2020 | Volume 41 | Number 2
A Peer-Reviewed Publication

Diabetes
a dietetic practice group of the
eat right. Academy of Nutrition and Dietetics
Experts in Diabetes Care and Education

ON THE CUTTING EDGE

Diabetes Dietetic Practice Group

THE SPECTRUM OF HYPOGLYCEMIA: FROM FEAR TO CONFIDENCE

Message from the Theme Editor

Nicole Patience, MS, RD, LDN, CDCES, CEDRD

A severe hypoglycemic event can be a gripping experience. The fear, panic, helplessness, and sheer drive to raise glucose as quickly as possible is undisputed. We have come a long way since the days of frosting tubes and the vibrantly colored mouth left behind in the event's aftermath. Instead of frosting, we now employ convenient packets of glucose gel, tablets, and gummies for rapid glucose recovery. While advances in diabetes treatment, technology, medications and hypoglycemia prevention training have been helpful, the risk of hypoglycemia has not been eliminated.

We recognize insulin as a vital life-saving medication and understand it presents risk of hypoglycemia. Antihyperglycemic medication is not the only cause of hypoglycemia. Low glucose levels can be triggered by other conditions such as an insulinoma, an eating disorder with food insecurity or as a complications of bariatric surgery.

Hypoglycemia has been a concern for every population I have served in several different job roles including diabetes care and education specialist, eating disorders specialist, diabetes camp dietitian, research dietitian, and hypoglycemia clinic dietitian. Each of these jobs required hypoglycemia knowledge, but also further developed my understanding of the prevention and treatment of hypoglycemia.

Most dietitians know the basic 15:15 hypoglycemia rule as outlined in the call out box.

15-15 Rule – Four Steps to Treat

1. Check glucose level. If glucose is <70 mg/dL treat with 15 g of fast-acting carbohydrate such as 3-4 glucose tablets or 4 oz of juice. If glucose is <54 mg/dL, treat with 30 g of fast-acting carbohydrate.
2. Wait 15 minutes, then re-check glucose.
3. If glucose is not >80 mg/dL repeat steps 1 and 2.
4. Eat a small snack if your next meal is more than an hour away.

But this issue will present additional considerations for the treatment of hypoglycemia in special populations and to accommodate advances in technology.

Job:7933 OTCE Vol 41 No 2(11323)

ON THE
CUTTING EDGE
Diabetes Dietetic Practice Group

eat right. Academy of Nutrition and Dietetics

*News*FLASH and *On the Cutting Edge* are bi-monthly publications of the Diabetes Dietetic Practice group (DDPG) of the Academy of Nutrition and Dietetics (the Academy).

Print Communications Chair:
Patricia Davidson, DCN, RDN, CDCES, LDN, FAND

***News*FLASH Editor:**
Mamie Lausch, MS, RDN, RN, CDCES

***On the Cutting Edge* Editor:**
Patricia Davidson, DCN, RDN, LDN, CDCES, FAND

***On the Cutting Edge* Associate Editor:**
Karen Lau, MS, RDN, LDN, CDCES

Content printed in these publications does not imply a statement of policy or endorsement by the DDPG. The opinions expressed represent those of the authors and do not reflect official policy of the Academy.

Mention of product names in this publication does not constitute endorsement by DDPG or the Academy.

Subscriptions are available for people who are ineligible for Academy membership for $35 (domestic) and $40 (international) by sending a check to:

Linda Flanagan Vahl
DDPG Administrative Manager
Academy of Nutrition and Dietetics
120 South Riverside Plaza, Suite 2190
Chicago, IL 60606-6995

Payable to Academy of Nutrition and Dietetics/DDPG noting preferred mailing address.

Library of Congress National Serials Data Program
ISSN #1070-5945, issued 7/93.

DDPG MISSION

Optimizing the prevention and management of diabetes through person-centered care, including nutrition and collaborative partnerships.

DDPG VISION

A world where all people affected by diabetes thrive.

The first article highlights the human elements of the hypoglycemia experience. For young persons with diabetes and their parents the fear of hypoglycemia (FOH) can significantly impact how diabetes is managed and the level of stress associated with the diagnosis of type 1 diabetes (T1D). This article, written by Clary and her team, offers a tool to identify FOH and describes programs to connect these individuals with additional support.

Technology has come a long way in supporting people with diabetes and increasing understanding of hypoglycemia. McElwee Malloy and Singh explore advances in insulin pumps and continuous glucose monitors (CGMs). They highlight the essential role of the Registered Dietitian Nutritionists (RDNs) in discussing not only glucose data patterns but also the psychosocial impact of hypoglycemia.

Isaacs and Zolna present an overview of glucagon products available for hypoglycemia treatment, including instructions for use. They also highlight additional medications that influence blood glucose levels.

Many individuals with long-standing T1D have impaired awareness of hypoglycemia (IAH). Lois Maurer, RDN details how IAH can develop and describes educational programs that aim to restore awareness of low glucose levels.

The Hypoglycemia Confidence scale can help assess how confident an individual feels about their ability to respond to hypoglycemia. Beebe and Polonsky present a case study and overview of how to use this tool to initiate discussion with individuals and their loved ones.

Older adults with diabetes are a demographic which is especially vulnerable to hypoglycemia. Burani details risk factors and, suggests adjusted glucose targets. Burani presents the broader scope of challenges older adults face as they manage diabetes care along with other comorbidities.

As noted above, hypoglycemia does not exclusively impact people with diabetes. Post-bariatric hypoglycemia (PBH) is a potentially disabling complication of bariatric surgery that may not emerge until years after the procedure. In this article Sheehan and the Joslin Diabetes Center Hypo Clinic team review etiology and treatment of PBH, and highlight the essential role of RDNs.

The Hypoglycemia Prevention Initiative is conducting a study to identify approaches to assess

STRATEGIES:

- Provide the tools, resources, and support to all RDNs and NDTRs to empower them to become competent providers and leaders in diabetes nutrition.
- Work to create and increase confidence in RDNs and NDTRs to assert their knowledge and expertise when working with all people affected by diabetes.
- Develop volunteers to be leaders within the organization and the profession in order to advance RDNs and NDTRs as the nutrition and dietetics experts when treating pre-diabetes, diabetes, and complications associated with diabetes.
- Focus on collaborative partnerships to further the mission and vision of DDPG through community engagement, public policy and legislative initiatives, clinical care, and research.

Job:7933 OTCE Vol 41 No 2(11323)

hypoglycemia risk and incidence in the clinical setting. The study will also explore educational approaches to prevention. Warshaw interviews two researchers to share more about this study, and the targeted outcomes.

It is my hope that this publication provides you with a greater understanding of the challenges an individual may experience related to hypoglycemia, and tools to support them.

Acknowledgments: *The Spectrum of Hypoglycemia: From Fear to Confidence*

CPE Reviewers:
Emmy Suhl, MS, RD/LDN (retired), CDCES
Sacha Uelman, RDN, CDCES
Patricia Davidson, DCN, RDN, CDCES, LDN, FAND

Reviewers:
Amy Campbell, MS, RDN, LDN, CDCES
Donna M. White, RPh, CDCES, BCACP
John Zrebiec, LCSW
Fran Cogen, MD, CDCES
Kim Miller, BCADM, CDCES
Sarah Sy, MD
Jen Kirby, PhD, MD
Laura Andromalos, RD
Amy Hess-Fishl, MS, RD, LDN, BC-ADM, CDCES
Professor Stephanie Amiel, BSc, MBBS, MD, FRCP
Emma Smith, PhD
Nicole de Zoysa, PhD

OTCE Editor
Patricia Davidson, DCN, RDN, LDN, CDCES, FAND

OTCE Associate Editor
Karen Lau, MS, RDN LDN CDCES

Item Writer
Mary L. Perry, MS, RDN, CDCES
Patricia Davidson, DCN, RDN, CDCES, FAND

CPEU Approval
Mary L. Perry, MS, RDN, CDCES

Understanding, Assessing and Treating Fear of Hypoglycemia in Youth With Type 1 Diabetes and Their Parents

Lauren E. Clary, PhD
Children's National Hospital and George Washington University School of Medicine
Washington, D.C.

Christine Wang, PhD, Manuela Sinisterra, MS, Meredith Rose, LGSW
Children's National Hospital
Washington, D.C.

Abstract

Hypoglycemia is a common occurrence for individuals with type 1 diabetes (T1D), and can have significant health consequences for children and teens with T1D. Given the serious effects of hypoglycemia, parents and youth can experience fear of hypoglycemia (FOH), and high levels of FOH can impact diabetes management and psychosocial functioning. This article provides recommendations for assessing and treating FOH. Exposure therapy and other cognitive-behavioral strategies can successfully reduce behaviors that maintain FOH. We also discuss how members of the diabetes care team can help families manage FOH.

Introduction

Hypoglycemia is a common complication that can occur in T1D management; it can also interfere with short and long-term health in pediatric patients and families (1). The American Diabetes Association (ADA) guidelines define hypoglycemia across three levels in Table 1 (2).

Hypoglycemia can include a variety of symptoms, such as dizziness, sweating, confusion, irritability, attention concerns, and in extreme cases, loss of consciousness, seizure and/or death. Given these symptoms and possible severe outcomes, FOH is used to describe significant worry and avoidance behaviors exhibited to avoid hypoglycemia (4-6). FOH is common in both youth with T1D and their parents, and it can significantly impact quality of life, emotional well-being, sleep, and diabetes management behaviors (7,8). FOH tends to be greater in youth and parents when they have experienced severe hypoglycemic episodes or have higher levels of pre-existing anxiety. While occasional FOH is normal, some youth and parents experience higher levels of FOH that impair daily functioning, mood, or participation in typical activities, such as sleep and physical activity.

FOH can manifest in various ways, including youth and parent avoidance behaviors aimed at preventing low blood glucose (BG). These avoidance behaviors can include youth or parents over-treating low BG (e.g., consuming more carbohydrates than necessary to bring BG back into recommended range) or deliberately keeping BG in the "psychologically safe" range, as opposed to the medically recommended range (9,20) (see Table 2). Youth and parents who experience FOH may also exhibit suboptimal T1D management behaviors related to food

Job:7933 OTCE Vol 41 No 2(11323)

consumption such as excessive eating, intentionally taking less insulin than recommended for meals/snacks, and overeating before bedtime in order to avoid low BG while asleep (10). Youth with T1D and FOH may also avoid engaging in regular physical activity due to concerns about experiencing low BG levels. Parents of youth with T1D are often involved in nutrition and physical activity decisions; thus, parents' FOH may lead to decision-making about food and physical activity that overemphasizes the prevention of low BG levels.

Not only does FOH directly affect T1D management, but it is also associated with increased psychosocial concerns. Specifically, in youth, FOH is associated with increased symptoms of anxiety, sleep disturbances, and relationship stress (10). Parents' FOH is also associated with symptoms of anxiety, sleep problems, and problematic diabetes monitoring (10), and it can lead to more controlling parenting behaviors around T1D management, which may translate to parent-child conflict about diabetes management (7). Thus, FOH among youth with T1D as well as their family members can impact optimal T1D management and long-term health and psychosocial outcomes.

Assessment and Treatment of FOH

The ADA has established psychosocial screening guidelines for children and families with T1D, and it is well understood that individuals with T1D are at increased risk of developing co-occuring mental health conditions (such as depression) compared to that of the general population (11). The 2020 ADA Standards of Medical Care in Diabetes recommend screening for concerns related to depression, anxiety, diabetes distress (starting at age 7 or 8 years), and disordered eating (starting at ages 10 -12 years) (11). Some youth and parents may be more at risk for FOH (such as those with anxiety), and diabetes clinical teams may consider broader screening measures for these concerns to ensure appropriate support and interventions.

Table 1: Levels of Hypoglycemia

Level	Glycemic Criteria	Descriptions
Level 1 Hypoglycemia Alert Value	<70 mg/dL but ≥54 mg/dL	Sufficiently low for treatment of fast-acting carbohydrate and dose adjustment of glucose lowering therapy
Level 2 Clinically Significant Hypoglycemia	<54 mg/dL	Sufficiently low to indicate serious clinically important hypoglycemia
Level 3 Severe Hypoglycemia	No specific threshold	Hypoglycemia associated with severe cognitive impairment requiring external assistance for recovery

Adapted from: *Diabetes Care*. 2017; 40:1622-1630

One such measure is the Hypoglycemia Fear Survey –II. This 26-item measure assesses youth and parents' FOH (10). Questions range from 0 (never) to 4 (almost always) regarding the frequency in which youth or parents engage in behaviors to avoid low BG levels, such as eating large snacks at bedtime or keeping BG higher when children will be away from parents. It also assesses, using the same scale (0-4), the frequency in which youth worry about themselves, or parents about their children having lows, feeling symptoms of low BG or not recognizing lows. While this instrument has been validated and commonly used in T1D research, the lack of clinical cutoffs makes routine clinical use more difficult.

Regardless, having a method to routinely assess for FOH can help identify youth and families likely to benefit from additional services, such as diabetes self-management education and support (DSMES), nutrition consultation, and mental health support. Assessing FOH can also help medical teams to better understand barriers to adherence and optimal glycemic management. Providers can use the following checklist when assessing for FOH in youth and parents (Figure 1). These are suggested as a guide and clinicians can use their clinical expertise in determining which items they want to further explore. These could be given as part of routine diabetes visits or administered annually as patients and families wait to see a diabetes team provider. For young children, the questions can be adapted to ask parents about their own parenting behaviors.

Although many understand the importance of identifying FOH, less information is available about the treatment of FOH. Mental health professionals familiar with T1D management, FOH, and cognitive behavioral therapy (CBT) are often integral members of this treatment

Job:7933 OTCE Vol 41 No 2(11323)

Table 2. Example Treatment Strategies Used to Reduce Unhelpful or Avoidant Behaviors that Maintain Fear of Hypoglycemia

Unhelpful behaviors	Relevant treatment strategies to consider
Excessively checking BG levels and/or looking at CGM	Gradually reduce the number of BG checks/day (e.g., if checking 20x/day, reduce to 18x/day, then 16x/day) and slowly increase the time between urges to look at the CGM and looking at the CGM (e.g., 1 minute, then 3 minutes) (9).
Keeping BG levels in the "psychologically safe" range, particularly before bedtime	Gradually reduce the BG level treated with carbohydrates (e.g., if treating BG levels of <200 mg/dL, reduce to BG levels <195 mg/dL or <190 mg/dL) until the patient can tolerate BG levels within their medically recommended range without treating.
Treating low BG levels with more carbohydrates than recommended	Gradually reduce the amount of carbohydrates used to treat low BG (e.g., if using 24 g to treat low BG, reduce to 22 g, then 20 g) until the recommended grams of carbohydrates is met.
Intentionally administering lower amounts of insulin than needed/recommended	Gradually increase the amount of insulin based on recommendations (e.g., if the recommendation is 1 unit for 7 g carbohydrates, and the patient is giving 1 unit for 10 g carbohydrates, increase to 1 unit for 9 g carbohydrates until the goal is met).
Exhibiting rigidity around methods used to treat low BG levels	If treating low BG levels with the same method (e.g., one specific brand of juice), gradually introduce different brands, flavors, box sizes, etc. Encourage other methods of treatment, such as glucose tablets (e.g., introduce glucose tablets via clear Ziploc bag that initially remains in supply bag with no demand to use it to treat BG levels; then introduce the use of glucose tablets as able to tolerate).
Carrying excessive supplies to treat low BG (e.g., 8 boxes of juice) at all times	Gradually reduce the amount of unnecessary supplies that are carried (e.g., if carrying around 8 boxes of juice, reduce to 7 boxes, then 6 boxes until the goal is met).
Avoiding exercise, sports, or other physical activity	Slowly increase the intensity of physical activity (e.g., start with speed walking, then jogging, then sprinting) or gradually increasing the amount of time (e.g., jogging for 1 minute, then 3 minutes) spent on an activity.
Avoiding being alone	Gradually introduce time alone initially starting with a short period of time (5 minutes, then 10 minutes until the goal is met).

Note: All goals should be set with input from medical team members (diabetes provider, dietitian, diabetes care and education specialist, mental health professional) and youth/family.

process. CBT is an evidence-based psychosocial treatment for various anxiety and mood symptoms. In CBT, problematic behaviors are reduced through identification and modification of one's thoughts, feelings and behaviors. Exposure therapy, a component of CBT that focused heavily on the behavioral aspect, has been shown to reduce anxiety in the general population (12). In exposure therapy, the feared stimuli are confronted, instead of avoided, in a gradual manner. The same behavioral strategies can be used to reduce FOH (9,10). As previously mentioned, FOH is often maintained by unhelpful behaviors that provide temporary relief and reduce anxiety (e.g., intentionally administering less insulin than recommended to avoid low BG levels). In the long term, these unhelpful behaviors maintain and exacerbate FOH, leading to impaired daily functioning (e.g., avoiding sports or sleepovers). In exposure therapy, each behavior is gradually reduced in frequency, intensity and/or duration in a manner that is tolerable to the individual and/or family members. The current data supporting the efficacy of exposure therapy for problematic FOH includes two case studies with adults (9,13), and a group CBT trial with adults (14). A group CBT trial for young adults is underway (15). A list of common unhelpful behaviors as well as treatment strategies are presented in Table 2. These behaviors and treatment strategies are based on both the current evidence (9) and our own clinical expertise.

In addition to the behavioral aspect of CBT, some FOH intervention studies

Job:7933 OTCE Vol 41 No 2(11323)

also focus on identifying and reframing unhelpful cognitions, increasing problem-solving skills and using relaxation strategies. Other psychoeducational interventions, such as Blood Glucose Awareness Training (BGAT), may also effectively reduce FOH in individuals with T1D (16). BGAT is focused on recognizing and responding to internal and external cues that affect BG levels. Some postulate that BGAT reduces FOH because it decreases uncertainty regarding hypoglycemia and increases confidence in one's ability to manage hypoglycemia (10). Studies, with mixed results, have further examined the role of technology, such as closed-loop systems, automatic bolus calculators, and continuous glucose monitors (CGMs), on reducing FOH (10,16). For example, Muller et al found that reduced hypoglycemia led to increased confidence in parents and therefore positively impacted diabetes management behaviors, which could be driven by reduced FOH (17). Another study showed that the use of CGMs helped families of children optimize their glycemic management, which in turn helped to reduce worry and FOH in parents and can improve the well-being of children and parents (18). Still, qualitative work on attitudes about closed-loop technology has found that parents' and youth's fear around hypoglycemia does not necessarily decrease as soon as they begin using the device, especially not during the night (19). Lastly, a behavioral intervention (which included motivational interviewing, problem-solving, family therapy, T1D education and social support) aimed at improving T1D ability to self-manage independently to reach clinical outcomes in adolescents also demonstrated reductions in FOH (20), though the exact treatment effects are not well-understood.

