The authors found that neither the duration of diabetes, sex, insulin delivery system or intensity of insulin therapy (<2 injections per day vs. >2 per day) had any effect on the prevalence of hypoglycaemia related driving mishaps. The major determinants contributing to crashes included more frequent episodes of hypoglycaemic stupor while driving and less frequent self monitoring of blood glucose before driving.

Hypoglycaemia that comes on during driving or in situations where high levels of psychophysical coordination is of major concern, requires immediate attention and adequate reversal. While jellybeans and solid sugars (eg. glucose tablets) are frequently used to self treat the hypoglycaemia, these methods are often too slow, resulting in a catastrophic outcome such as a motor vehicle accident or work related injury. The sugar in jellybeans is often bound up in gums, and other solid glucose supplements may take time to reach the bloodstream. Two men in our report used jellybeans. Despite recognising their hypoglycaemic symptoms,

they continued to drive and ended up crashing. These data support the need for the driver to stop the vehicle until the hypoglycaemic event has passed. It also suggests that using other supplements such as 'fizzy' glucose drinks may be a more appropriate and effective method of reversing the hypoglycaemia as this form of sugar may be more rapidly absorbed.

Preventing hypoglycaemia is preferable to its treatment. Individuals with recurrent hypoglycaemia should be carefully evaluated so as to exclude secondary causes (*Table 2*). Frequent self monitoring of blood glucose, adequate glucose intake before driving, and regular diabetes review are all essential factors responsible for preventing hypoglycaemia. The recent development of newer insulin analogues have also been shown to significantly reduce the frequency of hypoglycaemia related events.⁸ None of our patients were receiving these new analogues before their accidents.

Diabetes is only one of a number of medical disorders that place individuals at an increased risk of driving mishaps. Others include driver fatigue, psychological conditions (eg. hyperactivity, mania), sleep apnoea, alcohol or illicit drug abuse, and medications that may alter the driver's responsiveness or concentration. It is important that individuals with type 1 diabetes treated with insulin are not unfairly disadvantaged. Currently there are no well controlled studies or consensus which confirm or dispute the fact that individuals treated with insulin have more frequent driving mishaps than nondiabetic drivers.⁹ This report cannot provide evidence either way. It is designed to increase the vigilance of practitioners caring for drivers with type 1 diabetes.

The GP's role

The role of the general practitioner in managing diabetic drivers should be based on the guidelines of the Australian Driver Licensing Authorities (*Table 3*).¹⁰ Diabetics with hypoglycaemic unawareness and/or autonomic neuropathy, and those with impaired vision due to diabetic retinopathy are forbidden to

Table 2. Factors contributing to hypoglycaemia in individuals with type 1 diabetes³

- Increased insulin due to over dosage, ill timed, wrong type or erratic absorption (injection sites with fat hypertrophy)
- Decreased glucose delivery due to missed meals or snacks, malabsorption (eg. coeliac disease)
- Decreased endogenous glucose production due to alcohol ingestion, acute liver disease
- Increased glucose utilisation during exercise
- Increased insulin sensitivity following prolonged exercise, significant weight loss, improved glycaemia control, insulin sensitisers (metformin, angiotensin converting enzyme inhibitors)
- Decreased insulin clearance due to progressive renal disease
- Defective glucose counter regulation due to autonomic neuropathy, glucocorticoid deficiency (adrenal failure or hypopituitarism), aggressive glycaemic therapy
- Infrequent self monitoring, psychological disorders (eg. malingering and anorexia)

Table 3. Clinical management guidelines set out by the Australian Transport Council and all Australian Driver Licensing Authorities¹⁰

- 1.** Drivers should be advised not to drive after a defined hypoglycaemic episode* or after a hypoglycaemic episode experienced while driving until the primary care physician or specialist has cleared them
- 2.** The driver should also be advised to take appropriate precautionary steps to avoid hypoglycaemic episodes:
 - self monitoring of blood glucose levels
 - carrying of glucose in the vehicle
 - compliance with specified review periods (GP or specialist)
 - cessation of driving should a hypoglycaemic episode occur
- 3.** Driving standards for cars, light vehicles and motorcycles
 - a conditional licence is granted after taking into account the opinion of the treating doctor/GP and subject to at least a 2 yearly review
 - the condition is well controlled
 - the absence of defined hypoglycaemic episodes* and there is awareness of hypoglycaemia sufficient to stop driving a vehicle
 - absence of end organ effects which may affect driving
- 4.** Driving standards for heavy vehicles, public passengers vehicles and bulk dangerous goods vehicles
 - a conditional licence is granted after taking into account the opinion of a specialist in diabetes or endocrinology and subject to at least annual review
 - the condition is well controlled and the patient compliant with treatment

• conditions as outlined in 3 above

* In the event of a defined hypoglycaemic episode occurring in a previously well controlled person, driving should be prohibited for 6 weeks depending on identification of the reasons for the episode and a specialist opinion. Driver licensing authorities must be notified of all hypoglycaemic episodes associated with a motor vehicle

drive a vehicle, while those suffering a hypoglycaemic episode should be restricted from driving for at least 6 weeks until their diabetes has stabilised. Regular specialist attendance is essential for insulin treated diabetics, with GPs playing an important role in diabetes education and identifying risk factors for hypoglycaemia.

The Medical Code of Ethics makes it quite clear that a GP has an obligation to public health and safety where a patient ignores medical advice to cease driving a heavy vehicle until his diabetes is well controlled. Patients 1 and 5 in our report failed to comply with the legislation. Should their driving licences have been suspended? In the event of injuries or death of a third party, a treating GP may well be held liable as a party contributing to that death or injury. The reported case of Bednarek,¹¹ bears witness to such a ruling. In this case, a 7 year old pedestrian girl

was knocked down on the sidewalk when a car driven by an individual suffering from poorly controlled insulin requiring diabetes went out of control due to a hypoglycaemic event. She subsequently died as a result of the accident. The coroner ruled that the accident could have been prevented had the driver and his GP strictly adhered to legislation set out by the Australian Driver Licensing Authorities.

Conclusion

While patients are ultimately responsible for their own actions, GPs have a responsibility to alert and educate individuals with diabetes to the potential hazards of hypoglycaemia that may occur during driving, and to emphasise the importance of preventive action and adherence to the law.

Conflict of interest: none declared.

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