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LIFESTYLE MANAGEMENT TO REDUCE DIABETES/CARDIOVASCULAR RISK (B CONWAY AND H KEENAN, SECTION EDITORS)

Diabetes in the Workplace: the Hazards of Hypoglycemia

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Abstract

Purpose of Review The effects of hypoglycemia can result in injury, including at work. Our goal was to review the recent medical literature regarding hypoglycemia and occupational injuries and provide guidance to clinicians asked to render opinions regarding fitness for work duties in individuals with diabetes.

Recent Findings Recent studies contain conflicting conclusions regarding the occupational risks posed by workers with diabetes. However, the US Federal Motor Carrier Safety Administration concluded there was sufficient evidence to change the rule that previously disqualified commercial drivers with insulin-treated diabetes.

Summary Blanket employment policies that disqualify workers with diabetes are unnecessary in many occupational fields. In assessing occupational risks and fitness for duty in workers with diabetes, it is important to perform an individualized assessment of the worker and consider the risk factors for hypoglycemia, information from the treating clinician, essential functions of the job, and, if needed, availability of reasonable accommodations.

Keywords Occupational hazards · Diabetes · Hypoglycemia · Workplace accommodations

Introduction

More than 23 million people in the USA are currently diagnosed with diabetes, and type 2 diabetes (T2D) accounts for 90 to 95% of those cases, while an additional 7 million people are estimated to remain undiagnosed [1]. Improved glycemic control is a primary treatment goal in diabetes in order to postpone or hopefully prevent the onset of vascular and neurologic complications. Pursuit of tight control, however, is often complicated by episodes of hypoglycemia with quality of life and general health status being negatively affected by symptomatic hypoglycemia [2].

Diabetes is a risk factor for traumatic injuries, including those resulting from falls and motor vehicle collisions [3], and hypoglycemia is presumed to play an important role in such mishaps. In individuals with type 1 diabetes (T1D), episodes of severe hypoglycemia (requiring assistance from another person) have been reported to occur up to three times per year [4]. Severe hypoglycemia occurs less frequently in T2D, but because its prevalence is much greater than that of T1D, there are more overall cases of severe hypoglycemia in T2D than in type 1 [5].

Non-severe hypoglycemia can reduce work productivity, including by way of difficulties with attention, rescheduling of activities, not completing tasks in a timely manner, and absenteeism [6]. Impairment related to diabetes may result from treatment complications (e.g., hypoglycemia) or long-term complications such as poor vision due to retinopathy or foot numbness related to peripheral neuropathy. With severe hypoglycemia, sudden incapacity can occur, and with diabetes commonly affecting adults of working age, this diagnosis must be considered with regard to occupational health and safety.

This article is part of the Topical Collection on *Lifestyle Management to Reduce Diabetes/Cardiovascular Risk*

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Conflicting opinions exist regarding the occupational hazards posed by workers diagnosed with diabetes, and many studies have not differentiated the types of diabetes in the sample populations. Even without sudden incapacity, diabetes confers an increased risk of acute occupational injury, as reported in a cohort of manufacturing workers [hazard ratio (HR) 1.7] [7]. A cohort study from Finland also found diabetes to be associated with workplace and commuting injuries in women (HR 1.37 and 1.36, respectively), while men with insulin-treated diabetes had a higher risk of commuting injuries (HR 3.14) [8]. Canadian researchers associated diabetes with negative effects on employment and the workplace, including work-related injury [odds ratio (OR) 1.97–4.41] and decreased productivity due to absenteeism (OR 3.11–77.0) [9].

However, a case control study in Britain found no evidence that diabetes is an important factor in workplace injuries [10]. In addition, data from the National Health Interview Survey demonstrated no overall increased risk of occupational injury in workers with diabetes (adjusted OR 1.18), although subgroups of individual with diabetes with no current diabetes treatment (OR 1.87) or duration of diabetes greater than 12 years (OR 1.83) were at increased risk for occupational injury [11].

There is also the landmark Diabetes Control and Complications Trial/Epidemiology of Diabetes Intervention and Complications (DCCT/EDIC) study in which individuals with T1D in the intensive treatment group experienced severe hypoglycemia at a frequency of 62 episodes per 100 patient-years. Although this frequency was three times higher than that of the conventional treatment group, there were no adverse effects of intensive therapy on repeatedly tested cognitive function in adults or adolescents [12].