Figure 1. Checklist for Assessing Fear of Hypoglycemia in Youth and Parents

Do your (or your child's) worries about hypoglycemia or low BG ever lead to:	
1) Sleep disruptions (e.g., excessive monitoring of CGM overnight)	❑
2) Disruptions with daily activities	❑
3) Carrying around excessive supplies to treat low BGs	❑
4) Emotional distress/burnout	❑
5) Feeling more comfortable with higher BG levels than recommended by the medical team	❑
6) Reducing or avoiding physical activity	❑
7) Not wanting/willing to be alone	❑
8) Eating more carbohydrates than recommended by a medical team	❑
9) Giving less insulin than recommended for meals/snacks	❑
10) Treating lows with more carbohydrates than recommended/needed	❑

Special Considerations for Reducing FOH in Youth With T1D

For youth, the roles of medical providers, diabetes care and education specialists including dietitians, nurses, school nurses and parents are vital in reducing FOH. Medical providers and diabetes care and education specialists can provide consultation on various aspects of education and treatment, including education about managing BG before bedtime and appropriate treatment of low BG during physical activity. Further, parents often report increased FOH while their children are at school, and about one in five children and parents reported giving less insulin in the morning before school due to FOH (21). Given that school nurses or other personnel are primarily responsible for T1D management in the school setting, feedback from school nurses is important when assessing and treating FOH in youth. It is imperative that families and school personnel collaborate to create and execute a written 504 Plan (or diabetes management plan) for care at school and have a clear communication strategy in case of fluctuations in BG. For example, school nurses can provide additional data regarding how often youth are coming to check BG and can help set a reasonable plan of communication with parents when youth BG levels are out of range.

Parents are integral to reducing FOH in youth, as they often support and implement the treatment strategies described above at home (10). Further, given that parents' FOH is related to several negative health and behavioral outcomes among youth with T1D, reducing parents' FOH is another important intervention target. Fortunately, emerging data show that parents' FOH can be effectively reduced. For example, an internet-delivered CBT program demonstrated more reductions in FOH in parents of young children with T1D compared to that of parents in the control condition (22), and one trial examining the efficacy of four types of behavioral interventions for

Job:7933 OTCE Vol 41 No 2(11323)

parents' FOH in young children with T1D is underway (23). Thus, monitoring, assessing and treating parents' FOH are important and essential elements of treatment when working with young children with T1D.

Summary

Hypoglycemia is a common side effect of insulin therapy and worrisome for many children, teens and parents living with T1D. It is important that all members of a clinical team understand that FOH may impact diabetes management behavior, adherence to treatment recommendations, psychosocial adjustment, sleep, and quality of life. Asking questions about FOH (worry and behavioral avoidance of low BG) specifically may be useful for clinical teams to identify those who may need additional support or benefit from a referral to a mental health professional familiar with both T1D and cognitive behavioral approaches.

References

1. Abraham MB, Jones TW, Naranjo D, et al. ISPAD Clinical Practice Consensus Guidelines 2018: Assessment and management of hypoglycemia in children and adolescents with diabetes. *Pediatric Diabetes.* 2018;19(suppl 27):178-192.
2. Agiostratidou G, Anhalt H, Ball D, et al. Standardizing clinically meaningful outcome measures beyond HbA1c for type 1 diabetes: a consensus report of the American Association of Clinical Endocrinologists, the American Association of Diabetes Educators, the American Diabetes Association, the Endocrine Society, JDRF International, The Leona M. and Harry B. Helmsley Charitable Trust, the Pediatric Endocrine Society, and the T1D Exchange. *Diabetes Care.* 2017; 40: 1622-1630.
3. Cryer PE, Fisher JN, Shamoon H. Hypoglycemia. *Diabetes Care.* 1994;17(7):734-755.
4. Wild D, von Maltzahn R, Brohan E, Christensen T, Clauson P, Gonder-Frederick L. A critical review of the literature on fear of hypoglycemia in diabetes: implications for diabetes management and patient education. *Patient Education and Counseling.* 2007;68(1):10-15.
5. Fidler C, Elmelund Christensen T, Gillard S. Hypoglycemia: an overview of fear of hypoglycemia, quality-of-life, and impact on costs. *Journal of Medical Economics.* 2011;14(5):646-655.
6. Irvine AA, Cox D, Gonder-Frederick L. Fear of hypoglycemia: relationship to physical and psychological symptoms in patients with insulin-dependent diabetes mellitus. *Health Psychology.* 1992;11(2):135-138.
7. Gonder-Frederick L, Nyer M, Shepard JA, Vajda K, Clarke W. Assessing fear of hypoglycemia in children with type 1 diabetes and their parents. *Diabetes Management.* 2011;1(6):627-639.
8. Gonder-Frederick LA, Fisher CD, Ritterband LM, et al. Predictors of fear of hypoglycemia in adolescents with type 1 diabetes and their parents. *Pediatric Diabetes.* 2006;7(4):215-222.
9. O'Donnell HK, Berget C, Wooldridge JS, Driscoll KA. Graduated exposure to treat fear of hypoglycemia in a young adult with type 1 diabetes: A case study. *Pediatric Diabetes.* 2019;20(1):113-118.
10. Driscoll KA, Raymond J, Naranjo D, Patton SR. Fear of hypoglycemia in children and adolescents and their parents with type 1 diabetes. *Current Diabetes Reports.* 2016;16(8):77.
11. American Diabetes Association. 13. Children and Adolescents: Standards of Medical Care in Diabetes– 2020. *Diabetes Care.* 2020;43(suppl 1):S163-S182.
12. Olatunji BO, Cisler JM, Deacon BJ. Efficacy of cognitive behavioral therapy for anxiety disorders: a review of meta-analytic findings. *Psychiatric Clinics.* 2010;33(3):557-577.
13. Boyle S, Allan C, Millar K. Cognitive-behavioural interventions in a patient with an anxiety disorder related to diabetes. *Behaviour Research and Therapy.* 2004;42(3):357-366.
14. Amsberg S, Anderbro T, Wredling R, et al. A cognitive behavior therapy-based intervention among poorly controlled adult type 1 diabetes patients—a randomized controlled trial. *Patient Education and Counseling.* 2009;77(1):72-80.
15. Martyn-Nemeth P, Duffecy J, Quinn L, Park C, Mihailescu D, Penckofer S. A cognitive behavioral therapy intervention to reduce fear of hypoglycemia in young adults with type 1 diabetes (FREE): study protocol for a randomized controlled trial. *Trials.* 2019;20(1):1-9.
16. Hendrieckx C, Gonder-Frederick L, Heller S, Snoek F, Speight J. How has psycho-behavioural research advanced our understanding of hypoglycaemia in type 1 diabetes? *Diabetic Medicine.* 2020;37(3):409-417.
17. Müller L, Habif S, Leas S, Aronoff-Spencer E. Reducing hypoglycemia in the real world: a retrospective analysis of predictive low-glucose suspend technology in an ambulatory insulin-dependent cohort. *Diabetes Technology & Therapeutics.* 2019;21(9):478-484.
18. Ng SM, Moore HS, Clemente MF, Pintus D, Soni A. Continuous glucose monitoring in children with Type 1 diabetes improves well-being, alleviates worry and fear of hypoglycemia. *Diabetes Technology & Therapeutics.* 2019;21(3):133-137.
19. Elleri D, Acerini CL, Allen JM, et al. Parental attitudes towards overnight closed-loop glucose control in children with type 1 diabetes. *Diabetes Technology & Therapeutics.* 2010;12(1):35-39.
20. Mayer-Davis EJ, Maahs DM, Seid M, et al. The Flexible Lifestyles Empowering Change (FLEX) Intervention for Adolescents with Type 1 Diabetes: Randomized Clinical Trial Results for Effect on Metabolic Status, Diabetes Related Behaviors, and Quality of Life. *The Lancet Child & Adolescent Health.* 2018;2(9):635-646.
21. Smith LB, Terry A, Bollepalli S, Rechenberg K. School-Based Management of Pediatric Type 1 Diabetes: Recommendations, Advances, and Gaps in Knowledge. *Current Diabetes Reports.* 2019;19(7):37.
22. Patton SR, Clements MA, Marker AM, Nelson EL. Intervention to reduce hypoglycemia fear in parents of young kids using video-based telehealth (REDCHiP). *Pediatric Diabetes.* 2020;21(1):112-119.
23. Berget C, Driscoll KA, Lagges A, et al. Optimizing the use of continuous glucose monitoring in young children with type 1 diabetes with an adaptive study design and multiple randomizations. *Contemporary Clinical Trials.* 2019;82:60-65.

CPE CREDIT
ANSWER KEY

See the CPE credit self-assessment questionnaire on page 35.

1. A
2. A
3. B
4. D
5. C
6. C
7. C
8. C
9. B
10. C

Job:7933 OTCE Vol 41 No 2(11323)

Diabetes Technology: Importance of Evaluating Both the Clinical and Psychosocial Impact of Hypoglycemia in People With Diabetes

Molly McElwee Malloy, RN, CDCES
Harsimran Singh, PhD
Tandem Diabetes Care
San Diego, CA

Abstract

Research and technological advancements in the last decade have improved our clinical understanding and management of hypoglycemia. Hypoglycemia is the most common complication of insulin therapy and its prevention and management necessitate a holistic approach including both clinical and psychosocial factors. Integrating technological data into provider visits helps identify hypoglycemia and its patterns of occurrence. Registered Dietitian Nutritionists (RDNs) have the unique challenge of helping someone manage diabetes through food choices, eating patterns, and making healthy lifestyle decisions. Addressing an individual's concerns about hypoglycemia and how technology may assist them is critical to addressing the psychosocial impact of hypoglycemia.

Introduction

Hypoglycemia (low blood glucose) remains a common complication associated with diabetes treated with insulin (1). Mild hypoglycemia is categorized as blood glucose (BG) less than <70 mg/dL (level 1); moderate hypoglycemia less than 54 mg/dL (level 2), (also known as biochemical hypoglycemia) (2). Severe hypoglycemia is defined as hypoglycemia requiring physical assistance from someone else for recovery (level 3) (3). Previous research has shown that, compared to people with type 2 diabetes (T2D), those with type 1 diabetes (T1D) are likely to have twice as many hypoglycemic episodes per day and spend more hours/per day in the hypoglycemic range (4).

Remarkable medical and technological advancements during the last five years have improved our ability to prevent, recognize, and manage hypoglycemia in people with diabetes. These advancements include bolus calculators, automated insulin delivery systems, and continuous glucose monitoring systems providing real time sensor glucose information (5). Unlike the clinical consequences of hypoglycemia, the psychosocial consequences of hypoglycemia (e.g., resistance to treatment intensification for improved management, hypoglycemia related fear and anxieties) are not frequently monitored and addressed by health care providers (HCPs) (6). Such psychosocial factors, however, can have devastating effects on the lives of people with diabetes, impacting their ability to optimize their diabetes treatment. This is where RDNs can assist by evaluating for psychosocial outcomes related to hypoglycemia at regular intervals.

Clinical Assessment and Management of Hypoglycemia – Where are We?

There are well-defined clinical guidelines for people with diabetes (7). Overall, our efforts as diabetes care and education specialists and clinicians treating people with diabetes revolve around helping them achieve the best possible diabetes outcomes while minimizing the risk of hypoglycemia. One way to achieve this is by improving access to both insulin pumps and continuous glucose monitors (CGMs). While the use of pump therapy has increased by 63% from 2016-2018, use of CGM increased by only 30% in the same time frame, with a 50% increase exhibited in pediatric use (8). A T1D Exchange Registry data analysis from 2016-2018 revealed that although diabetes-related technology had improved, outcomes had unfortunately not kept pace with only 21% of adults with diabetes achieving the recommended HbA1c of 7% or below. Almost 6% of all people with diabetes also reported a seizure or loss of consciousness due to hypoglycemia in the previous three months (9). The T1D Registry data showed that hypoglycemia persisted even with the insulin pump and (continuous) glucose

Job:7933 OTCE Vol 41 No 2(11323)

monitoring technology available at the time. Since 2018 diabetes technology has advanced significantly.

Currently, there are four commercially available insulin pump systems with automated insulin delivery (AID) in the US market that can help prevent hypoglycemia. These include systems from Medtronic Diabetes (Minimed 670G and 630G) and Tandem Diabetes Care (Basal-IQ and Control-IQ technologies). These systems rely on a CGM system integrated into an insulin pump which uses sensor glucose (SG) readings. One goal of automated insulin delivery is preventing hypoglycemia by proactively suspending insulin when SG as measured by a CGM is below 80 mg/dL (10,11). The current landscape of automated insulin delivery to help prevent hypoglycemia is best defined through the CARES model, detailed in Table 1 (12). The CARES paradigm addresses the integration of a system with a CGM using the actions: calculate, adjust, revert, education and sensor/sharing as important comparison metrics. These simple guidelines allow HCPs to easily delineate differences between automated insulin delivery systems. Prior to these systems, CGMs could only alarm a patient of impending or current hypoglycemia that needed attention.

Buckingham and colleagues discovered that alerting someone to hypoglycemia was not enough to prevent hypoglycemia events and recorded people with diabetes who had slept through alerts and alarms with sustained hypoglycemia (13). Therefore, an automated system can be much more effective in helping to prevent hypoglycemia for people with diabetes compared to simply alerting people with diabetes to low SG using alarms and other techniques. Recent data from a pediatric population with T1D using Basal-IQ technology (Tandem Diabetes Care) demonstrated significant reductions in the burden of diabetes on daily life, specifically with respect to hypoglycemia related concerns (e.g., "worry about going low" and "wake up at night to treat low BG") (14). Data from other published studies have also demonstrated modest improvements in quality of life parameters for people with diabetes using the Medtronic sensor (15). These findings highlight how the use of advanced technology systems can help alleviate both clinical and psychological concerns related to hypoglycemia.

Table 1. Updated CARES Paradigm for Advanced Diabetes Devices

C: Calculate	• How does the algorithm calculate insulin delivery? • Which components of insulin delivery are automated (e.g., basal suspensions, basal modulation, high glucose corrections, food boluses, etc.)?
A: Adjust	• How can the user adjust insulin delivery? • Which parameters can be adjusted to influence insulin delivery during automation (e.g., carbohydrate ratios, insulin action time, basal rates, sensitivity factors)? • Which parameters are fixed?
R: Revert	• When should the user choose to revert to open-loop/no automation? • When will the system default to open-loop/no automation?
E: Educate	• What are the key education points for the advanced diabetes device (e.g., essential training, tips and tricks, best practices, etc.)? • How does the user optimize time using the automated features? • Where can users and clinicians find additional education?
S: Sensor/Share	• What are relevant sensor characteristics for each device (e.g., calibration and therapeutic blood glucose requirements, duration of sensor wear, etc.)? • What are the system capabilities for remote monitoring and cloud-based data sharing?

Psychosocial Impact of Hypoglycemia

Experiencing and managing hypoglycemia can have significant psychosocial consequences for people living with diabetes and their significant others (specifically parents caring for children with diabetes) (16).

In a clinic setting, it is important that people with diabetes have the opportunity to discuss their experiences with hypoglycemia at visits, in a non-judgmental environment. This will allow them to comfortably share their challenges in blood glucose management while providing the healthcare team opportunities to intervene where necessary. RDNs can assist in this

Job:7933 OTCE Vol 41 No 2(11323)

endeavor by collecting psychosocial data related to hypoglycemia and also by informing their clients about diabetes technology that is available to assist them in managing their diabetes.

Summary

This article urges healthcare professionals to address not only the clinical but also the psychosocial aspects of hypoglycemia in people with diabetes. Hypoglycemia is a common complication of insulin therapy for diabetes. While the clinical impact of hypoglycemia is well documented, research in the last few years has highlighted the significant psychosocial consequences of hypoglycemia on people with diabetes and their significant others. Since 2018, diabetes technology has become available that allows people with diabetes to not only optimize the clinical aspects of their diabetes management but also helps them mitigate the psychosocial consequences of hypoglycemia. Optimizing diabetes management with the integration of new technologies necessitates a comprehensive approach that leans on both the clinical and psychosocial understanding of people with diabetes.

Treatment of Hypoglycemia With Integrated Technology

Advanced diabetes devices such as low glucose suspend, predictive low glucose suspend, and hybrid closed-loop devices change the way that hypoglycemia should be managed. These systems reduce or suspend basal (background) insulin delivery when the CGM predicts a future or current low glucose level. When the "Rule of 15s" is used with these devices, the person with diabetes often experiences rebound hyperglycemia due to the reduction of insulin-on-board. Our Practical Advanced Therapies for Diabetes (PANTHER) team at Barbara Davis Center recommends the following:

- If glucose levels are <70 mg/dL, consider treating with 5-10 g CHO and checking to see if the CGM arrow ticks upward in 15 minutes. If the glucose level is still low and the arrow is still decreasing, treat again with 5-10 g as needed.
- Recommending 5 or 10 g CHO depends on the person and the situation. If the CGM is showing 2 arrows down, treat with a higher CHO amount. If the CGM has 1 arrow or slant arrow down, try the lower amount of CHOs. Young children often need only the smaller amount.
- Consider not preemptively treating hypoglycemia—it is likely the advanced system will prevent many hypoglycemia episodes with pump suspension before they occur. Wait until glucose levels are actually low before treating. Or, if preemptively treating, start with 2-5 g CHO.

