

National Driver Licence Service An tSeirbhis Náisiúnta um Cheadúnais Tiamána

## Diabetes and Driving

This is an overview of driving with diabetes. The complete standards are published in Sláinte agus Tiomáint: Medical Fitness to Drive (MFTD) Guidelines.



# **Diabetes and Driving**

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## Introduction

- The risk of drivers with diabetes having a MVA is similar to that of the general population
- Meta-analysis of 15 studies demonstrated the RR of MVA for people with DM was 1.2-2% higher compared with the general population but this was not statistically significant<sup>1</sup>
- Drivers with T1DM may have slightly higher risk
- Main concerns related to the risks associated with diabetes in the context of driving are;
  - Hypoglycaemia that impairs the ability to drive
  - Neuropathy that reduces the capacity to feel or operate foot pedals, and
  - Retinopathy/vision issues that may affect the ability to safely operate a vehicle

## Driving Mishaps Among Individuals With Type 1 Diabetes

A prospective study

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- N = 452 drivers, reporting monthly occurrences of driving mishaps
- Over 12 months, 52% of drivers reported at least 1 hypoglycaemia-related driving events, 5% reported >6 hypoglycaemia-related driving events

Relative risk of hypoglycaemia related event occurring adjusted for no. of miles driven per year	Adjusted Relative Risk (95% CI)	P value
Use of insulin pump therapy	1.35 (1.12-1.64)	0.002
History of SH in the past year	1.06 (1.03-1.08)	<0.001
Collision in past 2 years	1.20 (1.07-1.34)	0.001
Hypoglycaemia related driving mishaps in past 2 years	1.06 (1.05-1.08)	<0.001
Mild symptomatic hypoglycaemia while driving in past 6 months	1.03 (1.01-1.05)	<0.001

Daniel J. Cox, Derek Ford, Linda Gonder-Frederick, William Clarke, Roger Mazze, Katie Weinger, Lee Ritterband; Driving Mishaps Among Individuals With Type 1 Diabetes: A prospective study. *Diabetes Care* 1 December 2009; 32 (12): 2177–2180.

# Guidelines for insulin treated diabetes mellitus and medications that cause hypoglycaemia

## Group 1 - Car, motorcycle, tractor

# \*1-3 year license may be issued if following standards are met

- No >1 episode of SH in the preceding 12 months
- Appropriate awareness of hypoglycaemia at appropriate glucose level
- Understanding of risks of hypoglycaemia
- Must monitor glucose at times relevant to driving
- Must be under regular review
- No other debarring complications of DM
- Not regarded as source of danger to public while driving

## Group 2

- \*1 year license may be issued if following standards are met
- No episode of SH in the preceding 12 months
- Appropriate awareness of hypoglycaemia at appropriate glucose level
- Understanding of risks of hypoglycaemia
- Must show adequate control of diabetes by monitoring BLOOD glucose at least BD and times relevant to driving, 3/12 record must be available at consultant review
- Must be under regular review
- No other debarring complications of DM

# Defining hypoglycaemia

Table 1—Levels of hypoglycemia				
	Glycemic criteria and description			
Level 1	Glucose <70 mg/dL (<3.9 mmol/L) and ≥54 mg/dL (≥3.0 mmol/L); hypoglycemia alert level			
Level 2	Glucose <54 mg/dL (<3.0 mmol/L); significant hypoglycemia			
Level 3	A severe event characterized by altered cognitive impairment and requiring assistance for treatment of hypoglycemia, irrespective of glucose level			
Derived from the International Hypoglycaemia Study Group joint position statement and the ADA "Standards of Care in Diabetes" (13,23).				

