Published in final edited form as:
Am J Med Sci. 2013 April ; 345(4): 263–265. doi:10.1097/MAJ.0b013e31828bf8d7.

Diabetes and Driving Safety: Science, Ethics, Legality & Practice

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Abstract

Diabetes affects over 25 million people in the United States, most of whom are over the age of 16 and many of whom are licensed to drive a motor vehicle. Safe operation of a motor vehicle requires complex interactions of cognitive and motor functions and medical conditions that affect these functions often will increase the risk of motor vehicle accidents (MVA). In the case of diabetes, hypoglycemia is the most common factor that has been shown to increase MVA rates. When people with diabetes are compared with non-diabetic controls, systematic analyses show that the relative risk of MVA is increased by between 12 and 19% (RRR 1.12-1.19). In comparison, the RRR for Attention Deficit Hyperactivity Disorder is 4.4 and for Sleep Apnea is 2.4.

Epidemiologic research suggests that patients at risk for hypoglycemia-related MVAs may have some characteristics in common, including a history of severe hypoglycemia or of hypoglycemia-related driving mishaps. Experimental studies also have shown that people with a history of hypoglycemia-related driving mishaps have abnormal counter-regulatory responses to hypoglycemia and greater cognitive impairments during moderate hypoglycemia.

There are medical, ethical and legal issues for health care professionals who care for people with diabetes regarding their patients' risk of hypoglycemia-related driving mishaps. This includes identifying those at increased risk and counseling them on preventive measures, including more frequent blood glucose testing, delaying driving with low or low normal blood glucose, and carrying readily available emergency supplies in the vehicle for the treatment of hypoglycemia.

Keywords

Diabetes; driving; licensure; risk

Overview

Over 26 million people in the United States suffer from diabetes mellitus. Most over the age of 16 either currently drive or have in the past. With the exception of large metropolitan areas, motor vehicle licensure is essential to employment, school, shopping, and many other activities of daily life. Driving is a common yet highly complex task. It involves maneuvering a multi-ton projectile through time and space at high speeds, negotiating road, signal, traffic and weather conditions, and requires multitasking incorporating visual, motor,

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and cognitive abilities. Safe operation of a vehicle has significant implications for the physical and financial well-being of both our patients and the general public and, as such, it becomes a medical and public health issues.

There are numerous medical conditions (e.g. sleep apnea[i], epilepsy[ii], narcolepsy[iii]) and medical interventions (e.g. chemotherapy[iv], anesthesia[v], coronary Artery Bypass Grafting[vi]) that have been shown to jeopardize driving safety. As health care professionals, we have a responsibility to the individual and to the general public to address driving safety with patients who may have compromised driving ability secondary to medical issues. This may involve adaptive changes to the vehicle, modification of medication, increased monitoring, and, at an extreme, recommending that the person retire from driving. The American Medical Association (AMA) recognizes motor-vehicle related trauma to be a major health concern and has developed both ethical and health policies to address physicians' responsibilities related to impaired drivers under their care. Specifically, the AMA recommends that if the physician's clinical assessment/judgment indicates driving impairment; they should have a "tactful but candid discussion with the patient and family, may suggest further treatment, and may encourage patient and family to decide on a restricted driving schedule." Moreover, the AMA also states that "where clear evidence of substantial driving impairment implies a strong threat to patient and public safety, and where the physician's advice to discontinue driving privileges is ignored, physicians have an ethical duty to notify the Department of Motor Vehicles (DMV)." vii

A program of medical warnings in Ontario, Canada resulted in 100,075 patients being given a medical warning over a three year period.[viii] Warnings were issued for different medical issues, including alcoholism, epilepsy, dementia, sleep disorders, and diabetes. Receiving medical warnings resulted in a 45% reduction in annual accident rates when compared to the period before the warning. People with diabetes who received warnings (n=18,104) had a 41% reduction (from 4.49 events per 1000 patients per year to 2.71 events per patient per year), similar to the total cohort (4.76 events per 1000 patients per year pre-warning to 2.73 patients per year post-warning).

Medical warnings, however, are not without negative impacts. Warnings were associated with an increase in emergency room visits for depression and fewer return visits to the physician issuing the warning.

When evaluating potential increased risks for the driver with diabetes, one should consider the impact of both acute and chronic effects of the disease. Both proliferative and advanced non-proliferative retinopathy may cause significant loss of peripheral vision and visual acuity (particularly in dim light situations or night driving). Peripheral neuropathy may result in significant lower limb proprioceptive defects, interfering with safe use of the pedals. Acute complications like significant hypoglycemia and hyperglycemia may impair perceptual, motor, cognition, awareness, and judgment. This review will focus primarily on the available scientific data about diabetes and driving safety and then conclude with recommendations concerning the evaluation and management of diabetes and driving.