Laurel H. Messer, PhD, RN, CDCES
PANTHER Research Team (Practical Advanced THERapies for Diabetes)
Barbara Davis Center for Diabetes
Aurora, CO 80045

References

1. Cryer PE. Hypoglycemia: still the limiting factor in the glycemic management of diabetes. *Endocr Pract.* 2008;14(6):750-756. doi:10.4158/EP.14.6.750
2. International Hypoglycaemia Study Group, Heller SR. Glucose Concentrations of Less Than 3.0 mmol/L (54 mg/dL) Should Be Reported in Clinical Trials: A Joint Position Statement of the American Diabetes Association and the European Association for the Study of Diabetes. *Diabetes Care.* 2017;40(1):155-157.
3. Agiostratidou G, Anhalt H, Ball D, et al. Standardizing Clinically Meaningful Outcome Measures Beyond HbA1c for Type 1 Diabetes: A Consensus Report of the American Association of Clinical Endocrinologists, the American Association of Diabetes Educators, the American Diabetes Association, the Endocrine Society, JDRF International, The Leona M. and Harry B. Helmsley Charitable Trust, the Pediatric Endocrine Society, and the T1D Exchange. *Diabetes Care.* 2017;40(12):1622-1630.
4. Bode BW, Schwartz S, Stubbs HA, Block JE. Glycemic characteristics in continuously monitored people with diabetes with type 1 and type 2 diabetes: normative values. *Diabetes Care.* 2005;28(10):2361-2366.
5. Yeoh E, Choudhary P. Technology to Reduce Hypoglycemia. *J Diabetes Sci Technol.* 2015; 9(4):911–916.
6. Edelman SV, Blose JS. The Impact of Nocturnal Hypoglycemia on Clinical and Cost-Related Issues in People with diabetes With Type 1 and Type 2 Diabetes. *The Diabetes Educator.* 2014;40(3):269–279.
7. American Diabetes Association. *Standards of Medical Care in Diabetes-2019* Abridged for Primary Care Providers. *Clin Diabetes.* 2019;37(1):11-34.
8. Foster NC, Beck RW, Miller KM, et al. State of Type 1 Diabetes Management and Outcomes from the T1D Exchange in 2016-2018 [published correction appears in *Diabetes Technol Ther.* 2019;21(4):230]. *Diabetes Technol Ther.* 2019;21(2):66-72.
9. Miller KM, Foster NC, Beck RW, et al. Current State of Type 1 Diabetes Treatment in the U.S.: Updated Data from the T1D Exchange Clinic Registry. *Diabetes Care.* 2015;38(6):971-978. doi: 10.2337/dc15-0078
10. Zhong A, Choudhary P, McMahon C, et al. Effectiveness of Automated Insulin Management Features of the MiniMed®640G Sensor-Augmented Insulin Pump. *Diabetes Technol Ther.* 2016;18(10):657-663.
11. Müller L, Habif S, Leas S, Aronoff-Spencer E. Reducing Hypoglycemia in the Real World: A Retrospective Analysis of Predictive Low-Glucose Suspend Technology in an Ambulatory Insulin-Dependent Cohort. *Diabetes Technol Ther.* 2019;21(9):478-484.
12. Messer LH, Berget C, Forlenza GP. A clinical guide to advanced diabetes devices and closed-loop systems using the CARES Paradigm. *Diabetes Technol Ther.* 2019;21(8):462-469.
13. Buckingham B, Cobry E, Clinton P, et al. Preventing Hypoglycemia Using Predictive Alarm Algorithms and Insulin Pump Suspension. *Diabetes Technol Ther.* 2009;11(2):93- 97.
14. Singh H, Manning M, Malloy MM, Habif S. SAT-LB113 Psychosocial Benefits of Using Basal-IQ® Predictive Low Glucose Suspend Technology in a Real-world Setting: Results from Pediatric People with diabetes with Type 1 Diabetes. *JES.* 2020;4(suppl 1).
15. Polonsky WH. Psychosocial Aspects of Diabetes Technology: Adult Perspective. *Endocrinol Metab Clin North Am.* 2020;49(1):143-155.
16. Kovacs Burns K, Nicolucci A, Holt RIG, et al. Diabetes Attitudes, Wishes and Needs second study (DAWN2TM): cross-national benchmarking indicators for family members living with people with diabetes. *Diabet Med.* 2013;30(7):778-788.
17. Gonder-Frederick L. Fear of hypoglycemia: a review. *Diabetic Hypoglycemia.* 2013;5(3):3-11.

Job:7933 OTCE Vol 41 No 2(11323)

Medication-Related Hypoglycemia: Causes and Treatments

Diana Isaacs, PharmD, BCPS, BCACP, CDCES, BC-ADM and Jacob Zolna, PharmD Candidate 2020
Cleveland Clinic Diabetes Center
University Heights, OH

Abstract

Medications used to treat diabetes that directly affect insulin secretion create the highest risk for hypoglycemia. Additionally, some medications used for comorbidities cause glucose excursions creating intensified treatment leading to increased risk of hypoglycemia. These can include antipsychotics, steroids, anti-rejection medications, certain hypertension medications, and hormone therapy. Other health conditions like mental health disorders and substance use disorders also impact glycemic management which can indirectly put people at greater risk of hypoglycemia. This article will discuss how these factors contribute to hypoglycemia and will compare and contrast new glucagon treatment options for severe hypoglycemia.

Introduction

The hallmark of diabetes is hyperglycemia and the treatment of hyperglycemia can lead to the adverse effect of hypoglycemia. People with type 1 diabetes (T1D) are often treated with intensive insulin regimens while people with type 2 diabetes (T2D) are usually treated with oral medication and non-insulin injectables. Due to the progressive nature of T2D, insulin is often required over the lifetime. Most people treated with insulin experience hypoglycemia. Data show that approximately 50% of people with T2D experience hypoglycemia and 20% experience at least one severe hypoglycemia event per year which is defined as requiring assistance from another individual (1,2). Although intensive diabetes management is a risk factor of hypoglycemia, studies show that people with HbA1c greater than 9% actually have the highest rates of hypoglycemia compared to those with lower HbA1c levels (3,4).

There are numerous factors that contribute to hypoglycemia, including the effects of non-insulin antihyperglycemic agents, inadequate education related to insulin dosing, mental health conditions and the medications used to treat them, and the influence of opioids and recreational drugs. Additionally, some medications used to treat comorbidities cause glucose excursions and increase the risk of hypoglycemia. This article will discuss how these factors can contribute to hypoglycemia and compare and contrast new treatment options to treat severe hypoglycemia.

Antihyperglycemic Medications

Some antihyperglycemic medications used to treat diabetes increase the risk of hypoglycemia. The most common are secretagogues and insulin. Secretagogues include sulfonylureas like glipizide, glyburide, and glimepiride and meglitinides like repaglinide and nateglinide. Other antihyperglycemic medications including metformin, sodium glucose like transporter-2 (SGLT-2) inhibitors, glucagon-like peptide-1 (GLP-1) receptor agonists, alpha glucosidase inhibitors, dopamine agonists, amylin mimetics, bile acid sequestrants and thiazolidinediones, are not expected to cause hypoglycemia when used alone; however, any time they are used in conjunction with secretagogues or insulin, hypoglycemia risk is increased. When initiating such agents, the insulin or secretagogue dose often needs to be decreased, especially if HbA1c is near or below target (5).

Insulin Dosing Education

It has been estimated that 9.2% of emergency department (ED) visits are due to insulin-related hypoglycemia (6). Precipitating factors leading to ED visits are most often related to mealtime insulin dosing, such as taking the wrong dose, taking insulin and not eating, or taking the wrong type of insulin (6). Other risk factors for hypoglycemia include advanced age, erratic mealtimes, increased or unplanned physical activity, long-standing history of diabetes, alcohol use, and malnutrition. It's important for people with diabetes to receive education on these factors and ensure they understand the mode of action of different types of insulin and, if applicable, how to calculate insulin doses using their individual insulin to carbohydrate ratio and correction factor. Insulin pumps and connected smart pens can be programmed to perform the calculations with the patient's settings. They also have the added benefit of recording insulin on board to avoid insulin stacking (an insulin bolus within 3 hrs of a previous bolus) and allow information to be downloaded and reviewed with the person's healthcare team. If a patient doesn't have one of these devices, it is recommended that they avoid dosing

Job:7933 OTCE Vol 41 No 2(11323)

fast acting insulin more than once every four hours for the purpose of correcting hyperglycemia.

Medications That May Indirectly Contribute to Hypoglycemia

Many drug classes used to treat diabetes comorbidities can increase blood glucose levels, including statins, beta blockers, steroids, thiazides, and anti-rejection medications prescribed after transplant surgery. If the patient's antihyperglycemic medications are adjusted to treat the resulting hyperglycemia, and the dose of the comorbidity drug is subsequently reduced, the patient may be at risk of hypoglycemia. To make matters worse, certain medications such as beta blockers can mask the early adrenergic symptoms of hypoglycemia such as feeling shaky or sweating, putting the patient at risk of more severe hypoglycemia. Often the only symptom a person may experience is sweating. As any of these drugs are tapered or discontinued, antihyperglycemic medication adjustments must be made to avoid hypoglycemia. People with diabetes should be advised to not suddenly stop any medications without first notifying their diabetes care team and, if necessary, having a plan for glycemic management in place (7).

Mental Health Conditions

The prevalence of diabetes in those with severe mental disorders, including bipolar disorder and schizophrenia, is 28%, much higher than the general population (8). The medications used to treat these conditions, including mood stabilizers like lithium and antipsychotics such as olanzapine (Zyprexa), contribute to hyperglycemia and weight gain. Additionally, mental health conditions themselves are associated with poor glycemic management. Other mental health conditions including depression, anxiety, and diabetes distress can affect medication adherence and self-management behaviors increasing glycemic variability and risk of hypoglycemia (8).

Opioids and Recreational Drugs

Substance use disorder and the opioid epidemic is a growing problem in the United States. In one study, adults with T2D were found to have higher rates of substance use disorder (4.2%) compared to people without diabetes (2.1%) (9). People that use substances are more likely to have limited access to care, poor follow-up and sub-optimal self-management skills. They also may have poor nutrition, associated mental illness and erratic lifestyle which affects adherence to prescribed medication regimens. These are all risk factors for hypoglycemia (10).

Treating Hypoglycemia

People with diabetes who are at risk of hypoglycemia should carry some form of quick acting carbohydrate to treat hypoglycemia. A continuous glucose monitor (CGM) can help to provide directional alerts for hypoglycemia. Glucagon is recommended for hypoglycemia emergencies.

The Role of Glucagon

Glucagon is a counter-regulatory hormone that plays a significant role in stabilizing blood glucose levels. It is secreted by the pancreatic α-cells to stimulate gluconeogenesis, i.e. the production of glucose by the liver. Gluconeogenesis enables increases in blood glucose (BG) concentrations (11). The American Diabetes Association recommends that glucagon be prescribed for all individuals at increased risk of clinically significant hypoglycemia, i.e. BG less than 54 mg/dL or Level 2 hypoglycemia. This includes anyone taking insulin or a secretagogue. The guidelines recommend caregivers, school personnel, or family members of these individuals know where the glucagon is stored, and educated on when and how to use it (12).

Glucagon Emergency Kit

Glucagon was first produced and used for therapy in the 1950s when Eli Lilly and Co. purified and crystalized glucagon so that they could determine the biochemical structure. The original Glucagon Emergency Kit was designed shortly thereafter. Novo Nordisk then followed by designing their own product called the GlucaGen HypoKit (13,14). This product was considered revolutionary at the time, but it was difficult to administer. Both the Emergency Kit and the HypoKit include a vial of lipophylized powder glucagon and a syringe that contains the diluent used to activate the glucagon. The glucagon must be reconstituted before use. This process requires many steps that can be particularly challenging in an emergency situation (13). In 2019, two new formulations of glucagon were approved by the FDA: nasal glucagon (Baqsimi) and liquid-stable glucagon injection (Gvoke).

Liquid Stable Glucagon (Gvoke)

The liquid stable glucagon formulation is available as an auto-inject pen and pre-filled syringe. These new products are available as

Job:7933 OTCE Vol 41 No 2(11323)

Table 1: Comparison of Glucagon Formulations (13-16)

	Nasal glucagon (Baqsimi)	Liquid stable glucagon (Gvoke)	Lyophilized glucagon powder injection (glucagon emergency kit)	Lyophilized glucagon powder injection (GlucaGen)
Available Doses	3 mg	0.5 mg, 1 mg	0.5 mg, 1 mg	0.5 mg, 1 mg
FDA-Approved Ages	Over 4 years	Over 2 years	Any age	Any age
FDA-Approved Indications	Severe hypoglycemia	Severe hypoglycemia	Severe hypoglycemia	Severe hypoglycemia, diagnostic agent
Route of Administration	Nasal	SC	SC, IM, IV	SC, IM, IV
Location of Administration	Nose	Lower abdomen, outer thigh, or outer upper arm	Upper arms, thighs, or buttocks	Upper arms, thighs, or buttocks
Dosage	3 mg	Over 12 years of age: 1 mg; Under 12 years of age and <45 kg: 0.5 mg	Adults and pediatrics weighing >20kg: 1 mg; Pediatrics weighing <20 kg: 0.5 mg or dose equivalent to 20-30 mcg/ kg	Adults and pediatrics weighing >25 kg or >6 years: 1 mg; Pediatrics weighing <25 kg or < 6 years: 0.5 mg
Requires Reconstitution Prior to Use?	No	No	Yes	Yes
Time to Peak Concentration	15 minutes	50 minutes	20 minutes (SC) 12 minutes (IM)	30 minutes
Half-Life	35 minutes	32 minutes	8-18 minutes	45 minutes
Shelf Life Stability	24 months	24 months	24 months; If reconstituted, must use immediately	24 months; If reconstituted, must use immediately
Storage Temperature	Up to 86° F (30° C) in the shrink-wrapped tube provided	59°- 86° F (15° to 30° C) in the sealed foil pouch provided	Controlled room temperature 68° to 77° F (20° to 25° C)	Controlled room temperature 68° to 77° F (20° to 25° C)
Common Adverse Effects	Nausea, vomiting, headaches, nasal discomfort, upper respiratory tract infection	Nausea, vomiting, headaches, injection site reactions	Nausea, vomiting, headaches, injection site reactions	Nausea, vomiting, headaches, injection site reactions

a single or double pack. Double packs are often preferred in case two doses are required for treatment. The new formulations have been compared to the traditional Glucagon Emergency Kit in multiple clinical trials and demonstrated efficacy and quick administration (15,16). There are no head-to-head studies between the newer products.

Nasal Glucagon (Baqsimi)

Nasal glucagon is available in a 3 mg dose. The most common adverse reactions that can occur with nasal glucagon are nausea, vomiting, headache, nasal congestion, cough, epistaxis, and oropharyngeal pain. In a phase 3 clinical trial conducted by Seaquist ER et al, nasal glucagon was found to demonstrate effectiveness in treating adults who were having a hypoglycemic episode (17). They found it had

Job:7933 OTCE Vol 41 No 2(11323)

limited side effects that were only mild to moderate in severity. Another phase 3 trial conducted by Deeb LC et al found that a 3 mg dose of nasal glucagon was effective in treating children and adolescents with T1D and showed ease of use and a reasonable safety profile (18).

Liquid stable glucagon dosing is 1 mg for ages 12 and above. Ages 2 through 12 years should be given a dose of 0.5 mg if less than 45 kg or 1 mg if more than 45 kg. The most common adverse reactions are nausea, vomiting, headache, and injection site reactions. A phase 3 trial conducted by Christiansen M et al found that the glucagon autoinjector was effective, safe and well tolerated (19). This formulation was used for rescue treatment of adults who were undergoing a severe hypoglycemic episode. A second study that was conducted by Buckingham B et al found similar results in pediatric patients, ages 2 through 17, that were undergoing a severe hypoglycemic episode (20).

Table 1 has detailed descriptions of the different glucagon formulations. Of note, there are differences in sites of administration and dosing between formulations. Due to the way the respective clinical trials were performed and the slight differences in formulations, there are different pharmacokinetic values, but these are not clinically significant. All formulations typically provide relief within fifteen minutes; if hypoglycemia has not resolved by then, a second dose can be administered. After each dose, a person should be rolled onto their side in case of nausea or vomiting. Cost is similar between products, but insurance coverage may prefer one over another. All have co-pay cards for those with commercial insurance.

Glucagon Warnings and Adverse Effects

All glucagon formulations are contraindicated in pheochromocytoma, insulinoma, and glucagon hypersensitivity. There is a warning about lack of efficacy in patients with decreased hepatic glycogen, which can occur in states of starvation, adrenal insufficiency, chronic hypoglycemia, and patients who follow a very low carbohydrate eating pattern (13-16).

Conclusion

There are multiple contributing factors to hypoglycemia including antihyperglycemic medication and lack of education around insulin dosing. Therapy adjustments made to account for glycemic excursions from several medications can also lead to hypoglycemia. For severe hypoglycemia, glucagon is the treatment of choice. Newer glucagon formulations include nasal glucagon and liquid stable glucagon and have made delivering glucagon a much simpler process. All people with diabetes at risk of severe hypoglycemia should have a prescription for glucagon and their caregiver should be educated on how to use it. (For more information on currently available Glucagon products please see the OTCE addendum folder on DDPG website.)