• The yearly occurrence of severe hypoglycaemia among individuals with T1D ranges between 30% and 40%

# Driving performance and hypoglycaemia

- n = 37 adults with T1D
- Driving performance, EEG, corrective behaviours monitored
- Glucose level, sx perception, judgement concerning impairment were assessed



Table 4—Performance at three levels of hypoglycemia based on z scores derived from indi	vidual
euglycemic performance	

Variable	BG 4.0-3.3	BG 3.3-2.8	BG <2.8
Driving performance z score deviation			
from euglycemia			
SD steering	0.04 (NS)	-0.02 (NS)	-0.04 (NS)
Off-road	0.25 (NS)	0.45 (NS)	0.57 (NS)
Risk midline	0.05 (NS)	0.17 (<0.1)	0.11 (<0.01)
Low speed	0.01 (NS)	-0.05 (NS)	0.37 (NS)
High speed	0.23 (<0.01)	0.56 (<0.001)	0.26 (NS)
SD speed	-0.09 (NS)	0.09 (NS)	0.23 (NS)
Inappropriate braking	0.0 (NS)	0.61 (<0.05)	0.00 (NS)
Composite driving impairment score	0.83 (<0.01)	1.83 (<0.005)	1.52 (<0.005)
% Subjects significantly impaired	12	26	16
Awareness deviation from euglycemia			
Difficulty driving rating	0.30 (<0.05)	0.35 (<0.1)	0.54 (<0.01)
% Subjects who detected their driving	21	22	25
impairment			
% Subjects who detected hypoglycemia	15	33	79
Corrective behaviors			
Self-treated (n)	2 (NS)	1 (NS)	8 (<0.05)
Stop driving (n)	1 (NS)	1 (NS)	5 (NS)
% Subjects who took corrective action	5	3	22
EEG power z score deviations from			
euglycemia			
0 (4-8 Hz)	0.01 (NS)	0.16 (NS)	0.76 (<0.001)
α (8–13 Hz)	0.10 (NS)	0.40 (<0.001)	0.80 (<0.001)
β (13–22 Hz)	-0.02 (NS)	0.30 (<0.001)	0.42 (<0.001)

D J Cox, L A Gonder-Frederick, B P Kovatchev, D M Julian, W L Clarke; Progressive hypoglycemia's impact on driving simulation performance. Occurrence, awareness and correction.. *Diabetes Care* 1 February 2000; 23 (2): 163–170.

### The Perception of Safe Driving Ability during Hypoglycemia in Patients with Type 1 Diabetes Mellitus

Katie Weinger, EdD, Brendan T. Kinsley, MD, Carol J. Levy, MD, Mandeep Bajaj, MD, Donald C. Simonson, MD, Daniel J. Cox, PhD, Christopher M. Ryan, PhD, Alan M. Jacobson, MD

• Men and middle aged people with T1D more likely to consider it safe to drive during hypoglycaemia



• More patients with few or no symptoms judged that they were able to drive safely vs those who had symptoms

**Table 4.** Frequency of Neurogenic and Neuroglycopenic Symptoms during Hypoglycemia and Perceived Ability to Drive Safely

	Symptoms, Number (percent)		
Serum Glucose Plateau	None to Mild*	Moderate	Severe
Symptoms at target of 60 mg/dL			
Neurogenic <sup>†</sup>	46 (77)	10 (17)	4 (7)
Perceived safe driving <sup>‡</sup>	33 (72)	0	0
Neuroglycopenic <sup>†</sup>	38 (63)	15 (25)	7 (12)
Perceived safe driving <sup>*</sup>	24 (63)	8 (53)	1 (14)
Symptoms at target of 50 mg/dL			
Neurogenic <sup>†</sup>	40 (67)	11 (18)	9 (15)
Perceived safe driving <sup>‡</sup>	19 (48)	4 (36)	0
Neuroglycopenic <sup>†</sup>	31 (52)	20 (33)	9 (15)
Perceived safe driving <sup>‡</sup>	14 (45)	8 (40)	1 (11)
Symptoms at target of 40 mg/dL			
Neurogenic <sup>†</sup>	18 (30)	23 (38)	19 (32)
Perceived safe driving <sup>*</sup>	6 (33)	7 (30)	0
Neuroglycopenic <sup>†</sup>	20 (33)	23 (38)	17 (28)
Perceived safe driving*	3 (15)	8 (35)	2 (12)

\* None to mild = mean symptom score <1.5; moderate = mean symptom score between 1.5 and 3.0; intense

= mean symptom score >3.0.