Evidence reports by the US Department of Transportation (DOT) Federal Motor Carrier Safety Administration (FMCSA), studies by the American Diabetes Association (ADA), and conclusions and recommendations by the FMCSA Medical Review Board have indicated that drivers with well-controlled, insulin-treated diabetes are as safe as other drivers [13], thus resulting in a significant rule change. As of November 19, 2018, the use of insulin by a commercial motor vehicle (CMV) driver is no longer an automatic disqualification per the FMCSA. However, the FMCSA's *Insulin-Treated Diabetes Mellitus Assessment Form* (also known as MCSA-5870) is required to be completed by the driver's treating clinician before medical clearance can be addressed. The driver is disqualified if an unstable insulin regimen is present and the condition is not adequately controlled. If a driver experiences a severe hypoglycemic episode, then that driver is prohibited from operating a CMV at least until further evaluations are completed by the treating clinician and a Medical Examiner certified by the FMCSA [14].

In the workplace, the health and safety of individuals with diabetes, their co-workers, and the surrounding public may be adversely affected by hypoglycemic episodes and other diabetic complications. For that reason, health care providers should be aware of the clinical significance of diabetes in the workplace and have an understanding of the regulatory environment related to job positions, particularly those that are safety sensitive.

Definition and Symptoms of Hypoglycemia and Risk Factors

The threshold for the plasma glucose level to generate symptoms of hypoglycemia varies among individuals with diabetes. Symptoms occur at higher glucose concentrations in individuals with poor glycemic control and at lower concentrations in those with better control [15]. Therefore, the American Diabetes Association (ADA) does not cite a specific plasma glucose level in defining hypoglycemia in diabetes, but instead defines it as "all episodes of an abnormally low plasma glucose concentration that expose the individual to potential harm" [5]. The ADA does suggest that those at risk of hypoglycemia regard a glucose level of ≤ 70 mg/dL (≤ 3.9 mmol/L) as an "alert value" so that measures may be taken to prevent the worsening of hypoglycemia and the onset or progression of associated symptoms.

The physiologic response for falling plasma glucose levels is for the pancreas to secrete less insulin and more glucagon, while the adrenal glands increase the release of epinephrine in the absence of an increase in glucagon [16]. The surge of epinephrine leads to tachycardia, diaphoresis, irritability, tremulousness, and anxiety. If the plasma glucose level continues to decrease, blurred vision, tremors and other motor dysfunction, lightheadedness, impaired cognition, and sleepiness can occur and, without intervention, eventually progress to loss of consciousness, seizures, coma, and sometimes death (Table 1) [17, 18••].

A steering committee of experts has classified hypoglycemia into three categories (Table 2) [19]. Level 1 corresponds to a glucose concentration of < 70 mg/dL but ≥ 54 mg/dL

Table 1 Signs and symptoms of hypoglycemia

Anxiety	Tremulousness
Palpitations	
Diaphoresis	Confusion
Hunger	Lightheadedness
Irritability	Nausea
Headache	Fatigue/sleepiness
Feeling weak	Paresthesias of the face or mouth
Confusion	Speech difficulties
Impaired vision	Coordination problems
Seizures	Coma

Information from references [17, 18••]

(3.0 mmol/L) and can alert the patient to take the appropriate actions. Level 2 hypoglycemia occurs at a glucose level of < 54 mg/dL, and immediate action is necessary to prevent the occurrence of neurologic symptoms related to the central nervous system being deprived of glucose. Level 3 hypoglycemia is defined as an event with altered mental and/or physical status requiring the assistance of another person for recovery.