References

1. Gehlaut RR, Dogbey GY, Schwartz FL, Marling CR, Shubrook JH. Hypoglycemia in Type 2 Diabetes - More Common Than You Think: A Continuous Glucose Monitoring Study. *Journal of Diabetes Science and Technology.* 2015;9(5):999-1005.
2. Edridge CL, Dunkley AJ, Bodicoat DH, et al. Prevalence and Incidence of Hypoglycaemia in 532,542 People with Type 2 Diabetes on Oral Therapies and Insulin: A Systematic Review and Meta-Analysis of Population Based Studies. *PLoS ONE.* 2015;10(6):e0126427.
3. Lipska KJ, Warton EM, Huang ES, et al. HbA1c and risk of severe hypoglycemia in type 2 diabetes: The Diabetes and Aging Study. *Diabetes Care.* 2013;36(11):3535-3542. doi:10.2337/dc13-0610
4. Foster NC, Beck RW, Miller KM, et al. State of Type 1 Diabetes Management and Outcomes from the T1D Exchange in 2016-2018. *Diabetes Technol Ther.* 2019;21(2):66-72. doi:10.1089/dia.2018.0384
5. American Diabetes Association. 9. Pharmacologic Approaches to Glycemic Treatment: Standards of Medical Care in Diabetes—2020. *Diabetes Care.* 2020 Jan; 43(suppl 1):S98-S110. doi:10.2337/dc20-S009
6. Geller AI, Shehab N, Lovegrove MC, et al. National estimates of insulin-related hypoglycemia and errors leading to emergency department visits and hospitalizations. *JAMA Intern Med.* 2014;174(5):678-686. doi: 10.1001/jamainternmed.2014.136
7. Fathallah N, Slim R, Larif S, Hmouda H, Ben Salem C. Drug-Induced Hyperglycaemia and Diabetes. *Drug Saf.* 2015;38(12):1153-1168. doi:10.1007/s40264-015-0339-z
8. Mangurian C, Schillinger D, Newcomer JW, et al. Comorbid Diabetes and Severe Mental Illness: Outcomes in an Integrated Health Care Delivery System. *J Gen Intern Med.* 2020;35(1):160-166. doi:10.1007/s11606-019-05489-3.
9. Walter KN, Wagner JA, Cengiz E, Tamborlane WV, Petry NM. Substance use disorders among patients with Type 2 Diabetes: A dangerous but understudied combination. *Curr Diabetes Rep.* 2017;17(1):2. doi: 10.1007/s11892-017-0832-0
10. Ojo O, Wang XH, Ojo OO, Ibe J. The Effects of Substance Abuse on Blood Glucose Parameters in Patients with Diabetes: A Systematic Review and Meta-Analysis. *Int J Environ Res Public Health.* 2018;15(12):2691. doi:10.3390/ijerph15122691
11. Hædersdal S, Lund A, Knop FK, Vilsbøll T. The role of glucagon in the pathophysiology and the treatment of type 2 diabetes. *Mayo Clin Proc.* 2018;93(2):217-239. doi: 10.1016/j.mayocp.2017.12.003
12. American Diabetes Association. 6. Glycemic targets: standards of medical care in diabetes. *Diabetes Care.* 2020;43(suppl 1):S66-S76. doi:10.2337/dc20-S006
13. Beato-Víbora PI, Arroyo-Díez FJ. New uses and formulations of glucagon for hypoglycaemia. *Drugs Context.* 2019;8:212599. doi:10.7573/dic.212599
14. GlucaGen [prescribing information]. Plainsboro, NJ: Novo Nordisk Inc; 2018. novo-pi.com/ glucagenhypokit.pdf. Accessed April 14, 2020.
15. BAQSIMI (glucagon) [package insert]. Exchange Tower, Ontario; Eli Lilly and Co.; Revised September 2019.
16. GVOKE (glucagon) [package insert]. Chicago, IL; Xeris Pharmaceuticals; Revised February 2020.
17. Seaquist ER, Dulude H, Zhang XM, et al. Prospective study evaluating the use of nasal glucagon for the treatment of moderate to severe hypoglycaemia in adults with type 1 diabetes in a real-world setting. *Diabetes Obes Metab.* 2018;20(5):1316-1320.
18. Deeb LC, Dulude H, Guzman CB, et al. A phase 3 multicenter, open-label, prospective study designed to evaluate the effectiveness and ease of use of nasal glucagon in the treatment of moderate and severe hypoglycemia in children and adolescents with type 1 diabetes in the home or school setting. *Pediatr Diabetes.* 2018;19(5):1007-1013.
19. Christiansen MP, Cummins MJ, Prestrelski SJ, Strange P. A Phase 3 Comparison of a Novel Liquid Glucagon Autoinjector to Glucagon Emergency Kit for the Treatment of Severe Hypoglycemia. *Diabetes.* 2018 Jul; 67(supp 1).
20. Buckingham B, Cummins MJ, Prestrelski S, Strange P. Liquid Room Temperature Stable Glucagon—Glucose Response in Pediatric Type 1 Diabetes Patients. *Diabetes.* 2018 Jul; 67(supp 1).

Job:7933 OTCE Vol 41 No 2(11323)

Educational Programs to Restore Hypoglycemia Awareness

Lois Maurer, MS, RD, CDCES
Joslin Diabetes Center
Boston, MA

Abstract

It's important for people with type 1 diabetes (T1D) to recognize when their blood glucose level is low. Some, particularly those with long diabetes duration, may experience impaired awareness of hypoglycemia (IAH). For those with IAH early warning signals of low blood glucose are missing and they are unable to quickly respond. This can result in extended periods of time with low blood glucose. Blood glucose awareness programs are designed to help people with IAH. They help people with IAH identify person-specific hypoglycemia cues, help them learn to predict their blood glucose level, and help them make better decisions about activities, food, and insulin to prevent low blood glucose. This article discusses the history and implementation of blood glucose awareness programs.

Background

Blood Glucose Awareness Training (BGAT) programs have been available in the US and Europe for people with IAH for a number of years. The BGAT program is designed to reduce the incidence of severe hypoglycemia (SH) and improve IAH (1). BGAT is an 8-week program which aims to increase awareness of both high and low blood glucose levels and also improve general diabetes self-management to improve hypoglycemia awareness (1). BGAT is one of the most well-studied blood glucose awareness training programs. Research at multiple research centers have demonstrated BGAT's benefits (1). However, due to its intensive, small group session approach, BGAT proved to be limited as to how many people it could reach. A more recent online version (BGATHome), designed to be more accessible to adults with T1D, is offered as a self-directed tutorial in seven units/topics and is expected to take about 12 weeks to complete. BGATHome can also be used in a traditional group format led by diabetes experts (1).

IAH can be restored by rigorous avoidance of hypoglycemia for a period of time (2,3). A meta-analysis of 43 studies designed to restore awareness of hypoglycemia provided scientific evidence for the effectiveness of a stepped-care approach in management of individuals with IAH (4). Successful studies included a structured diabetes education program, flexible insulin prescriptions, psychotherapy, behavioral therapies, and if needed, diabetes technology (continuous glucose sensors and insulin pumps) (4). The addition of psychotherapeutic techniques provided a benefit in improving hypoglycemic awareness (HA). Both insulin pump therapy and conventional Multiple Daily Injection (MDI) therapy (in patients with acceptable glycemic control) are able to improve HA (5).

HARPdoc Elements

In 2014, a pilot HARPdoc (Hypoglycemia Awareness Restoration Program for people with type 1 diabetes and problematic hypoglycemia persisting despite optimized care) study of 24 individuals in London and Sheffield, England showed favorable outcomes (6). Although small and non-randomized, this yearlong study demonstrated that using psychoeducational approaches can have sustained positive effects on reducing SH and non-severe hypoglycemia episodes in people who have IAH. This study showed a 43% improvement in SH in people with IAH without any deterioration in overall glycemic goals (7). These results prompted Dr. Stephanie Amiel, Professor of Diabetes Research, King's College, London to conduct a larger, randomized, controlled trial comparing HARPdoc with BGAT. This larger, multi-center study is targeted for completion in 2020. An overview of this study and its protocol has been published (7). The HARPdoc curriculum is designed for groups of 4-6 participants; it includes 32 hours of classroom time spread over six weeks. In addition to classroom discussion, weeks 4 and 5 include individual support, i.e. scheduled calls with diabetes care and education specialists. Week 6 focuses on relapse prevention, driving, and support for relatives (i.e. a group session led by a psychologist). Post-group follow-up sessions are scheduled at 3, 6 and 12-months; additional sessions may occur at the request of individual participants.

Job:7933 OTCE Vol 41 No 2(11323)

The HARPdoc curriculum is an expansion of BGAT. It explores behaviors surrounding hypoglycemia, as well as an individual's personal beliefs about hypoglycemia, which may be just as important as their behaviors (6). Similar to the BGAT program, participants in the HARPdoc program are encouraged to identify hypoglycemia cues, consider causes and consequences of IAH, and to explore ways to reduce the occurrence of hypoglycemia. Homework is valuable in both programs to gain confidence using the skills taught. Homework assignments include estimating blood glucose, practicing the mindfulness-based body scan, and noting awareness hypoglycemia cues. Homework is reviewed weekly and additional activities are suggested, such as identifying thoughts in response to blood glucose levels (7). Participants keep a journal to record carbs consumed, insulin given, and glucose estimations before looking at a fingerstick result or continuous glucose monitor (CGM) reading. This helps participants recognize patterns of behavior related to glucose levels and body cues for hypoglycemia.

Long duration of diabetes is not the only cause of IAH. Other causes include frequent fasting or pre-meal glucose levels below target, recurrent hypoglycemia, and long duration of hypoglycemic episodes. The problem is that a person having IAH experiences no timely physical or mental stress response, and therefore feels no warning signs until their blood glucose is extremely low. Blood glucose awareness training is important because it can help individuals identify subtle cues of hypoglycemia which previously went unnoticed. Body scans can identify visual, mood, and physical cues. In addition, coordination and performance cues can portend hypoglycemia, i.e., changes in the performance of fine motor tasks such as untying a knot, opening a lock, or flipping a coin. These cues allow people at risk of IAH to detect hypoglycemia without the use of glucose meters or CGM.

Since hypoglycemia can occur unexpectedly, blood glucose awareness training programs include safe driving guidelines. These guidelines include monitoring glucose before getting behind the wheel, wearing a diabetes alert ID, and carrying quick-acting glucose and/or other forms of treatment. If hypoglycemia occurs, the person should get off the road, treat their low glucose, and wait 45 minutes before resuming driving (8). A long-term follow-up study of BGAT participants showed a two-thirds reduction in crashes and motor vehicle violations (9).

Understanding Thoughts and Behaviors

A core element of HARPdoc classes is helping participants understand how their thoughts and related behaviors can maintain problematic hypoglycemia. Even though most people with IAH express a desire to eliminate SH and its causes, their actions and/or inactions may inadvertently result in further sustaining their hypoglycemia problem. Blood glucose awareness training raises this issue during class discussions so that participants can hopefully identify how their own "thinking traps" might inhibit restoring hypoglycemia awareness. One common belief includes placing a higher level of importance on avoiding high blood glucose rather than lows. Fear of high blood glucose might drive a person to give extra insulin "just in case." Another common thinking trap is minimizing the consequences of hypoglycemia by putting off corrective measures and perhaps even saying to themselves, "nothing bad can happen." A third thinking trap is when an individual does not want to interrupt what they are doing to treat hypoglycemia due to an insistence to keep going and "not make a fuss" (6).

Downside to Technology

Today, Continuous Glucose Monitors (CGMs) can quickly remind a person of their numbers. While technology can drive home an embedded fear of highs, it can also cause a person to become overly dependent upon the information it provides. In other words, by having access to constant data, a person may become less likely to attend to body cues. How does a person with IAH keep themselves safe if their CGM fails or when they are frustrated with technology and stop using CGM? The ADA recommends that a person with IAH, specifically those with one or more episodes of IAH, enroll in a hypoglycemia avoidance education program (10). This means attending a structured program that will not only support their unique needs, but also motivate them to practice ways of thinking and behaving to minimize or eliminate IAH. Those with IAH need to know with the right training, it's possible to regain an ability to sense low BG and rescue themselves in time to make decisions about activities, food, and insulin needs. After completing the program, treatment focus should emphasize safety and less stringent A1C targets should be considered. However, it is possible that participating in programs such as BGAT and HARPdoc can help people avoid hypoglycemia without sacrificing optimum glucose control.

Job:7933 OTCE Vol 41 No 2(11323)

Acknowledgments

For the past three years I've been involved in the HARPdoc program, along with Nicole Patience, as a Joslin educator trained at King's College in London, England alongside UK-based diabetes care and education specialists. The study will conclude in the US in 2020, with completion of data collection, analysis and presentation of outcomes to follow in 2021.

References

1. Cox J, Gonder-Frederick L, Ritterband L, et al. Blood Glucose Awareness Training: What Is It, Where Is It, and Where Is It Going? *Diabetes Spectrum.* 2006;19(1):43-49.
2. Cox D, Kovatchev B, Koev D, et al. Hypoglycemia Anticipation, Awareness and Treatment Training (HAATT) Reduces Occurrence of Severe Hypoglycemia Among Adults with Type 1 Diabetes Mellitus. *International Journal of Behavioral Medicine.* 2004;11(4):212–218.
3. Cranston I, Lomas J, Maran A, Macdonald I, Amiel S. Restoration of Hypoglycaemia Awareness in Patients with Long Duration Insulin-dependent Diabetes. *Lancet.* 1994;344(8918):283-287.
4. Yeoh E, Choudhary P, Nwokolo M, Ayis S, Amiel SA. Interventions That Restore Awareness of Hypoglycemia in Adults with Type 1 Diabetes: A Systematic Review and Meta-analysis. *Diabetes Care.* 2015;38(8):1592-1609.
5. Little SA, Leelarathna L, Walkinshaw E, et al. Recovery of Hypo Awareness in Long-Standing Type 1 diabetics: A Multicenter 2X2 Factorial Randomized Controlled Trial Comparing Insulin Pump with MDI and Continuous with Conventional Glucose Self-Monitoring (HypoCOMPaSS). *Diabetes Care.* 2014;37(8):2114-2122.
6. de Zoysa N, Rogers H, Stadler M, et al. Psychoeducational Program to Restore Hypoglycemic Awareness: The DAFNE – HARP Pilot Study. *Diabetes Care.* 2014;37(3):863-866.
7. Amiel SA, Choudhary P, Jacob P, et al. Hypoglycaemia Awareness Restoration Programme for People with Type Diabetes and Problematic Hypoglycaemia Persisting Despite Optimized Self-care HARPdoc): protocol for a group randomized controlled trial of a novel intervention addressing cognitions. *British Medical Journal.* 2019;9(6):e030356.
8. Gravel AJ, Warren RE, Frier BM. Hypoglycemia and Driving in People with Insulin-Treated Diabetes: Adherence to Prescription for Avoidance. *Diabetes Medicine.* 2004;21(9):1014-1019.
9. Cox DJ, Gonder-Frederick LA, Julian DM, Clarke W. Long-term follow-up evaluation of blood glucose awareness training. *Diabetes Care.* 1994;(17):1–5.
10. American Diabetes Association. 6. Glycemic Targets: Standards of Medical Care in Diabetes – 2020. *Diabetes Care.* 2020;43(suppl 1):566-576.

Hypoglycemic Confidence in People with Diabetes and their Loved Ones: The Dietitian's Role in Accentuating the Positive

Christine Beebe, MS, RD
Quantumed Consulting
San Diego, CA

William Polonsky, PhD, CDCES
Behavioral Diabetes Institute
Encinitas, CA

Abstract

Hypoglycemia, including severe hypoglycemia, is recognized as a substantial burden to persons with diabetes (PWD), their partners, and family members. Worries and fears about hypoglycemia, or low glucose, contribute to not achieving the glucose goal and impaired quality of life. Hypoglycemic Confidence (HC) is the degree to which an individual feels able, secure and comfortable in his or her ability to stay safe from hypoglycemia-related problems. Assessing HC in PWD and their loved ones can be the catalyst for conversations that engage persons to prepare, optimize medications, and select tools that can provide comfort and security to master hypoglycemia-related problems.

Introduction

Robert and his wife Betsy admit their lives have been turned upside down since his type 1 diabetes (T1D) diagnosis last year. Robert's regular exercise routine has become much more burdensome and less enjoyable because of constant insulin and food adjustments to prevent severe hypoglycemia. Even worse, Betsy had to call 911 for a serious low following a particularly active day. As a result, Betsy now sleeps poorly as she worries his blood glucose will fall dangerously low during the night. Robert now secretly takes less insulin than prescribed and snacks more to both avoid those frightening lows and get Betsy off his back. The result is a higher HbA1c, weight gain, frustration, and a lot of stressful disagreements between the two of them.

Hypoglycemia, and particularly severe hypoglycemia, are primary contributors to diabetes-related emotional distress in PWD, their partners, and family members (1,2). Fear of Hypoglycemia (FOH) and its concerns are often even greater in partners and family members than in PWD (3). More than two-thirds of partners and family members of PWD say they are exhausted by worrying about hypoglycemia (4). This should come as no surprise as treating severe hypoglycemia is demanding, immediate, frightening, and can leave partners traumatized.

Any PWD using insulin, T1D, type 2 diabetes (T2D) on basal/prandial, and T2D on basal, is at risk for hypoglycemia and, potentially, severe hypoglycemia (5-7). Severe hypoglycemia occurs at all ages and all levels of glycemic management. A 2019 study in PWD with T1D (T1 PWD) ages 1 to 93 years found that 3-14% of PWD experienced a severe low in the past three months (8). The greatest frequency was found in those with A1C <7% and >9%. The use of real-time continuous glucose monitor (CGM) systems lowered the incidence

Job:7933 OTCE Vol 41 No 2(11323)

of severe hypoglycemia in the previous three months from 7% among non-users to 4.5% among users. Compared to those using multi-daily injections, pump users had a lower incidence of severe hypoglycemia (9% vs 5%) (8). Although technologies could help to lower the occurrence, they were not able to entirely eliminate severe hypoglycemia.

Until recently, healthcare professionals have focused on assessing and alleviating diabetes distress (DD) and FOH in PWD and their loved ones. New evidence, however, suggests that it may also be valuable to focus on a third element: the opposite side of fear, Hypoglycemia Confidence (HC). HC is distinctly different from hypoglycemia fear in both PWD and their partners. The Hypoglycemia Confidence Scale (HCS) and the Partner-HCS are reliable and validated measures that can be used in PWD and their partners (3,9). Registered Dietitian Nutritionists (RDNs) have unique relationships and conversations with PWD and their families that frequently focus on hypoglycemia concerns and issues. These conversations can be enriched when tools such as the HCS are employed to help identify overall confidence as well as individual contributors to HC. Together with PWDs and their loved ones, RDNs can inform and explore ways to build HC. Here we will review the research behind the HC concept and components, who should be assessed, and what can be done to help improve HC.

Hypoglycemia Confidence in PWD

Diabetes care and education specialists and healthcare professionals are familiar with helping PWD develop the confidence to adopt self-management behaviors that lead to optimal health and quality of life (QOL). A certain degree of confidence, or self-efficacy, is critical to successfully perform most self-management tasks and to cope with the demands of living with diabetes.

Enhancing HC by helping an individual feel able, secure, and comfortable in his or her ability to stay safe from hypoglycemia-related problems can be part of any educational intervention when there is a concern of hypoglycemia. As previously noted, we now have validated reliable tools for assessing HC in T1D adults, T2D adults using insulin, and T1D spouses/partners (3,9). Furthermore, though not yet formally validated, we strongly suspect that the tool for T1D and insulin-using T2D adults will be usable by older teens, and that the tool for T1D spouses/partners will be equally applicable for the spouses/partners of insulin-using T2D adults.