<sup>†</sup> Number (percent) of patients with that category of symptoms at the target glucose level.

<sup>\*</sup> Number (percent) of those with perceived safe driving among those with that level of symptoms.

## Impaired awareness of hypoglycaemia

 Impaired awareness of hypoglycaemia is defined as 'an inability to detect the onset of hypoglycaemia because of a total absence of warning symptoms'

=> preventative action is not taken in a timely manner

- The prevalence of impaired awareness of hypoglycaemia (IAH) was 23.2%-58.5%
- IAH increases the risk of SH six-fold
- Neither Group 1 nor Group 2 drivers are permitted to drive if IAH



Yu X, Fan M, Zhao X, Ding Y, Liu X, Yang S, Zhang X. Prevalence of impaired awareness of hypoglycaemia in people with diabetes mellitus: a systematic review and meta-analysis from 21 countries and regions. Diabetic Medicine. 2023 Sep;40(9):e15129.

# How can diabetes technology help drivers with diabetes?

## Continuous glucose monitors



## **3 components**

- L. Sensor contains glucose oxidase platinum electrode, reacts with ISF glucose to produce hydrogen peroxide and electrons. Electric signal produced is proportional to ISF glucose
- **2. Transmitter -** sends the signal from to receiver
- 3. Receiver displays glucose level

Soni A, Wright N, Agwu JC, Drew J, Kershaw M, Moudiotis C, Regan F, Williams E, Timmis A, Ng SM. Fifteen-minute consultation: Practical use of continuous glucose monitoring. Archives of Disease in Childhood-Education and Practice. 2021 May 7.

## Sensor glucose lags behind blood glucose

#### Sensors and meters measure glucose in different places





Soni A, Wright N, Agwu JC, Drew J, Kershaw M, Moudiotis C, Regan F, Williams E, Timmis A, Ng SM. Fifteen-minute consultation: Practical use of continuous glucose monitoring. Archives of Disease in Childhood-Education and Practice. 2021 May 7.

# Key benefits of CGM

- (1) Availability of glucose data
- 24 hour glucose profile
- Instant access to results
- Reduced SMBG burden
- (2) Trend arrows indicating direction of glucose travel
- (3) Adjustable alerts for hypoglycaemia or hyperglycaemia
- (4) Facilitate data sharing with healthcare team/family/carers
- (5) Link with insulin pumps to facilitate automated insulin delivery



## UK ABCD FSL audit – Improved IAH with CGM

- Paired baseline and follow up data for 1606 drivers with T1D
- GOLD score improved from 2.3 -> 2.0 (p<0.001) at 6 months</li>
- No. of people with IAH (GOLD>4) decreased from 20.4% -> 11.6% (p<0.001)</li>
- No. of people who experienced a SH episode decreased from 12.1% -> 2.7% (p<0.001)</li>

Bar chart showing resource utlitisation of people with type 1 Diabetes who hold a driving licence at baseline and at follow up



Mark-Wagstaff C, Deshmukh H, Wilmot EG, Walker N, Barnes D, Parfitt V, Saunders S, Gregory R, Choudhary P, Patmore J, Walton C. Intermittently scanned continuous glucose monitoring and hypoglycaemia awareness in drivers with diabetes: Insights from the Association of British Clinical Diabetologists Nationwide audit. Diabetes, Obesity and Metabolism. 2024 Jan;26(1):46-53.



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Continuous glucose monitoring with low-glucose alerts in insulin-treated drivers with diabetes: A randomized crossover study

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#### Aim

Insulin-treated

drivers with

diabetes

(n = 30)

This study aimed to evaluate the effectiveness of the continuous glucose monitoring (CGM) with low-glucose alerts for preventing hypoglycemia in insulin-treated drivers with diabetes.