Research Findings

Epidemiology

A recent meta-analysis suggests that people with diabetes have between 12 and 19% increased risk of a motor vehicle accident[ix]. This review did not differentiate between those at higher risk and those with little or no risk. Several studies suggest that people with type 1 diabetes have a relative risk of approximately twice that of non-diabetic drivers.

A large, multi-national retrospective survey of drivers with diabetes and their non-diabetic spouses[x] found that those with type 1 diabetes had twice the collisions and similarly increased moving vehicle violations as their spouses without diabetes. Drivers with type 1 diabetes who were most likely to have reported driving mishaps in the past two years also reported more frequent episodes of hypoglycemic stupor while driving, less frequent blood glucose monitoring before driving, and the use of insulin injection instead of pump therapy. Fully one-half of the drivers with type 1 diabetes had never discussed diabetes and driving safety with their physicians. In a subsequent prospective study, 452 U.S. drivers with type 1 diabetes were followed for 12 months to document the occurrence of driving mishaps including collisions, citations, losing control, automatic driving, times when someone else had to take over driving, and moderate or severe hypoglycemia while driving. [xi] Over 12 months, 52% of the drivers reported at least one hypoglycemia-related driving mishap while 5% of the drivers reported six or more of such mishaps. Conversely, 48% of type 1 diabetic drivers had no hypoglycemic driving mishaps. Mishaps were significantly related to mileage driven, history of severe hypoglycemia or hypoglycemic driving mishaps, and use of insulin pump therapy.

These results imply that not all drivers with type 1 diabetes are at equal risk of driving mishaps. A number of other studies have attempted to differentiate drivers who are at increased risk from those who are not.

Harsch et al[xii] surveyed 450 patients with type 1 and type 2 diabetes. Symptomatic hypoglycemia while driving ranged between 0.02 and 0.63 events per year driven or between 0.19 and 8.26 per 100,000 kilometers driven. Hypoglycemia-induced accidents were rare, ranging between 0.007 and 0.01 per year driven or between 0.01 and 0.49 per 100,000 km driven. Although hypoglycemic episodes increased with increased intensity of diabetes management (Oral Agents to Conventional Insulin Therapy to Intensive Insulin Therapy to Insulin Pump therapy), the rate of hypoglycemic accidents was not significantly affected by choice of therapy.

A 30 month prospective study of MVAs in Norway[xiii] found that people using insulin for diabetes control had an accident Standardized Incidence Ratio (SIR) of 1.4 (1.2-1.6), those on oral agents SIR of 1.2(1.0-1.3). A non-diabetic comparator group on medications for peptic ulcer and Gastro-Esophageal Reflux disorders had a SIR of 1.3 (2-1.4) The highest diabetes-related SIR (1.5 [1.1-1.9] was found in the youngest (18-34 years old) insulin users consistent with other studies of type 1 diabetes..

Signorovitch et al.[xiv] reviewed claims data from a large U.S. insurance data base, comparing 5582 individuals with type 2 diabetes not on insulin who had claims for medical treatment of hypoglycemia with 27,910 non-diabetic controls. The results differed by age, with those over age 65 had increased rate of injuries from falling, but no increase in MVAs, and those under age 65 had increased MVAs but no increase in falls.

Controlled Trials

There have been at least three published laboratory reports investigating what differentiates drivers with type 1 diabetes who have a recent history of driving mishaps compared to those who do not. The first was a *post hoc* analysis of 38 drivers with type1 diabetes who drove a simulator during euglycemia and progressive hypoglycemia. These participants were subsequently divided into drivers who reported no (n=22or >1 driving mishap) [+Hx] (N=16) in the previous two years.[xv] During euglycemia, +Hx (i.e. those reporting a recent history of driving mishaps) required more dextrose infusion to maintain euglyemia with the same insulin infusion.

During progressive hypoglycemia, +Hx participants demonstrated less epinephrine release and greater driving impairments.

In a subsequent *prospective* study[xvi] where drivers with type 1 diabetes were explicitly recruited such that in the previous two years they either had no (N=22) of >1 (N=16) driving mishaps, it was affirmed that the +History drivers had greater insulin sensitivity during euglycemia and, during hypoglycemia they drove worse and had less of a counter-regulatory epinephrine response. Additionally, +History participants had fewer functional hypoglycemic symptoms. When these two groups were compared on neuropsychological testing[xvii], both at euglycemia and mild hypoglycemia, +History drivers demonstrated slower information processing speed and worse working memory.