HC illustrates the importance of not just focusing on the negative (e.g., fear), but considering in parallel the positive aspects of a PWD's experience. Feeling safe and confident is not merely the absence of fear and worry, it is a sense that hypoglycemia can be generally avoided and managed, if not mastered. The 9-item Hypoglycemia Confidence Scale (HCS) self-report tool was studied in T1 PWD and PWD with T2D (T2 PWD) on basal/prandial insulin or basal insulin only. Higher HCS scores were significantly associated with measures of diabetes-related QOL, including lower levels of DD and FOH in all three groups (3). Higher HCS was associated with better glycemic management in T1 PWD and T2 PWD on basal/prandial insulin. The failure of HC linked with glycemic management in PWD on basal insulin only may be due to fewer hypoglycemia events and thus less hypoglycemia experience (3).

As noted, real-time CGM (RT-CGM) and insulin pumps have reduced the prevalence of hypoglycemia and severe hypoglycemia. Can RT-CGM also serve as a tool to enhance HC in PWD? In two recent clinical trials, HCS rose significantly in T1 PWD after RT-CGM was introduced (10,11).

Hypoglycemic Confidence in Partners of PWD

Nearly 65% of partners of PWD report being moderately to extremely worried about hypoglycemia in contrast to 40% of PWD (2). Since partners and family members are often more distressed and anxious about hypoglycemia and severe hypoglycemia than PWD, a 12-item self-report Partner-HCS was developed to study if HC is present in T1 partners (9). As expected, greater partner HC scores were associated with lower levels of DD, FOH, and general anxiety. Greater partner HC was related to the PWD experiencing fewer severe hypoglycemia episodes in the past six months and partners not having to directly assist in helping PWD recover from severe hypoglycemia. This suggests that HC results from individual experiences with hypoglycemia. Having glucagon available for the treatment of severe lows and confidence in the ability to use glucagon were also linked with greater HC scores (9).

In the Partner-HCS validation study, more than one in three partners (38.5%) had low HC, which was surprisingly high since 92.2% of T1 PWD were using CGM (9). These data underscore the complexity of HC and the importance of gauging the partner or family member's

Job:7933 OTCE Vol 41 No 2(11323)

confidence and comfort in dealing with hypoglycemia and severe hypoglycemia since their beliefs and concerns can influence the support that they provide to their PWD. For example, a partner like Betsy could appear to be nagging their PWD to check blood glucose levels more frequently or even encourage them, directly or indirectly, to keep blood glucose levels higher than recommended.

Addressing HC in Clinical Practice?

Since every PWD on insulin is at risk for hypoglycemia, clinicians need to be diligent in recognizing the problem exists and that hypoglycemia avoidance tactics may be impacting behaviors of the PWD and their loved ones. Even clinicians are not immune to hypoglycemia avoidance tactics. Therapeutic inertia, the failure to escalate therapy when glycemic goals are not met, is receiving considerable emphasis as the number of individuals achieving glycemic goals has stagnated over the last 10 years (12). Concern regarding hypoglycemia is identified as a major barrier to escalating glycemic therapy and therapeutic inertia in PWD and their clinicians.

Sharing in decision making with PWD and their loved ones.

1. Discuss hypoglycemia concerns with PWD and loved ones. Consider asking the PWD: *"How confident are you that you can avoid or address serious problems with hypoglycemia?"* Ask a second question to a loved one: *"How confident are you that your partner will be able to avoid or address serious problems with hypoglycemia when you are not around?"*
2. Consider using the full HCS for PWD and/or Partner-HCS to identify specific elements of hypoglycemia to focus on in the discussions. Demonstrate your desire to *talk about what concerns them most.* Refer to team members to address issues when needed.
3. Advise PWD and loved ones to *talk to each other* about hypoglycemia concerns. Ask children if they have talked to their friends about how to help them when needed.
4. Discuss CGM and the *value of checking blood glucose* results to evaluate issues they can then seek help in problem solving.
5. Evaluate medication regimen together to *problem solve* around dosing and timing. Watch for overbasalization in T2 PWD who may be trying to avoid prandial insulin.
6. Evaluate and *discuss prevention strategies*, especially around vigorous or unusual exercise bouts or changes in food intake or timing.
7. Evaluate and *discuss hypoglycemia treatment strategies*. Be nonjudgmental in how PWD reacts to lows and severe low; PWD may find them embarrassing, frightening, and physically and mentally draining. The 15:15 rule (see details on page 1) is a place to start but all PWD eventually develop their treatment algorithm based on how low and how rapidly their blood glucose falls.
8. Emphasize the goal of being confident and how confidence can be achieved by *being prepared.* Emphasize what to do and what is needed, including carrying fast-acting carbohydrates and glucagon so that these are available when and where needed, such as school, home, gym or sports venue, or office.

Partners and family members need to provide support to PWD, but they also need support themselves; they commonly feel the responsibility to help manage hypoglycemia in the PWD. In a large survey of T1D and T2D family members, respondents said they provided emotional support, helped prevent hypoglycemia, helped treat mild/moderate hypoglycemia, and treated severe hypoglycemia (13). Nearly half (48%) claimed such took up too much energy. Only 20.5% of partners felt they have support from family and friends on these issues and only 12.4% felt support from HCPs.

Peer support from partners, family members and friends is extremely important to overall health and well-being and even more so for the PWD, especially children with T1D (14). Developing resilience in youth with T1D involves promoting protective skills and behaviors, including obtaining support from family and friends. Youth with T1D completing resilience assessments at summer camps scored lowest in their ability to share their diabetes with friends and felt they could not rely on their friends to help with their diabetes if needed (15). This represents a high-risk situation in youth who have frequent episodes of hypoglycemia and severe hypoglycemia. Parents from the same camps concurred that the most important topic they wanted their children to discuss with their friends was recognizing and treating hypoglycemia, yet most said they had not (15).

When to Address HC

When striving to enhance self-efficacy in PWD and their loved ones, healthcare professionals have the opportunity to explore the issue of confidence to manage hypoglycemia.

Job:7933 OTCE Vol 41 No 2(11323)

This can be done periodically by addressing issues directly or referring individuals to appropriate members of the healthcare team to address.

Times to explore and possibly measure HC include:

- At diagnosis. Both PWD and loved ones are overwhelmed at diagnosis, however, T1 PWD or T2 PWD starting insulin are at risk and should be taught how to recognize and treat hypoglycemia.
- When medication dose or timing changes occur, especially if a sulfonylurea or insulin is being introduced, prandial insulin is added, or basal insulin dose is increased. Resistance to medication changes may occur if a PWD has experienced frequent hypoglycemia or has had a severe event that was traumatic for all involved. See "Medication-Related Hypoglycemia: Causes and Treatments "article in this *OTCE* issue for further information about medications that impact hypoglycemia, page 11.
- When glycemic goals have not been achieved in the recommended time frame. Quite often elevated FOH or low HC may result in PWD and loved ones keeping blood glucose levels "running high" to prevent lows.
- When physical activity, food intake, or sleep patterns change. Partners of PWD express they are most concerned about severe hypoglycemia while their loved one is exercising or sleeping. CGM data illustrates that over 40% of nighttime readings are often in the "low range." Clear guidance for adjusting medication and/or food intake to prevent lows at this time is important. Appropriate treatment during an activity such as consuming an appropriate amount of fast-acting carbohydrates and having easy-to-use glucagon available can go a long way to helping everyone feel prepared.

Summary

Hypoglycemic confidence in PWD using insulin and their partners or loved ones is a unique and important dimension of the hypoglycemia experience worthy of evaluation and intervention. All diabetes team members can bring the topic up with a simple question and, if warranted, consider using validated HC measures that can further direct the conversation. The resulting interventions designed to enhance HC can improve an individual's medication experience and skillset to be prepared to prevent and treat hypoglycemia and severe hypoglycemia. The RDN, as a key member of the diabetes team, frequently has more interaction with the PWD than other team members. The RDN can assume responsibility for identifying issues and concerns about hypoglycemia and help PWD and their loved ones enhance their confidence to feel safe and prepared to master hypoglycemia-related problems.

Permission for reprint has been provided for the two scales mentioned in this article: 1) Hypoglycemic confidence scale, 2) Hypoglycemic confidence scale for partners of adults with type 1 diabetes. (Please see the OTCE addendum folder for these these two confidence scales.)

References

1. Fidler C, Christensen TE, Gillard S. Hypoglycemia: an overview of fear of hypoglycemia, quality-of-life, and impact on costs. *J Med Econ.* 2011;14(5):646-655.
2. Polonsky W, Fisher L, Hessler D, Johnson N. Emotional distress in the partners of type 1 diabetes adults: Worries about hypoglycemia and other key concerns. *Diabetes Technol Ther.* 2016;18(5):292-297.
3. Polonsky W, Fisher L, Hessler D, Edelman S. Investigating hypoglycemic confidence in type 1 and type 2 diabetes. *Diabetes Technol Ther.* 2017;19(2):131-136.
4. Ratzki-Leewing A, Rizi E, Harris S. Family members: The forgotten players in the diabetes care team (The TALK-HYPO Study). *Diabetes Ther.* 2019;10(6):2305-2311. doi:10.1007/s13300-019-00687-y
5. American Diabetes Association. 6. Glycemic Targets: Standards of Medical Care in Diabetes—2020. *Diabetes Care.* 2020;43(suppl 1):S66-S76.
6. Jensen MH, Kjolby M, Hejlesen O, Jakobsen PE, Vestergaard P. Risk of major adverse cardiovascular events, severe hypoglycemia, and all-cause mortality for widely used antihyperglycemic dual and triple therapies for type 2 diabetes management: A cohort study of all Danish users. *Diabetes Care.* 2020;43(6):1209-1218. Doi:10.2337/dc19-2535
7. McCoy RG, Lipska KJ, Van Houten HK, Shah ND. Association of Cumulative Multimorbidity, Glycemic Control, and Medication Use with Hypoglycemia-Related Emergency Department Visits and Hospitalizations Among Adults with Diabetes. *JAMA Netw Open.* 2020;3(1):e1919099. doi:10.1001/jamanetworkopen.2019.19099
8. Foster NC, Beck RW, Miller KM, et al. State of type 1 diabetes management and outcomes from the type 1 diabetes exchange 2016-2018. *Diabetes Technol Ther.* 2019;21(2):66-72.
9. Polonsky WH, Fortmann AL, Johnson KE, Nguyen A, Beebe C. Hypoglycemic confidence in the partners of adults with type 1 diabetes. *Diabetes Technol Ther.* 2020;22(4):249-255.
10. Polonsky WH, Hessler D, Ruedy KJ, Beck RW, DIAMOND Study Group. The impact of continuous glucose monitoring on markers of quality of life in adults with type 1 diabetes: further findings from the DIAMOND randomized clinical trial. *Diabetes Care.* 2017;40(6):736-741.
11. Lind M, Polonsky W, Hirsch IB, et al. Continuous glucose monitoring vs conventional therapy for glycemic control in adults with type 1 diabetes treated with multiple daily insulin injections: the GOLD randomized clinical trial. *JAMA.* 2017;317(4):379-387.
12. Kazemian P, Shebi FM, McCann N, Walensky RP, Wexler DJ. Evaluation of the cascade of diabetes care in the United States, 2005-1016. *JAMA Intern Med.* 2019;179(10):1376-1385. doi:10.1001/jamainternmed.2019.2396
13. LaManna J, Litchman ML, Dickinson JK, et al. Diabetes education impact on hypoglycemia outcomes: A systematic review of evidence and gaps in the literature. *The Diabetes Educator.* 2019;45(4):349-369.
14. Warshaw H, Hodgson L, Heyman M, et al. The role and value of ongoing and peer support in diabetes care and education. *The Diabetes Educator.* 2019;45(6)569-579.
15. Beebe C, Joyce M, Alesia T. Assessing social support in diabetes camp. *Diabetes.* 2019;68 (suppl1):694-P. https://doi.org/10.2337/db19-694-P.

Job:7933 OTCE Vol 41 No 2(11323)

The Uniqueness of Hypoglycemia in Elderly Individuals with Diabetes

Johanna Burani, MS, RDN, CDCES
Nutrition Works
Wayne, NJ

Abstract

Age-related changes in the mind and body may place elderly people living with diabetes at greater risk for hypoglycemia. Neurological, hormonal, and physiological changes, as well as cognitive and psychomotor decline, multiple comorbidities, polypharmacy, and poor nutrition are distinct risk factors for hypoglycemia in the elderly. The Registered Dietitian Nutritionist (RDN) must recognize the unique characteristics of the elderly and focus on hypoglycemia awareness and prevention education. The RDN must also adapt standardized guidelines to meet the individual status and circumstances of each elderly person while providing best care practices for blood glucose (BG) management.

Introduction

The frequency of hypoglycemic events in elderly people with diabetes is believed to be underestimated, unrecognized, and under-reported by both individuals and their health care team. There are several reasons for this: Symptoms of hypoglycemia become non-specific with age and can be mistaken for symptoms of dementia or can go unnoticed by the individual. Older people may forget or be unable to communicate their hypoglycemic symptoms. They may be too frail or too absorbed with multiple comorbidities to report their hypoglycemic episodes. Because hypoglycemic individuals may present with vague symptoms, health professionals may misdiagnose the problem.

Treatment-induced hypoglycemia has been a concern since insulin was first used to address hyperglycemia in 1922 and continues to pose a potential problem for those who use it. Hypoglycemia, however, can also result from other glucose-lowering medications and certain aberrant lifestyle behaviors, such as unintentional fasting or medication errors or overdosing. This is particularly worrisome in the elderly population, who may have been living with diabetes for many years, may have developed hypoglycemia unawareness, may experience a decline in physical and cognitive capabilities, may be depressed, or may be living alone. This article highlights several distinctive characteristics of diabetes phenomena in the elderly and the concerns of healthcare professionals caring for them.

Prevalence of Hypoglycemia in the Elderly Diabetes Population

In 2017, the Centers for Disease Control and Prevention (CDC) ascertained that 19% of adults ≥75 years of age had diabetes (1). A 2011 study showed that 65% of people with type 1 diabetes (T1D) or type 2 diabetes (T2D) (mean age 75 years) experienced ≥1 hypoglycemic events and 69% had ≥1 episodes of nocturnal hypoglycemia lasting approximately 56 minutes, with no recognition by the individuals (2). The National Electronic Injury Surveillance System – Cooperative Adverse Drug Event Surveillance (NEISS-CADES) Project and the National Health Interview Survey (NHIS) reported in 2014 that approximately 100,000 Emergency Department (ED) visits occur annually for insulin-related hypoglycemia. Individuals ≥80 years of age were 2.5 times more likely to present to the ED and 4.9 times more likely to be hospitalized than younger individuals (3). An observational retrospective study (1999-2011) of nearly 34 million Medicare beneficiaries highlighted that hospital admissions for hypoglycemia were greater than for hyperglycemia in older adults (4). Elderly people ≥ 65 years of age accounted for 48% of hypoglycemia hospitalizations in the US in 2011, and the cost per hospitalization for those ≥85 years in 2014 was estimated at $8,401 (5).
These statistics paint a clear picture of the exaggerated prevalence and severity of hypoglycemia in the elderly diabetes population. They also validate the heightened concerns all health professionals should have for these individuals.

Defining and Classifying Hypoglycemia in the Diabetes Population

A widely accepted definition of hypoglycemia in diabetes was published in 2013 by a workgroup of

Job:7933 OTCE Vol 41 No 2(11323)

the American Diabetes Association (ADA) and the Endocrine Society. While concluding that they could not assign one glycemic threshold value to define hypoglycemia because glycemic thresholds for symptomatic hypoglycemia vary under differing metabolic conditions, these experts did offer an "alert value" to be used as a cut-off point to classify hypoglycemia in diabetes. This value was identified as <70 mg/dL (<3.9 mmol/L) (6) which represents the approximate level of plasma glucose concentration at which the counterregulatory hormonal response spontaneously activates.

As expected, the workgroup also did not provide specialized glycemic thresholds for hypoglycemia for elderly individuals. They strongly encouraged consideration of an individual's age, overall health, cognitive and functional statuses, and life expectancy when establishing glycemic targets. For these individuals a reasonable goal could be striving for blood glucose levels that prevent symptoms of hyperglycemia. Their emphasis was on individualized treatment. The workgroup offered standardized classifications of hypoglycemia for general clinical use and recommended, at a minimum, that hypoglycemic events in each of the first three categories should be reported (see Table 1).

Table 1: Classification of Hypoglycemia in Diabetes

Severe hypoglycemia: requiring assistance from another person to take corrective actions to elevate the plasma glucose concentration; measured plasma glucose concentrations may/may not be available.
Documented symptomatic hypoglycemia: <70 mg/dL plasma glucose concentration + typical symptoms of hypoglycemia.
Asymptomatic hypoglycemia: <70 mg/dL plasma glucose concentration without typical symptoms of hypoglycemia.
Probable symptomatic hypoglycemia: no measured plasma glucose concentration (presumed <70 mg/dL) + typical symptoms of hypoglycemia.
Pseudo-hypoglycemia (relative): >70 mg/dL plasma glucose concentration + individual's reporting typical symptoms of hypoglycemia.

Adapted from Seaquist ER, Anderson J, Childs B, et al. Hypoglycemia and Diabetes: A Report of a Workgroup of the American Diabetes Association and The Endocrine Society. *Diabetes Care.* 2013;36(5):1384-1395.

Guidelines For Hypoglycemia in Elderly Individuals With Diabetes

The 2020 Standards of Medical Care in Diabetes published by the ADA provide the following recommendation for hypoglycemia in the elderly: "Hypoglycemia should be avoided in older adults with diabetes. It should be assessed and managed by adjusting glycemic targets and pharmacologic regimens" (7). Guidelines for considering treatment goals for glycemia for older adults with diabetes are illustrated in Table 2. Consensus guidelines draw attention to hypoglycemia prevention and individualized HbA1c targets with less rigid BG mangement as the preferred approach for treating elderly people with diabetes. Meeting the elderly person where his/her learning deficits about hypoglycemia begin, the RDN can effectively address hypoglycemia prevention and management.

Unique Risk Factors Of Hypoglycemia in the Elderly

There are changes in the mind and body that occur with aging that can expose the body to unprecedented risks of hypoglycemia.

Predominance of neurological symptoms. Autonomic symptoms of hypoglycemia (hunger, sweating, shakiness, tachycardia) are less prevalent in the elderly than neuroglycopenic symptoms (dizziness, drowsiness, blurred vision, ataxia, abnormal behavior and speech); which can lead to hypoglylcemia being misdiagnosed as dementia. A good approach to address this reality could be for the RDN to familiarize the individual, caregiver and family members with all signs of hypoglycemia so as to foster a productive conversation with the individual's physician.