4 weeks

**Alert Period** 

CGM with low

glucose alerts

No Alert

Period

Blinded CGM

**Research design and Methods** 

n = 15

¶ n = 15

#### **Results**



• Low-glucose alerts improved time in hypoglycaemic range in drivers with T1DM

# Guidelines for CGM use in drivers

- CGM can be used for monitoring glucose at times relevant to driving Group 1 vehicles
- Users must carry equipment for CBG testing whilst driving as confirmatory blood glucose readings are required if;
  - Glucose < 4.0 mmol/l
  - Person has symptoms of hypoglycaemia
  - CGM reading is not consistent with symptoms being experienced
- Group 2 drivers using CGM devices must continue to monitor capillary blood glucose measurements



Sensor alerts are not a substitute for adequate hypoglycaemia awareness



## Managing insulin treated diabetes and driving

- Must always carry a glucose meter and glucose strips
- Check glucose pre-driving and every 2 hours whilst driving
- If glucose is 5.0 mmol/l or less, have a snack
- If glucose < 4.0 mmol/l or Sx of hypoglycaemia DO NOT DRIVE, Treat hypoglycaemia ensure glucose > 5.1mmol/l

Hypoglycaemia whilst driving

- Stop your vehicle as soon as possible and switch off the engine
- Take keys out of the ignition and move from the driver's seat
- Treat hypoglycaemia but do not drive until 45 mins after glucose returned to normal

Ensure supply of fast acting CHO in vehicle

Take regular meals, snacks and rest periods at least every two hours on long journeys

Avoid alcohol

## Guidelines for non-insulin treated diabetes mellitus

## Group 1 - Car, motorcycle, tractor

Managed with OHAs/Injectable therapy/diet

- Permitted to drive
- Needn't notify NDLS unless visual problems occur affecting acuity or visual fields

## Group 2

#### Managed with OHAs/Injectable therapy

- Permitted to drive
  - if under regular review
  - Drivers are advised to monitor their blood glucose regularly & times relevant to driving
- Needn't notify NDLS unless visual problems occur affecting acuity or visual fields

#### Managed with diet alone

- Permitted to drive
- Needn't notify NDLS unless visual problems occur affecting acuity or visual fields

## Other diabetes-related conditions

- Lower limb peripheral neuropathy may reduce a driver's ability to feel and operate foot pedals
  - Reduced fine motor control and proprioceptive function in LL
  - Performance improves with practice
  - Meds used to treat DPN can impair driving
  - Amputations Adaptation of the vehicle may be required
- Vision loss secondary to diabetic retinopathy, glaucoma, or cataract formation
  - Enrolment in the diabetic retinal screening program
  - Up-to-date ophthalmology review





# Hyperglycaemia and driving

- Effect of hyperglycemia on driving performance has received very little attention
- In 1 study, 8 % of participants with T1DM & 40% of people with insulin treated T2DM reported at least 1 episode of disrupted driving associated with hyperglycemia over 1 year <sup>1</sup>
- In a driver simulation study, during hyperglycaemia, participants less likely to identify a hazard, glanced fewer times at the hazard, maintained shorter between vehicle distance and û no. of breaking events per km



<11.1mmol/l

>16.6mmol/l

1.Cox DJ, Ford D, Ritterband L, Singh H, Gonder-Frederick L. Disruptive effects of hyperglycemia on driving in adults with type 1 and type 2 diabetes. Diabetes Care. 2011;60 Suppl 1:A223. 2.Haim A, Shamy RS, Ridel D, Parmet Y, Loewenthal N, Liberty I, Tejman-Yarden S, Hershkovitz E, Borowsky A. Acute hyperglycaemia can impair driving skill in young type 1 diabetes mellitus patients. Diabetes & Metabolism. 2021 Mar 1;47(2):101176.

## Take home messages

- Diabetes can impair driving performance in several ways, through short-term metabolic and longer-term complications
- Despite the risks associated with hypoglycaemia and driving, several surveys have shown that drivers with insulin-treated diabetes continue to embrace unsafe practices
- Risk assessment of a driver should be individualised and in line with guidelines
- People with diabetes should have educational reinforcement of safe driving practices and road safety guidelines at each clinic visit
- In cases where indicators of elevated driving risk result in the person with diabetes being advised not to drive, the clinical team should devise an appropriate management plan in collaboration with the person with diabetes, to ensure reinstatement of driving privileges as soon as possible