There is overlap with the risk factors for hypoglycemia in T1D and T2D. There is a greater risk of severe hypoglycemia in certain patient populations with diabetes (Table 3), such as those 55 years of age and older as hypoglycemic unawareness fades, particularly in those with T1D; in those with associated chronic kidney disease, congestive heart failure, cardiovascular disease, depression, or higher glycated hemoglobin levels; and in those using insulin, insulin secretagogues, or beta blockers [5, 6]. The long-acting sulfonylureas glyburide and glimepiride have an increased risk of severe hypoglycemia (hazard ratio 2.83) [20]. Other risk factors for hypoglycemia in diabetes include a long duration of diabetes (i.e., decades), inconsistent meal times, previous episodes of hypoglycemia, increased physical activity, and alcohol consumption [21–23]. Another risk factor is hypoglycemia-associated autonomic failure, including hypoglycemia unawareness, which can occur with recurrent episodes of hypoglycemia, as well as age, and become dangerous due to a loss of recognition of hypoglycemic symptoms, thus facilitating a continued decline in the plasma glucose level.

Glycemic Management

In addition to diet, exercise, and patient education, treatment of individuals with T1D (with its total dependence on exogenous insulin) includes injections of basal and prandial insulin or continuous subcutaneous insulin infusion. It is important for individuals with T1D, and those with advanced T2D with its associated depletion of beta cell function, to be knowledgeable regarding the relationship between matching prandial insulin dosing with the prandial glucose level, anticipated carbohydrate intake, fluctuations in glucose patterns across the day, and physical activity. The use of fast-acting insulin analogs reduces the risk of hypoglycemia [17]. In addition, among adults aged 18–65 years using insulin, the use of the insulin analog detemir was associated with a much lower risk of hypoglycemia compared to NPH insulin (adjusted HR 0.07) [24].

Continuous glucose monitoring has been shown to be useful in improving glycemic control in patients with T1D, but there have been reports of inaccurate readings. Therefore, validation with finger stick or laboratory testing has been recommended [25].

Metformin is first-line medical treatment for T2D and does not cause hypoglycemia unlike sulfonylureas, insulin, and meglitinides. Sodium-glucose cotransporter-2 (SGLT2) inhibitors, glucagon-like peptide-1 (GLP-1) receptor agonists, dipeptidyl peptidase-4 (DPP-4) inhibitors, and thiazolidinediones lower glucose levels by various mechanisms also without causing hypoglycemia [26].

Table 2 Classification of hypoglycemia

Level 1	Glucose level of < 70 mg/dL (≤ 3.9 mmol/L) but ≥ 54 mg/dL (3.0 mmol/L)
Level 2	Glucose level of < 54 mg/dL, indicating the need for immediate action
Level 3	Severe mental status changes and/or physical impairment with the need for assistance of another person for recovery

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Table 3 Risk factors for severe hypoglycemia

Older age	Chronic kidney disease
Congestive heart failure	Cardiovascular disease
Higher glycated hemoglobin levels	Depression
Use of insulin or secretagogues	Use of beta blockers
Longer duration of diabetes	Inconsistent meal times
History of severe hypoglycemia	Physical activity
Alcohol	Hypoglycemia-associated autonomic failure

Information from references [5, 6, 21–23]

Legal Considerations

Most American adults with diabetes are active members of the workforce, and many function without their employers even being aware of the diagnosis [27••], although it is likely that some employers would fear hiring such individuals. However, there are now legal protections in place for workers with diabetes.

The Americans with Disabilities Act, which was expanded by the Amendments Act of 2008 (ADAAA), applies to employers with 15 or more employees and prohibits discrimination against qualified individuals with disabilities. As a result of the passage of the ADAAA, individuals with diabetes are considered to have a disability. Therefore, by law, employers are required to provide reasonable accommodations (i.e., adjustments or modifications) to enable job applicants or employees to engage in equal employment opportunities unless doing so would cause "undue hardship," i.e., significant difficulty or expense, to the employer. Examples of accommodations that in many situations are deemed reasonable for employees with diabetes include the following:

- Breaks to eat or drink, take medication, or test blood glucose levels;
- A private place to test blood glucose levels or to administer insulin injections;
- A storage place for insulin and related supplies if the work environment prevents carrying such supplies on the person;
- A place to rest until the blood glucose levels normalize.

Work schedules, including rotating shifts, can affect the timing of medications and nutritional intake, thus making it more challenging for individuals to effectively manage the condition. Time away from work may also be necessary for medical appointments or illness [27••].