Non-specific symptoms. The 2012 Action to Control Cardiovascular Risk in Diabetes (ACCORD) study highlighted nonspecific fatigue or weakness as the most documented symptoms of hypoglycemia by participants with a mean age of 62 years (8). Such vague symptoms can exacerbate misdiagnosis by health professionals. The RDN can investigate and document how frequently the individual feels fatigued or weak.

Impaired awareness of hypoglycemia. In the older body, autonomic symptoms of hypoglycemia occur at a lower glycemic level and cognitive dysfunction occurs at a higher level than in the younger body. This can result in severe hypoglycemia occurring with little warning, a condition known as impaired awareness of hypoglycemia (IAH). Additionally, hypoglycemic episodes

Job:7933 OTCE Vol 41 No 2(11323)

Table 2: Guidelines for Treatment Goals for Glycemia In Older Adults with Diabetes (2020)

Personal characteristics/ health status	Rationale	Reasonable A1C goal‡	Fasting or preprandial glucose	Bedtime glucose
Healthy (few coexisting chronic illnesses, intact cognitive and functional status)	Longer remaining life expectancy	<7.5% (58 mmol/mol)	90–130 mg/dL (5.0–7.2 mmol/L)	90–150 mg/dL (5.0–8.3 mmol/L)
Complex/intermediate (multiple coexisting chronic illnesses or 2+ instrumental ADL impairments or mild-to-moderate cognitive impairment)	Intermediate remaining life expectancy, high treatment burden, hypoglycemia vulnerability, fall risk	<8.0% (64 mmol/mol)	90–150 mg/dL (5.0–8.3 mmol/L)	100–180 mg/dL (5.6–10.0 mmol/L)
Very complex/poor health (LTC or end-stage chronic illnesses or moderate-to-severe cognitive impairment or 2+ ADL dependencies)	Limited remaining life expectancy makes benefit uncertain	<8.5%† (69 mmol/mol)	100–180 mg/dL (5.6–10.0 mmol/L)	110–200 mg/dL (6.1–11.1 mmol/L)

ADL: activities of daily living; LTC: long-term care
Adapted from Older Adults: Standards of Medical Care in Diabetes—2020
American Diabetes Association. *Diabetes Care.* 2020; 43(suppl 1):S152-S162. doi:10.2337/dc20-S012

with vague symptoms may lower the glycemic threshold and decrease the individual's awareness of the onset of severe hypoglycemia. The RDN can play an important role in alerting a individual's caregiver and family members to the symptoms and timely treatment of hypoglycemia. Educating them about hypoglycemia can reduce the risk of hypoglycemia and enhance prevention.

Hormonal changes. Diabetes in the elderly distinguishes itself by metabolic processes that are age specific. For instance, the counterregulatory hormones glucagon and growth hormone are deficient in the elderly body. As a result, the body's most effective defense system against hypoglycemia is impaired. Keeping this in mind, the RDN can review the individual's BG or continuous glucose monitor (CGM) data and subsequently query him/her about low blood sugar symptoms and awareness of symptoms. Documentation should be ongoing.

Table 3: Individuals with Diabetes with PWD

INCREASED	DECREASED
Dependence on others	Quality of life
Risk of frailty, falls and fractures	Mobility
Hospitalizations	Visual Acuity
Risk of vascular disease	Manual dexterity
Risk of dementia	Cognitive function
Risk of fear, anxiety, panic attacks	
Behavioral changes	
Risk of mortality	

Physiological changes. Autonomic warning signs of hypoglycemia (sweating, palpitations, etc.) become weaker with age and thus may hinder the elderly person from taking immediate action to drive up blood glucose levels. Neurological symptoms like dizziness, confusion and visual disturbances appear more pronounced and this may lead to a misdiagnosis of dementia rather than hypoglycemia. The RDN might suggest that the person's caretaker or relevant family members attend medical visits with him/her and discuss the individual's affect in the home setting to ascertain normal/ abnormal behavior.

Cognitive decline. There may be cognitive decline that impedes the elderly person's understanding of what is happening during a hypoglycemic event or what to do about it. Some individuals may be unable to express their feelings or explain their symptoms. As stated above, educating the person and their caretaker and family members about the symptoms and treatment

Job:7933 OTCE Vol 41 No 2(11323)

of hypoglycemia can be an effective preventive measure. For those living alone, safety concerns should be discussed and may prompt a change in living situation.

Psychomotor decline. The elderly may suffer from declining psychomotor skills (dexterity, agility, visual acuity) that are accentuated during hypoglycemia and interfere with corrective actions even if they are aware of their symptoms. The RDN can problem solve potential treatment obstacles by suggesting proactive solutions at the onset of a hypoglycemic episode, like having an appropriate quick-acting carbohydrate source readily available in an obvious and accessible location.

Multiple comorbidities, polypharmacy. Some experts estimate that elderly people living with diabetes also coexist with 8.7 other chronic diseases (9). The most common comorbidities are hypertension, overweight or obesity, hyperlipidemia, chronic kidney, and cardiovascular diseases. According to the American Association of Consultant Pharmacists, seniors take 15-18 prescriptions annually (10). Drug interactions, side effects, and duration of action are elements of relevant diabetes management concerns for the elderly individual and the health care team. The RDN can review a person's current drug prescriptions, question him/her about the dose and timing of each medication, and discuss with the individual's physician any drug interactions that might increase the risk of hypoglycemia. The RDN can also review lab results for implications of renal or hepatic functional decline.

Poor nutrition. Living alone, poor eyesight, poor manual dexterity, depression, cognitive decline, and financial insecurity are some of the factors that contribute to an elderly person's poor diet. It is clear how these circumstances might influence both the quality and quantity of daily consumed calories. Between 2007-2011, nearly half of insulin-related preventable hypoglycemic events that required emergency department visits or hospitalization of older adults were related to inadequate intake, missed meals, or mistakes calculating the carbohydrate content of meals (11). No health care professional is better qualified to address problematic food intake and how it relates to hypoglycemia than an RDN. A brief 24-hour recall and questions about food shopping, cooking, and financial security are just some sources of meaningful nutritional information that an RDN can obtain as indications of hypoglycemic risk.

These metabolic, physiological, and psychosocial changes that occur with aging expose the body to unprecedented risks of hypoglycemia (see Table 3). They warrant attention, prevention, and intervention.

Conclusion

The ADA states that there are 12 million Americans aged ≥65 years with both diagnosed and undiagnosed diabetes (12). The projected prevalence of Americans aged ≥65 years with diabetes will increase from 24% (8 million) in 2020 to 34% (16 million) in 2060 (13). Despite these statistics, there remains a paucity of literature that adroitly addresses the risks and prevention of hypoglycemia in these individuals. It is within the RDN's Scope of Practice to identify and educate all individuals, including the elderly, at risk of hypoglycemia. Education can be the greatest antidote to this underestimated problem and dietitians are particularly well equipped with the practical and clinical knowledge needed to decrease the risks of hypoglycemia.

References

1. Centers for Disease Control and Prevention. Diabetes Atlas Data. US Diabetes Surveillance System, Division of Diabetes Translation. Diabetes Atlas Data. gis.cdc.gov/grasp/diabetes/diabetesatlas.html. Accessed January 27, 2020.
2. Munshi MN, Segal AR, Suhl E, et al. Frequent hypoglycemia among elderly patients with poor glycemic control. *Arch Intern Med.* 2011; 171(4):362-364.
3. Deitelzweig S, Bateman L, Bazzano L, et al. Emergency Department Visits, Hospitalizations Due to Insulin. Hospitalist. 2014;2014(8). https://www.the-hospitalist.org/hospitalist/article/126124/emergency-department-visits-hospitalizations-due-insulin. Accessed January 27, 2020.
4. Lipska KJ, Ross JS, Wang Y, et al. National trends in US hospital admissions for hyperglycemia and hypoglycemia among Medicare beneficiaries, 1999 to 2011. *JAMA Intern Med.* 2014;174(7):1116-1124.
5. Goyal RK, Sura SD, Mehta HB. Direct medical costs of hypoglycemia hospitalizations in the United States. Presented at: ISPOR 20th Annual European Congress, Glasgow, Scotland. 2017. https://www.rtihs.org/sites/default/files/28530%20Goyal%202018%20Direct%20medical%20costs%20of%20hypoglycemia%20hospitalizations%20in%20the%20United%20States.pdf. Accessed January 27, 2020.
6. Seaquist ER, Anderson J, Childs B, et al. Hypoglycemia and diabetes: a report of a workgroup of the American Diabetes Association and the Endocrine Society. *Diab Care.* 2013; 36(5) :1384-1395.
7. American Diabetes Association. 12. Older Adults: Standards of Medical Care in Diabetes – 2020. *Diabetes Care.* 2020;43(suppl 1):S152-S162.
8. Abdelhafiz AH, Rodriquez-Manas L, Morley JE, Sinclair AJ. Hypoglycemia in older people – a less well recognized risk factor for frailty. *Aging Dis.* 2015. 2015;6(2):156-167. doi:10.14336/AD.2014.0330
9. Bayliss EA, Ellis JL, Steiner JF. Barriers to self-management and quality-of-life outcomes in seniors with multimorbidities. *Ann Fam Med.* 2007;5(5):395-402.
10. Brenoff A. The elderly are taking too many pills. Huffpost. 2015. https://www.huffpost.com/entry/elderly-taking-too-many-pills_b_7079060. Accessed January 30, 2020.
11. Geller AI, Shehab N, Lovegrove MC, Kegler SR, Weidenbach KN, Ryan GJ, Budnitz DS. National Estimates of insulin-related hypoglycemia and errors leading to emergency department visits and hospitalizations. *JAMA Internal Medicine.* 2014;174:678-686. DOI: 10.1001/jamainternalmed.2014.136
12. American Diabetes Association. Statistics about diabetes. 2018. https://www.diabetes.org/resources/statistics/statistics-about-diabetes. Accessed February 4, 2020.
13. Bio Medical Central. Population Health Metrics. Table 1 Projection of the future number (in millions) and percent (%) prevalence of US adults with diagnosed diabetes, by age group for selected years 2014-2060. https://pophealthmetrics.biomedcentral.com/articles/10.1186/s12963-018-0166-4/tables/1. Accessed February 4, 2020.

Job:7933 OTCE Vol 41 No 2(11323)

Job:7933 OTCE Vol 41 No 2(11323)

Post-Bariatric Hypoglycemia: The Essential Role of the Registered Dietitian Nutritionist

Amanda Sheehan, NP
Joslin Diabetes Center
Boston, MA

Mary Elizabeth Patti, MD
Joslin Diabetes Center
Harvard Medical School
Boston, MA

Nicole Patience, MS, RD, LDN, CDCES, CEDRD
Joslin Diabetes Center
Boston, MA

Abstract

Hypoglycemia is an increasingly recognized complication following bariatric and other forms of upper gastrointestinal surgery, termed post-bariatric hypoglycemia (PBH). PBH can be severe and disabling for some patients, with frequent neuroglycopenia causing alterations in cognition, as well as potentially seizures, and loss of consciousness. Medical nutrition therapy (MNT) is foundational to treatment of PBH; therefore, the registered dietitian nutritionist (RDN) is an essential member of the multidisciplinary team both at the initial encounter and long-term. The aim of this review is to provide an overview of PBH, with a special focus on nutrition, and the important role of the RDN.

Introduction

Metabolic/bariatric surgery is increasingly recognized as a potent tool for the treatment of obesity and type 2 diabetes (T2D), yielding weight loss but also rapid improvements in glucose metabolism; this often allows discontinuation of diabetes-related and other medications within days after surgery. Despite its metabolic success, an increased incidence of hypoglycemia (termed post-bariatric hypoglycemia, PBH) exists and for a subset of individuals can be severe and debilitating.

While hypoglycemia most commonly occurs following Roux-en-Y gastric bypass (RYGB), it can also occur with other bariatric or upper gastrointestinal surgeries, including sleeve gastrectomy (SG), duodenal switch (DS), Nissen fundoplication (NF), and others.

Etiology of PBH

After upper gastrointestinal surgery profound alterations in glucose metabolism likely to contribute to the pathophysiology of PBH are summarized in Figure 1 (1). It begins with rapid emptying of nutrients out of the stomach into the foregut (2) resulting in rapid absorption of glucose, leading to an early and high glucose peak (2-4). At the same time, secretion of the hormone glucagon-like peptide-1 (GLP1) from the small intestine is increased by as much as tenfold (5), stimulating insulin release (3,6,7). These factors cause an increase in glucose uptake by the tissues, resulting in a rapid drop in plasma glucose levels (2,8-11). Simultaneously counterregulatory hormone release is impaired (12), similar to the impaired counter-regulation observed in patients with diabetes who experience recurrent hypoglycemia (13).

Clinical Characteristics

The clinical characteristics of PBH are described in Table 1. While some may be referred to endocrinology after an episode of severe hypoglycemia requiring assistance or resulting in injury, others may have symptoms for several years without receiving a diagnosis, as symptoms are often nonspecific. Fasting hypoglycemia (upon arising) is not typical of PBH and should prompt evaluation for other causes.

Prevalence of PBH

The precise incidence and prevalence of PBH is unknown. Severe hypoglycemia requiring hospitalization occurs in less than 1% of individuals (14); but estimates suggest symptomatic hypoglycemia occurs in 10-30% of individuals (15-16) after both RYGB and SG, with similar presentation and severity. Due to lack of awareness, as well as differences in diagnostic criteria, PBH is likely under-recognized and underdiagnosed.

Diagnosis

Meticulous history-taking remains a critical first step in the evaluation. Information about hypoglycemic episodes should include the severity (frequency, presence of neuroglycopenia, whether assistance has been required) and timing (relationship to fasting, meals, specific provocative foods, activity, and presence of nocturnal symptoms). Symptomatic

Job:7933 OTCE Vol 41 No 2(11323)

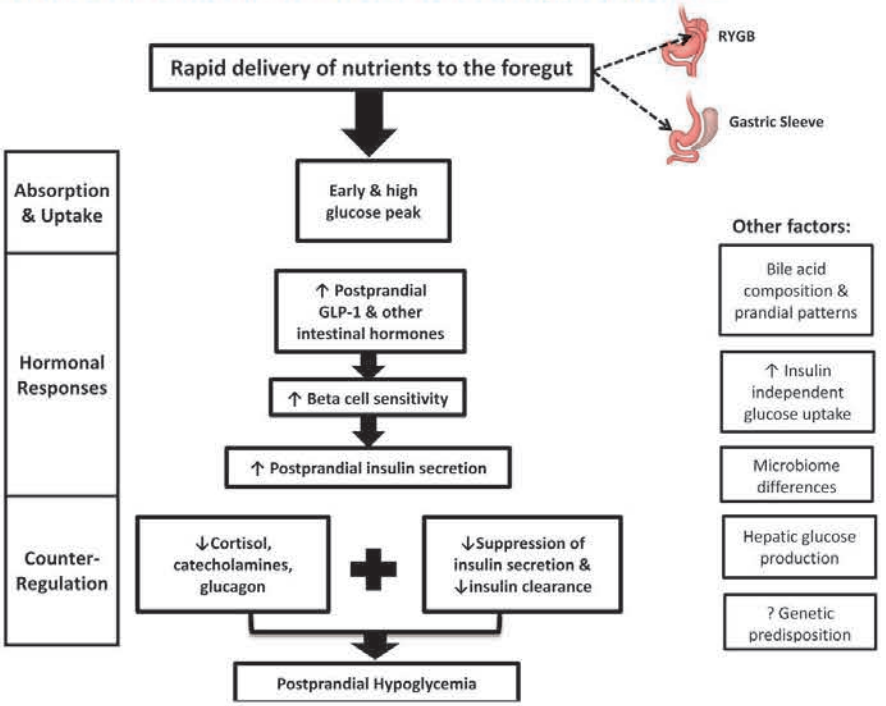
hypoglycemia occurring very early in the postoperative period (less than 6-12 months), in the fasting state, or more than four hours after caloric intake is not typical and should instead raise concern for other causes of hypoglycemia. Differential diagnoses may include malnutrition, side effects of medications or supplements, critical illness, hormone deficiencies (e.g., adrenal), autoimmune hypoglycemia, insulinoma, or non-islet cell tumors (17,18). Analysis of fasting glucose and hormone levels can be helpful to rule out other potential contributing factors.

If the history is typical for PBH, the next step is to determine whether symptoms are caused by hypoglycemia and relieved by carbohydrate ingestion (Whipple's triad) (19). This is an essential element of PBH diagnosis and can help to distinguish from symptoms of dumping syndrome.

Administering a provocative meal and then obtaining lab testing at the time of an episode is rarely required if history is typical. Glucose tolerance test can yield false positive results, is not physiologic and can provoke severe dumping syndrome in this population (17,20). Testing that may provoke severe hypoglycemia should be done in an appropriate setting where rescue treatment is available to ensure safety.

Although not used for diagnostic purposes, a masked professional continuous glucose monitor (CGM) (glucose is not visible to the individual) may be valuable for elucidating glycemic patterns and linking patterns to symptoms (21), while food and activity are recorded by the individual in a diary during CGM wear.

Figure 1. Mechanisms of Post-Bariatric Hypoglycemia[1]



Role of the Registered Dietitian Nutritionist

Medical nutritional therapy (MNT) is both the first step and the foundation of long-term treatment of PBH. As part of a multidisciplinary team, the RDN's expertise begins with an in-depth dietary history, eating behavior assessment, MNT education, and implementation. Over time, ongoing support from the RDN is vital to provide guidance with implementation, adaptation, and individualization of MNT recommendations.

RDN Approach to Assessment History

Detailed history should include assessment of both preoperative and postoperative food intake preferences, eating patterns, daily schedule, gastrointestinal diagnoses, history of disordered eating and fear of potential hypoglycemia, both pre and post diagnosis. This fear can contribute to food avoidance and exacerbate patterns of disordered eating. Information about prior RDN evaluation, approaches, and results can be helpful to assess nutrient needs and nutritional literacy.