Together these studies demonstrate a consistent pattern of a subgroup of adults with diabetes who are at a greater risk of having a hypoglycemia-related driving mishaps. At risk individuals with type 1 diabetes have greater insulin sensitivity, more frequent hypoglycemic episodes and, when hypoglycemic, have less of a counter-regulatory safety net, demonstrating greater driving impairment. It is important to note that these impairments are noted even during moderate hypoglycemia when individuals are relatively still coherent and not stuporous as with severe hypoglycemia. Of equal clinical interest are the variables on which these two groups did not differ. Drivers with type 1 diabetes at risk for driving mishaps do not differ in terms of age, gender, glycosylated hemoglobin, duration of diabetes or impaired hypoglycemia awareness from their counterparts who were not at risk. Individuals with type 2 diabetes have not been studied in as much detail; the limited data available indicate that prior hypoglycemia may be the best indicator of increased risk of hypoglycemia-related MVAs.

There is also growing evidence that moderate hyperglycemia (e.g. >250mg/dl), may impair cognitive functioning in both children and adults.[xviiixixxx] At this time, there are limited data concerning the effects of hyperglycemia on driving. In a recent study, parents of adolescent drivers felt that hyperglycemia contributed to their children's collisions and moving vehicle violations, but the adolescents attributed approximately one-third of their accidents to hypoglycemia, but none to hyperglycemia.[xxi] Additionally, adults with type 1diabetes in a prospective study reported experiencing disruptive hyperglycemia while driving about one-sixth as frequently as they experienced disruptive hypoglycemia while driving.[xxii] Further research is necessary to clarify the effects of hyperglycemia on driving safety.

In light of the legal and ethical issues surrounding these growing scientific findings, the American Diabetes Associationrecently released a Position Statement on diabetes and driving[xxiii] which states that, "people with diabetes should be assessed individually, taking into account each individual's medical history as well as the potential related risks associated with driving…

"Individuals whose diabetes poses a significantly elevated risk to safe driving must be identified and evaluated prior to getting behind the wheel…. To identify potentially at-risk drivers, a short questionnaire can be used to find those drivers who may require further evaluation." However, no practical, empirically based questionnaire has been available to screen for high-risk patients with diabetes. Recently, we reported on an 11-item questionnaire with 61% sensitivity and 75% specificity in predicting future collisions. Individuals with type 1 diabetes who scored in the upper third quartile reported 3.03 +4.39 driving mishaps in the following 12 months compared to patients in the lower third who reported (0.87 +1.92 mishaps). This questionnaire can be found at www.VADSL/diabetes.org. It is interesting to note that this research identified the following variables to most parsimoniously identify an individual's risk of future driving mishaps: exposure (miles

driven), history of hypoglycemia-related driving mishaps, mismanagement of low blood glucose, and lower limb neuropathy.

It is important that physicians and others caring for people with diabetes be knowledgeable and take the lead in discussing risk reduction for their patients with diabetes. This begins with a discussion of the implications of the patient's medication regimen and education about risk reduction.

People with diabetes who are at risk for disruptive hypoglycemia should be counseled to: 1) Test sugar before driving. 2) never begin an extended drive with low normal blood glucose (e.g., 70–90 mg/dL) without prophylactic carbohydrate consumption to avoid a fall in blood glucose during the drive; 3) always carry a blood glucose meter and appropriate snacks, including a quick-acting source of sugar (such as juice, non-diet soda, hard candy, or dextrose tablets) as well as snacks with complex carbohydrate, fat, and protein (e.g., cheese crackers), in their vehicle; 4) stop the vehicle as soon as any of the symptoms of low blood glucose are experienced and measure and treat the blood glucose level; and 5) do not resume driving until their blood glucose and cognition have recovered. Additionally your patients could be directed to www.diabetesdriving.com to participate in an NIH project directed at evaluating a voluntary and confidential program to assess an internet based program to reduce driving diabetes-related mishaps

Conclusions

1. Diabetes can contribute to higher risk of driving impairments but not everyone with diabetes is at increased risk.
2. Moderate hypoglycemia impairs driving safety
3. Some individuals with T1DM are more vulnerable to driving mishaps, and this is associated with a recent history of hypoglycemia-related driving mishaps, mismanagement of hypoglycemia, lower limb neuropathy and greater exposure, i.e. high volume driving.
4. Clinicians have legal and ethical responsibilities to evaluate and educate individuals with diabetes and to educate and counsel them in risk reduction.

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