In providing reasonable accommodations, an employer is not required to eliminate or reassign essential job functions or lower the standards for job performance or quality. Those workers with diabetic complications or with diabetes that is more challenging to control might be better served, in mutual agreement with the employer, by choosing or being assigned jobs with fewer physical demands or risks. Reassignment is a reasonable accommodation when other accommodations in the employee's current job are not possible, but the employee must be qualified to perform the job (with reasonable accommodations if necessary). The courts have also ruled that it is not reasonable to make fellow employees work significantly longer or harder in order to accommodate a co-worker with a disability [28].

The US Equal Employment Opportunity Commission (EEOC) enforces the employment provisions of the ADAAA. The EEOC advises that an employer may exclude an individual with diabetes from a job for safety reasons when that individual poses a "direct threat," defined as a significant risk of substantial harm to the individual or another that cannot be eliminated or reduced through reasonable accommodation [28]. The harm must be serious and likely to occur (not remote or speculative), and the employer must determine whether any reasonable accommodation would reduce or eliminate the risk. The determination that an individual poses a direct threat is to be based on an individualized assessment of the worker's present ability to safely perform the essential functions of the job. That assessment is also to be based on a reasonable medical judgment relying on the most current medical knowledge and/or the best available objective evidence [29, 30].

Due to the potential for underreporting of symptoms and complications by a job applicant or worker with diabetes, it is important to obtain information from other sources, particularly the treating health care professional(s) of the individual with diabetes. Form MCSA-5870 by the US DOT FMCSA is mandated when medically evaluating potential drivers of commercial motor vehicles [31]. It is completed by the diabetic worker's treating clinician and then used as part of an evaluation by a physician who is certified by the FMCSA in determining medical clearance for driving. The information obtained upon completion of that form includes medical history and findings such as the date that the insulin use was initiated, results of blood glucose self-monitoring, details surrounding severe hypoglycemic episodes, glycated hemoglobin results, and end-organ damage related to diabetes. Based on the content, format, and ease of use of MCSA-5870, it could be modified and served as a convenient tool for practitioners in providing an individualized assessment of risk and fitness for duty in workers with diabetes in other occupations.

Conclusions

In determining occupational safety risks, it is important for the evaluating health care professional to review the job description, including the list of essential functions. With jobs in an office or food service setting, for example, an employee with diabetes most likely does not jeopardize (or pose a direct threat to) the wellbeing of fellow employees or the public.

With the use of insulin increasing the risk of hypoglycemia, individuals with diabetes requiring the use of insulin could be excluded from certain fields of employment. These may include (but are not limited to) occupations that require the carrying of a firearm; operation of commercial motor vehicles, trains, or aircraft; or operation of dangerous machinery. Others have recommended that individuals with diabetes be more carefully assessed if they are to work in confined spaces (e.g., silos, crawl spaces, sewers, tank trucks, etc.) [32] but are also of the opinion that diabetes is not necessarily a contraindication to such environments.

Work-related mishaps can occur regardless of the glycemic state or presence of diabetic complications, but a worker or applicant with diabetes should not be excluded from a job position for safety reasons unless the individual poses a direct threat to health or safety in the workplace. Therefore, a blanket policy of disqualification of job applicants and workers with diabetes in most occupations, particularly those that do not include safety sensitive positions, is unnecessary and fails to consider the ongoing advances in the monitoring and management of diabetes. Addressing fitness for duty and safety concerns should occur through an individualized assessment. It should be realized that most individuals with diabetes do not experience episodes of severe hypoglycemia because of their own recognition of symptoms and prompt self-treatment with carbohydrate ingestion before the problem worsens.

Life with diabetes is unique for each affected individual, including the management and monitoring of the condition. Advances in treatment have included medications with a wider variety of pharmacokinetic properties and mechanisms of action making it easier for such individuals to receive effective, individualized care. To ignore these advances and prevent individuals with diabetes from engaging in employment

due to continued application of disqualifying, blanket policies is unnecessary and can have legal implications. Although hypoglycemia remains a workplace safety concern, an individualized assessment of fitness for job duties should significantly reduce risk and improve safety.

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Compliance with Ethical Standards

Conflict of Interest Robert M. Gerbo, Chuan Fang Jin, and Karen Clark declare that they have no conflict of interest.

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