Micronutrient Status

Since bariatric surgery may reduce both nutrient intake and absorption, assessment of prior or current micronutrient deficiency is important. The RDN should emphasize consistent and lifelong intake of prescribed vitamins, and ensure that monitoring of levels of vitamins D, A, B1, iron, calcium, zinc, copper, and folic acid is ongoing (22). While a direct link with PBH has not yet been formally established, the association of micronutrient deficiencies (e.g., B1, B12, magnesium, D (23)) and autonomic neuropathy has been reported in the literature (24,25). Compromised autonomic nervous system functioning could impair counterregulatory responses to hypoglycemia. A case report of an individual with type 1 diabetes (T1D) demonstrated correction of a B12 deficiency resulted in increased counter-regulatory hormone

Job:7933 OTCE Vol 41 No 2(11323)

Table 1. Clinical Characteristics of Post-bariatric Hypoglycemia

Risk Factors:	Female sex, no diagnosis of diabetes pre-surgery, and greater excess weight loss postoperatively.[14] Clinically observed (not formally tested): associations with nutritional deficiencies and dysregulation of autonomic control.
Onset:	Typically 1 to 3 years or more after surgery.
Signs and symptoms of hypoglycemia:	Sweating, tremor, profound hunger, palpitations, rapid heartbeat, dizziness. Bizarre dreams or morning headaches may suggest nocturnal hypoglycemia. Family or friends may report mood swings or changes in behavior, that the patient has distant stare or does not "look like themselves." Severe hypoglycemia may cause neuroglycopenia, manifested as difficulty concentrating, confusion, alteration or loss of consciousness, hypoglycemic seizure.
Timing of hypoglycemic events:	1 to 3 hours postprandial or with increased activity (so-called reactive pattern) or in middle of the night (not fasting)
Triggers:	Ingestion of rapidly absorbed, high glycemic index carbohydrates, activity, stress, prior alcohol ingestion, and caffeine. Consumption of liquids with meals can accelerate delivery of nutrients and stimulation of intestinal incretin hormone release, further increasing the risk of hypoglycemia.
Acute "Roller Coaster" Pattern:	Multiple episodes of hypoglycemia per day in response to foods and drinks that cause a spike and then drop,[15] creating a vicious cycle whereby individuals are instinctively self-treating symptoms of hypoglycemia with high glycemic index carbohydrates, causing spike and recurrent hypoglycemia: Usually a chronic condition, severity can fluctuate over time
Chronic Patterns:	Hypoglycemia may still be unpredictable Even with strict adherence to recommendations and pharmacotherapies, unpredictable Severity can fluctuate over time.
Dumping Syndrome (DS) versus PBH:	**Similarities:** - Symptoms of palpitations, lightheadedness, and severe fatigue in both DS and PBH. **Differences:** - 10 to 30 minutes postprandial (DS) vs. 1 to 3 hours post prandial (PBH). - At the time of symptoms, glucose values are typically not low in DS. Note that hypoglycemia which develops later after the meal is sometimes considered a component of "late dumping."

response and improved hypoglycemia awareness (26).

Dietary and Activity Recall

Dietary recall and use of a food log to document timing and quantity of each meal, snack, and all beverages can help define relationships between macronutrient composition or quantity and hypoglycemia, particularly when accompanied by CGM data. Ideally, this would occur at the initial encounter, but may be repeated on follow-up if there are significant changes to the pattern of hypoglycemia.

Additional information obtained during dietary recall includes the quantity of caffeine and alcohol, nighttime eating, and discussion of the person's reasoning for their dietary approach (e.g., attempts to avoid or treat hypoglycemia). Because hypoglycemia can be triggered by activity, specifically in individuals who are consuming less than the recommended amount of carbohydrate, identifying the type (aerobic vs. resistance), duration, and timing is helpful. Questions to ask include: Are snacks needed prior and during to avoid hypoglycemia? For people who are not exercising, is it due to fear of hypoglycemia? The treatment plan for some individuals will include strategies to help them avoid hypoglycemia while enjoying the benefits of exercise.

Job:7933 OTCE Vol 41 No 2(11323)

Possible Patterns of Dietary Intake at Presentation Observed Clinically

While there is a great degree of variability in how individuals attempt to manage hypoglycemia, two patterns seem to emerge: restriction and continuous intake, each with their own rationale and consequence. For example, some individuals severely reduce overall food intake (or carbohydrates specifically) in an attempt to feel better and/or prevent hypoglycemia during critical periods of the day (e.g., work hours). Modified ketogenic plans are often adopted. Unfortunately, we have observed clinically this pattern can result in weight loss, malnutrition, fatigue, activity or exercise-induced hypoglycemia, and in some cases, the emergence of more nocturnal hypoglycemia. Fear of eating, food intolerance or aversion can be an additional challenge to address when providing support during the transition to a nutritionally adequate meal plan.

A second pattern can be the near-continuous intake of either solid or liquid carbohydrates in an effort to avoid or treat the symptoms of hypoglycemia. Consequences of this pattern can include weight gain and repeated cycles of rebound hypoglycemia (initial treatment provoking hyperglycemia and then another episode of hypoglycemia) multiple times per day. Overnight hypoglycemia may follow bedtime or nocturnal eating. Individuals presenting with this pattern may be reluctant to decrease intake of foods or liquids which are perceived to help treat their hypoglycemia. In many cases, avoidance of high glycemic index carbohydrates will actually be effective in breaking this cycle and reducing hypoglycemia.

Table 2. Key Components of MNT (27-30)

Recommendation	Rationale
Choose exclusively low glycemic index (LGI) carbohydrates	Minimize post meal glucose spikes (27)
Frequent small meals and snacks Meals: 20-30 g LGI carbohydrates paired with healthy fat and protein Snacks: 10-15 g LGI carbohydrate paired with fat and protein	Sufficient food and carbohydrate intake to maintain adequate glycogen stores. If carbohydrate intake is insufficient, hypoglycemia may be more severe or prolonged.
Eat protein and fat before the carbohydrate (28) Eat slowly and chew all foods well	Lower insulin response
Avoid carbohydrate-containing liquid (29)	Stimulates excessive insulin secretion
Possibly limit caffeine	Individual trigger
Avoid alcohol	Reduces ability of liver to produce glucose (especially overnight) (30)

RDN Approach to Chronic Treatment

Goals of therapy should include decreasing the frequency and severity of hypoglycemia, helping to avoid injury and disability, and improving quality of life. The individual should be aware that MNT is unlikely to completely eliminate hypoglycemia, that MNT is individualized based on initial response, and even optimal MNT often requires the addition of one or more medications. In some cases, surgical intervention (G tube) or surgical reversal may be indicated.

Key Components of MNT

While food choices are not the cause of hypoglycemia, initial treatment focuses on a meal plan aimed at reducing high glycemic index carbohydrates in an attempt to minimize the initial post-meal glucose "spikes" (27). Table 2 includes recommendations based on practical clinical experience and the limited data from available research studies.

Cornstarch (CS), in uncooked form, has been used for years by individuals with glycogen storage disorders and in children with T1D (31). CS is not readily absorbed by the small intestine, but is slowly hydrolyzed by pancreatic amylase and intestinal glucoamylase to provide a steady supply of exogenous glucose. It can be purchased easily at the grocery store, mixed in unsweetened beverages, plain yogurt or cottage cheese, and can be consumed during the day and/or before bed, depending upon the timing of hypoglycemia. Commercial products that contain uncooked CS (e.g. nutritional bars, drinks) are also available.

Job:7933 OTCE Vol 41 No 2(11323)

Acute Treatment of Hypoglycemia

When symptomatic hypoglycemia develops, oral carbohydrates (10-15 grams), glucose tabs or gel are recommended to relieve symptoms and rapidly increase glucose to safe levels. Some individuals prefer to treat with 10-15 grams carbohydrate from juice or a high glycemic index food. However, if the individual is being treated with acarbose, treatment with glucose exclusively is recommended, as absorption of other forms of carbohydrate (e.g., sucrose) will be delayed. Since oral carbohydrates can produce a glucose "yo-yo" effect, we recommend follow-up with a snack containing low glycemic index carbohydrate mixed with fat/protein, such as 1-2 tablespoons of natural peanut butter on a ½ slice of sprouted-grain bread, to reduce rebound hypoglycemia (1,27).

If severe neuroglycopenia develops (not being able to safely consume oral carbohydrates due to confusion or loss of consciousness), glucagon can be administered by family members via either injection or nasal delivery. Repeat testing of blood glucose is recommended every 15 minutes until the blood glucose level is greater than 80 mg/dL.

Personal CGM

Use of a personal CGM (not masked or blinded) with alarms can be helpful in detection and treatment of dropping glucose levels before neuroglycopenia develops. This is particularly helpful for those with reduced or no awareness of hypoglycemia. Unfortunately obtaining insurance coverage for CGM devices can be difficult, and the out-of-pocket cost is prohibitive for most. While a flash glucose monitor may have a lower out-of-pocket cost, these devices do not have alarms and therefore cannot alert individuals when glucose is falling rapidly or to hypoglycemic levels.

Endocrinologist Prescribed Pharmacotherapy

Pharmacotherapy is utilized as an adjunct to treatment when MNT is insufficient. Acarbose is a first step due to its effect of slowing carbohydrate absorption, thus attenuating the postprandial glucose spike (32-35). Additional strategies aimed at reducing incretin (e.g., GLP1) and insulin responses to meals include diazoxide (reduces insulin secretion) and somatostatin receptor analogues (e.g., octreotide) (36-39).

Surgical Therapy with Feeding Gastrostomy (G-tube) and/or reversal of surgical procedure

When MNT, CGM, and pharmacotherapy are not successful, and quality of life is severely compromised, surgical treatments can be considered. Placement of feeding gastrostomy (G-tube) into the remnant stomach (bypassed portion) can be successful (40-42). Feeds via this route can be bolus, overnight, or continuous, according to individual preference and comfort, and different formulas and rates may need to be trialed to optimize glucose while minimizing discomfort and bloating associated with increasing delivery rates. With this approach, individuals will still develop hypoglycemia if they take carbohydrates by mouth, so oral carbohydrates should be avoided. Carbohydrates given via G-tube are not likely to elicit hypoglycemia. The RDN is essential in the discussion of expectations regarding nutrition, adherence, insurance coverage for supplies and formulas, and the likely utilization of different formulas and delivery rates.

Rare individuals with PBH continue to have mild episodic hypoglycemia despite continuous G-tube feeding. In this setting, reversal of the surgical procedure toward normal anatomy may be considered, when feasible; while this typically improves hypoglycemia, it does not always fully resolve the disorder (42-45).

Safety Considerations-Medical Identification and Driving

It is recommended that all individuals with a history of hypoglycemia obtain medical identification, as it can provide information for emergency medical providers to ensure rapid treatment for hypoglycemia.

Given the changes in cognition and consciousness that can occur with hypoglycemia, it is critical that all individuals with a history of hypoglycemia check their glucose level prior to any activity that could place themselves or others at risk, and treat as needed. Driving in particular is a complex, cognitively demanding activity. Research in individuals with diabetes has shown that hypoglycemia impairs driving performance and safety (46), and individuals may not be cognizant of the degree to which they are compromised. For those with a CGM, the directionality of their glucose trends must also be taken into account, and if glucose levels are falling, treatment to avoid hypoglycemia should occur.

Job:7933 OTCE Vol 41 No 2(11323)

Conclusion

The clinical relevance of severe PBH is undeniable, as a person's safety, nutrition, cognition, and quality of life can be compromised. Individuals with PBH will likely require lifetime support with MNT. Ongoing monitoring for nutritional deficiencies and supplementation should also be anticipated. Development of a sustained therapeutic relationship between the individual and the RDN is vital to aid in improving quality of life and reducing the severity of hypoglycemia. (For more information on "Potential Treatment and Self-Care Challenges Observed Clinically in Individuals with Post-Bariatric Hypoglyemia," please see DDPG website for the handout.)

Disclosure: MEP gratefully acknowledges support from NIH R01 DK121995, R01 DK106193, U01 DK114156, and P30 DK036836 (DRC, Joslin Diabetes Center), and the Chan Zuckerberg Foundation.

MEP has been a coinvestigator on an NIH R44 grant together with Xeris Pharmaceuticals.

References:

1. Salehi M, Vella A, McLaughlin T, Patti ME. Hypoglycemia After Gastric Bypass Surgery: Current Concepts and Controversies. *J Clin Endocrinol Metab.* 2018;103(8):2815-2826.
2. Nguyen NQ, Debreceni TL, Bambrick JE, et al. Rapid gastric and intestinal transit is a major determinant of changes in blood glucose, intestinal hormones, glucose absorption and postprandial symptoms after gastric bypass. *Obesity (Silver Spring).* 2014;22(9):2003-2009.
3. Salehi M, Gastaldelli A, D'Alessio DA. Blockade of glucagon-like peptide 1 receptor corrects postprandial hypoglycemia after gastric bypass. *Gastroenterology*. 2014;146(3):669-680.e2.
4. Dirksen C, Eiken A, Bojsen-Moller KN, et al. No Islet Cell Hyperfunction, but Altered Gut-Islet Regulation and Postprandial Hypoglycemia in Glucose-Tolerant Patients 3 Years After Gastric Bypass Surgery. *Obes Surg.* 2016;26(9):2263-2267.
5. Patti ME, Goldfine AB. Hypoglycemia after gastric bypass: the dark side of GLP-1. *Gastroenterology.* 2014;146(3):605-608.
6. Salehi M, Woods SC, D'Alessio DA. Gastric bypass alters both glucose-dependent and glucose-independent regulation of islet hormone secretion. *Obesity (Silver Spring).* 2015;23(10):2046-2052.
7. Salehi M, Gastaldelli A, D'Alessio DA. Altered islet function and insulin clearance cause hyperinsulinemia in gastric bypass patients with symptoms of postprandial hypoglycemia. *J Clin Endocrinol Metab.* 2014;99(6):2008-2017.
8. Service GJ, Thompson GB, Service FJ, Andrews JC, Collazo-Clavell ML, Lloyd RV. Hyperinsulinemic hypoglycemia with nesidioblastosis after gastric-bypass surgery. *N Engl J Med.* 2005;353(3):249-254.
9. Goldfine AB, Mun EC, Devine E, et al. Patients with neuroglycopenia after gastric bypass surgery have exaggerated incretin and insulin secretory responses to a mixed meal. *J Clin Endocrinol Metab.* 2007;92(12):4678-4685.
10. Patti ME, Li P, Goldfine AB. Insulin response to oral stimuli and glucose effectiveness increased in neuroglycopenia following gastric bypass. *Obesity (Silver Spring).* 2015;23(4):798-807.
11. Jacobsen SH, Bojsen-Møller KN, Dirksen C, et al. Effects of gastric bypass surgery on glucose absorption and metabolism during a mixed meal in glucose-tolerant individuals. *Diabetologia.* 2013;56(10):2250-2254.
12. Abrahamsson N, Börjesson JL, Sundbom M, Wiklund U, Karlsson FA, Eriksson JW. Gastric Bypass Reduces Symptoms and Hormonal Responses in Hypoglycemia. *Diabetes.* 2016;65(9):2667-2675.
13. Martín-Timón I, del Cañizo-Gómez FJ. Mechanisms of hypoglycemia unawareness and implications in diabetic patients. *World J Diabetes.* 2015;6(7):912-926.
14. Marsk R, Jonas E, Rasmussen F, Näslund E. Nationwide cohort study of post-gastric bypass hypoglycaemia including 5,040 patients undergoing surgery for obesity in 1986-2006 in Sweden. *Diabetologia.* 2010;53(11):2307-2311.
15. Goldfine AB, Patti ME. How common is hypoglycemia after gastric bypass? *Obesity (Silver Spring).* 2016;24(6):1210-1211.
16. Belligoli A, Sanna M, Serra R, et al. Incidence and Predictors of Hypoglycemia 1 Year After Laparoscopic Sleeve Gastrectomy. *Obes Surg.* 2017;27(12):3179-3186.
17. Cryer P, Axelrod L, Grossman A, et al. Evaluation and management of adult hypoglycemic disorders: an Endocrine Society Clinical Practice Guideline. *J Clin Endocrinol Metab.* 2009;94(3):709-728.
18. Mulla CM, Storino A, Yee EU, et al. Insulinoma After Bariatric Surgery: Diagnostic Dilemma and Therapeutic Approaches. *Obes Surg.* 2016;26(4):874-881.
19. Whipple AO, Frantz VK. ADENOMA OF ISLET CELLS WITH HYPERINSULINISM: A REVIEW. *Ann Surg.* 1935;101(6):1299-1335.
20. Tack J, Arts J, Caenepeel P, De Wulf D, Bisschops R. Pathophysiology, diagnosis and management of postoperative dumping syndrome. *Nat Rev Gastroenterol Hepatol.* 2009;6(10):583-590.
21. Nielsen JB, Abild CB, Pedersen AM, Pedersen SB, Richelsen B. Continuous Glucose Monitoring After Gastric Bypass to Evaluate the Glucose Variability After a Low-Carbohydrate Diet and to Determine Hypoglycemia. *Obesity Surgery.* 2016;26(9):2111-2118.
22. Lupoli R, Lembo E, Saldalamacchia G, Avola CK, Angrisani L, Capaldo B. Bariatric surgery and long-term nutritional issues. *World J Diabetes.* 2017;8(11):464-474.
23. Wadhwania R. Is Vitamin D Deficiency Implicated in Autonomic Dysfunction? J *Pediatr Neurosci.* 2017;12(2):119-123.
24. Lonsdale D. Dysautonomia, A Heuristic Approach to a Revised Model for Etiology of Disease. *Evid Based Complement Alternat Med.* 2009;6(1):3-10.
25. Briani C, Dalla Torre C, Citton V, et al. Cobalamin Deficiency: Clinical Picture and Radiological Findings. *Nutrients.* 2013;5(11):4521-4539.
26. Fujita S, Kozawa J, Ishibashi C, et al. An Impaired Awareness of Hypoglycemia Improved After Vitamin B 12 Treatment in a Type 1 Diabetic Patient. *Internal Medicine.* 2017;56(11):1383-1385.
27. Suhl E, Anderson-Haynes SE, Mulla C, Patti ME. Medical nutrition therapy for post-bariatric hypoglycemia: practical insights. *Surg Obes Relat Dis.* 2017;13(5):888-896.
28. Tricò D, Filice E, Trifirò S, Natali A. Manipulating the sequence of food ingestion improves glycemic control in type 2 diabetic patients under free-living conditions. *Nutr Diabetes.* 2016;6(8):e226.
29. van Beek AP, Emous M, Laville M, Tack J. Dumping Syndrome After Esophageal, Gastric or Bariatric Surgery: Pathophysiology, Diagnosis, and Management. *Obes Rev.* 2017;18(1):68-85.
30. Krebs HA, Freedland RA, Hems R, Stubbs M. Inhibition of hepatic gluconeogenesis by ethanol. *Biochem J.* 1969;112(1):117-124.
31. Gremse DA, Bucuvalas JC, Balistreri WF. Efficacy of cornstarch therapy in type III glycogen-storage disease. *Am J Clin Nutr.* 1990;52(4):671-674.
32. Frankhouser SY, Ahmad AN, Perilli GA, Quintana BJ, Vengrove MA. Post-gastric-bypass hypoglycemia successfully treated with alpha-glucosidase inhibitor therapy. *Endocr Pract.* 2013;19(3):511-514.
33. Moreira RO, Moreira RB, Machado NAM, Gonçalves TB, Coutinho WF. Post-prandial hypoglycemia after bariatric surgery: pharmacological treatment with verapamil and acarbose. *Obes Surg.* 2008;18(12):1618-1621.
34. Valderas JP, Ahuad J, Rubio L, Escalona M, Pollak F, Maiz A. Acarbose improves hypoglycaemia following gastric bypass surgery without increasing glucagon-like peptide 1 levels. *Obes Surg.* 2012;22(4):582-586.
35. Imhof A, Schneemann M, Schaffner A, Brändle M. Reactive hypoglycaemia due to late dumping syndrome: successful treatment with acarbose. *Swiss Med Wkly.* 2001;131(5-6):81-83.
36. Spanakis E, Gragnoli C. Successful medical management of status post-Roux-en-Y-gastric-bypass hyperinsulinemic hypoglycemia. *Obes Surg.* 2009;19(9):1333-1334.

Job:7933 OTCE Vol 41 No 2(11323)

37. Gonzalez-Gonzalez A, Delgado M, Fraga-Fuentes MD. Use of diazoxide in management of severe postprandial hypoglycemia in patient after Roux-en-Y gastric bypass. *Surg Obes Relat Dis.* 2013;9(1):e18-19.
38. Myint KS, Greenfield JR, Farooqi IS, Henning E, Holst JJ, Finer N. Prolonged successful therapy for hyperinsulinaemic hypoglycaemia after gastric bypass: the pathophysiological role of GLP1 and its response to a somatostatin analogue. *Eur J Endocrinol.* 2012;166(5):951-955.
39. Mohammadi A, Sulaiman RA, Grossman AB. Pasireotide and octreotide in the treatment of severe late dumping syndrome. *Clin Case Rep.* 2017;5(10):1608-1611.
40. McLaughlin T, Peck M, Holst J, Deacon C. Reversible hyperinsulinemic hypoglycemia after gastric bypass: a consequence of altered nutrient delivery. *J Clin Endocrinol Metab.* 2010;95(4):1851-1855.
41. Craig CM, Lamendola C, Holst JJ, Deacon CF, McLaughlin TL. The Use of Gastrostomy Tube for the Long-Term Remission of Hyperinsulinemic Hypoglycemia After Roux-en-y Gastric Bypass: A Case Report. *ACCR: AACE Clinical Case Reports.* 2015;1(2):e84-e87.
42. Davis DB, Khoraki J, Ziemelis M, Sirinvaravong S, Han JY, Campos GM. Roux en Y gastric bypass hypoglycemia resolves with gastric feeding or reversal: Confirming a non-pancreatic etiology. *Mol Metab.* 2018;9:15-27.
43. Arora I, Patti ME. Can reversal of RYGB also reverse hypoglycemia? *Mol Metab.* 2018;9:1-3.
44. Lee CJ, Brown T, Magnuson TH, Egan JM, Carlson O, Elahi D. Hormonal response to a mixed-meal challenge after reversal of gastric bypass for hypoglycemia. *J Clin Endocrinol Metab.* 2013;98(7):E1208-1212.
45. Qvigstad E, Gulseth HL, Risstad H, et al. A novel technique of Roux-en-Y gastric bypass reversal for postprandial hyperinsulinemic hypoglycaemia: A case report. *Int J Surg Case Rep.* 2016;21:91-94.
46. Ahmed AA. Hypoglycemia and safe driving. *Ann Saudi Med.* 2010;30(6):464-467.

The Endocrine Society's Efforts to Reduce the Burden of Hypoglycemia: An Interview with Drs. Lash and Boord Conducted by Hope Warshaw MMSc, RD, CDCES, BC-ADM

Introduction

The Endocrine Society (the Society) has, since 2015, been implementing efforts to reduce the incidence of hypoglycemia in the U.S. This effort, referred to as the Hypoglycemia Prevention Initiative, is being conducted in collaboration with Avalere Health, a national health care advisory firm, based in Washington DC. A major focus of the initiative is a multiyear quality improvement project, the HypoPrevent Study, designed to test interventions to improve early identification and management of hypoglycemia in older adults (>65 years) with type 2 diabetes (T2D) at high risk.

I have served on the steering committee of the HypoPrevent Study since 2015 on behalf of the Association of Diabetes Care & Education Specialist (formerly AADE) and have represented the perspectives of diabetes care and education specialists and people with diabetes (1). In this role I have had the pleasure of working with Dr. Jeffrey Boord, chair of this steering committee, and Dr. Rob Lash, chief professional and clinical affairs officer of the Endocrine Society (read brief bios at end of article). They graciously responded to the following questions so Diabetes Dietetic Practice Group members could become aware of this initiative and determine how, within your practice setting(s), you can help people with diabetes at risk of hypoglycemia to better prevent and manage it.

Q1: *Can you provide an overview of the overarching goal(s) of the Hypoglycemia Prevention Initiative and various aspects of the project?*

Dr. Lash: Hypoglycemia, an adverse drug event (ADE) related to insulin and sulfonylurea use, has been identified as one of the top three preventable ADEs by the US Department of Health and Human Services, and is the single largest barrier to optimal glycemic control (2). The Society's work to lower the incidence of hypoglycemia started with a series of roundtables, followed by the establishment of the Hypoglycemia Quality Collaborative (HQC). The HQC was formed in 2016 with 18 organizations and the work culminated in the release of the *Hypoglycemia Quality Collaborative Strategic Blueprint: Report and Strategic Recommendations* (3), which identified six domains that could be pursued by the diabetes community to reduce the incidence of hypoglycemic events. Of these domains, the people with diabetes at-risk and identifying effective resources for health care providers

Job:7933 OTCE Vol 41 No 2(11323)

and their patients to prevent hypoglycemia. This has led to the development of the *Hypoglycemia Prevention Initiative* that aims to accomplish three primary goals: 1) increase outpatient hypoglycemia surveillance and risk assessment; 2) improve management of people who take insulin and sulfonylureas through patient and provider education; and 3) align provider reimbursement to promote best practices. To reach these goals, we are testing risk assessment and provider and patient education through HypoPrevent, a quality improvement study.

Q2: *What was the rationale for focusing this effort on adults with T2D?*

Dr. Lash: It was our belief that people with type 1 diabetes (T1D) were more likely to receive education and reinforcement on managing hypoglycemia. Hypoglycemia is something they think about, and have to deal with, on a day to day basis. For people with T2D, hypoglycemia is often more insidious, and people with T2D may not even recognize that a specific symptom (like sweating) could be due to a low blood glucose. Most people, including me, are surprised to learn that the incidence of hypoglycemia among people with T2D who take insulin is, on average, **23 mild or moderate events** and **1 severe episode** per year (4). The combination of a large population of people at risk for a potentially serious complication started us thinking about ways that we could better understand and address this problem.

Q3: *Can you provide an overview of the HypoPrevent Study including the study design?*

Dr. Boord: HypoPrevent is a quality improvement study that tests whether application of risk assessment and shared decision-making tools in a primary care setting can reduce the number of people at risk for hypoglycemia. As mentioned above, we are looking at the impact in people with T2D who are over the age of 65, have an HbA1c of <7%, and take insulin and/or sulfonylureas. We felt it was essential to focus on the primary care setting, where the great majority of T2D care is delivered. The people with diabetes enrolled have a baseline visit with their provider, which includes a shared decision-making conversation, and may result in a change in HbA1c goal and/or medication. The person then has two follow-up visits during the study to review their progress toward reaching their new HbA1c goal and whether there has been a reduction in the number of hypoglycemic events.

Q4: *When and where is the HypoPrevent Study being conducted?*

Dr. Boord: Our study site is Pottstown Medical Specialists, Inc (PMSI), in Pottstown, PA. Their 15 primary care providers over five sites began recruiting people with diabetes for the study in July 2019. We expect the study will conclude in second quarter of 2020, followed by an in-depth analysis of the data.

Q5: *When will the results and learnings from the HypoPrevent Study be available and when will they be published? How will they be filtered down to primary care providers and others, like Registered Dietitian Nutritionists (RDNs), who counsel people with diabetes?*

Dr. Boord: We anticipate that the results of the study will be published in early 2021, with presentation of the findings at multiple meetings, including The Endocrine Society meeting in 2021. We expect to share the results with primary care providers, RDNs, and others through presentations, publications, webinars, and articles in trade publications. All tools and resources from HypoPrevent will be made available on www.endocrine.org/hypoglycemia-prevention-initiative.

Q6: *Why was it necessary for leading diabetes organizations to develop new definitions for the various levels of hypoglycemia? (5)*

Dr. Lash: There are two important reasons to define the different levels of hypoglycemia. The first is that you can't really study something until you define it. It sounds almost too simple, but it's of fundamental importance when you're designing studies and interventions. The second reason is that not all hypoglycemia is the same. Someone who gets a little shaky if they go shopping at the mall with a glucose level of 65 mg/dL is very different from someone who passes out while driving and has a glucose level of 26 mg/dL. Defining hypoglycemia by severity and symptoms helps clinicians identify the different needs of different groups of patients.

Job:7933 OTCE Vol 41 No 2(11323)

Q7: *Tell us about the development of the hypoglycemia quality measure set (6) and how the Society envisions its utilization?*

Dr Lash: Through the environmental scan (6) that we conducted prior to developing HypoPrevent, we found that no outpatient hypoglycemia quality measures existed. We believe that if providers want to reduce their at-risk population, they need measures to track their progress. A technical expert panel developed three quality measures on risk assessment, patient education, and patient-reported hypoglycemic events. The hypoglycemia measure set was recently published (6). We will be releasing an implementation guide to provide the specifications for any providers that wish to integrate these into their practice.

Q8: *What are your recommendations for how RDNs can work with primary care providers and assist adults with T2D to better prepare, to prevent, and/or manage hypoglycemia? (7)*

Dr. Lash: RDNs can be critical to helping their people prevent and manage hypoglycemia. On the prevention side, RDNs can help people better understand the connections between food intake, physical activity, and medication action. Skipping a meal, rapidly transitioning to a low carbohydrate eating plan, and/or deciding to finally start Zumba classes, can lead to an increased risk for hypoglycemia. RDNs are uniquely qualified to ask the right questions and give the right advice. For treatment, RDNs can help people better recognize the symptoms of hypoglycemia, symptoms that might just seem like "having a bad day" to many people. Similarly, RDNs can also help people and their caregivers, loved ones or others in their lives, develop strategies to treat hypoglycemia.

Bios of Drs. Lash and Boord:
Robert Lash, MD, is an endocrinologist and serves as the Chief Professional and Clinical Affairs Officer at the Endocrine Society in Washington, DC. He has been involved with Hypoglycemia Prevention Initiative since 2017 and has worked with its steering committee and Avalere to design and implement the HypoPrevent study.
Jeffrey Boord, MD, MPH, is a practicing adult endocrinologist and Chief Quality and Safety Officer of Parkview Health System in Northeast Indiana. His professional career has focused on patient safety, developing innovative care delivery systems for persons with diabetes, and quality improvement in healthcare.

References:

1. Association of Diabetes Care & Education Specialists. ADCES and Diabetes Care and Education Specialists' Engagement with Endocrine Society's Efforts to Reduce Incidences of Hypoglycemia https://www.diabeteseducator.org/news/perspectives/aade-blog-details/adces-perspectives-on-diabetes-care/2020/02/11/adces-and-diabetes-care-and-education-specialists-engagement-with-endocrine-society-s-efforts-to-reduce-incidences-of-hypoglycemia. Accessed April 20, 2020.
2. US Department of Health and Human Services, Office of Disease Prevention and Health Promotion (2014). National Action Plan for Adverse Drug Event Prevention. Washington, DC.
3. Endocrine Society. Hypoglycemia quality collaborative strategic blueprint: Report and strategic recommendations. (2016). https://endocrinenews.endocrine.org/wp-content/uploads/HQC_Strategic_Blueprint_VIEW.pdf. Accessed April 20, 2020.
4. Edridge CL, Dunkley AJ, Bodicoat DH, Rose TC, Gray LJ, Davies MJ, Khunti K. Prevalence and incidence of hypoglycaemia in 532,542 people with type 2 diabetes on oral therapies and insulin: a systematic review and meta-analysis of population based studies. *PLoS ONE.* 2015;10(6):e0126427.
5. Agiostratidou G, Anhalt H, Ball D, et al. Standardizing clinically meaningful outcome measures beyond HbA1C for type 1 diabetes: a consensus report of the American Association of Clinical Endocrinologists, the American Association of Diabetes Educators, the American Diabetes Association, the Endocrine Society, JDRF International, The Leona M. and Harry B. Helmsley Charitable Trust, the Pediatric Endocrine Society, and the T1D Exchange. *Diabetes Care.* 2017;40:1622–1630.
6. Lash RW, Lucas DO, Illes J. Preventing hypoglycemia in type 2 diabetes. *J Clin Endo & Metab.* 2018;103(4):1265–1268.
7. Warshaw HS. Game Changing Meds for Severe Hypoglycemia. Today's Dietitian. (Nov/Dec, 2019) http://viewer.zmags.com/publication/ad74dd2b#/ad74dd2b/25. Accessed April 20, 2020.

Job:7933 OTCE Vol 41 No 2(11323)

After reading this issue of *On The Cutting Edge*, current DDPG members can earn 4.0 hours of **free** continuing education units (CPEUs level 2) approved by the Commission on Dietetic Registration (CDR). Free CPE eligibility is based on active DDPG membership status and publication date. Non-DDPG members can purchase CPE for $24 (Academy members) or $54 (non-members).

Users must complete the post-test of the CPEs page and Critical Thinking Tool in the Academy's Learning Management System (LMS) by 9/31/2023. For each question, select the one best response. The LMS can be accessed through the DDPG website: http://www.dce.org/resources/cpeus or the eatrightStore: https://www.eatrightstore.org/dpg-products/diabetes. DDPG members will receive the articles for $0 in the Store. After passing the quiz, to view/print your certificate or access your CPEU credit history, go to: https://eatrightcpe.org

Please record 4.0 hours on your Learning Activities log and retain the certificate of completion in the event you are audited by CDR. The certificate of completion is valid when the CPE self-assessment questionnaire is successfully completed, submitted, and recorded by DDPG/Academy of Nutrition and Dietetics. *OTCE* is considered Pre-Approved Self-Study.

4 CPEUs are awarded for reading this issue and successfully completing the quiz. Access quiz and certificate by going on to www.dce.org professional resources. The website automatically logs your CPEU history.

CPE Credit Self-Assessment Questionnaire

1. Which population is the Endocrine Society's Hypoglycemia Prevention Initiative focused?
   a) T2D > 65 years on insulin and sulfonylureas
   b) All patients on insulin therapy
   c) Patients with hypoglycemia unawareness
   d) T1D with HbA1c <6.6%

2. Which of the following is associated with increased risk of severe hypoglycemia?
   a) Patients with HbA1c < 7% and >9%
   b) Duration of diabetes
   c) T2D on MDI
   d) T1D on insulin pumps

3. When kids with T1D and parents were asked about involving their friends in assisting with hypoglycemia
   a) Felt they could depend on their friends
   b) Felt they couldn't rely on their friends to assist
   c) Confidence increased if nasal glucagon was available
   d) Parents accurately perceived their kid's ability to discuss hypoglycemia with friends

4. Which of the following would be the best question to ask when exploring FOH (fear of hypoglycemia)?
   a) "What is your HbA1c goal?"
   b) "Tell me about your pump settings?"
   c) "How do you deal with anxiety?"
   d) "Do you have concerns about being alone?"

5. When compared to dumping syndrome, which of the following is a distinguishing feature of post-bariatric hypoglycemia (PBH)?
   a) Palpitations
   b) Fatigue
   c) Post prandial elevations occurring 1-3 hours after eating
   d) BG is normal in presence of symptoms

6. BGAT is a program
   a) aimed to improve awareness of low blood glucose levels only
   b) aimed to improve awareness high blood glucose levels only
   c) aimed to improve awareness of both high and low blood glucose
   a) that educates people with type 2 diabetes only

7. HARPdoc curriculum's primary focus is
   a) treating hypo/hyper glycemia
   b) treating hypoglycemia
   c) the behaviors influencing hypoglycemia treatment
   d) general diabetes education and support

8. The most common non-specific symptom(s) of hypoglycemia documented in the 2012 Action to Control Cardiovascular Risk in Diabetes study were
   a) Ataxia and nervousness
   b) Blurred vision
   c) Fatigue and weakness
   d) Changes in speech

9. Hormonal changes that contribute to the increased risk for hypoglycemia in elderly include
   a) Increased glucagon and growth hormones
   b) Decreased in glucagon and growth hormones
   c) Hormonal changes are not related
   d) Decreased thyroxine and anti-diuretic hormones

10. If hypoglycemia develops while a person is driving they should safely get off the road, treat, and wait up to _____ before driving.
    a) 60 minutes
    b) 30 minutes
    c) 45 minutes
    d) 15 minutes

Job:7933 OTCE Vol 41 No 2(11323)

Diabetes
a dietetic practice group of the
Academy of Nutrition and Dietetics
Experts in Diabetes Care and Education

PRESORT STANDARD
U.S. POSTAGE
PAID
CLEVELAND, OH
PERMIT NO. 2280

PRINTED ON RECYCLED PAPER

LETTERS TO
The Editor

Have you ever wanted to ask an *OTCE* author a question after reading an article? Did you ever disagree with an author? Or maybe you just wanted to comment on something you read. The Letters to the Editor column is a forum to ask questions or comment about any of the *OTCE* articles that interest you. Please send your questions or comments to the *OTCE* editor at the following address:

Patricia Davidson, DCN, RDN, LDN, FAND, CDCES
OTCE Editor
otceeditor@gmail.com

Let us hear from you!

Job:7933 OTCE Vol 41 No 2(11323)