MSL PROGRAM

Diabetes and Nutrition Management: Challenges and Opportunities

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Disclosures

- The content of this program has met the continuing education criteria of being evidence-based, fair and balanced, and non-promotional
- Funding from non-CPE revenue for CPE planning, development, review, and/or presentation has been provided by Colegio De Farmaceuticos De Puerto Rico
- I am an employee within Medical Affairs & Research at Abbott's Nutrition Division
- All the relevant financial relationships listed for the speaker have been mitigated

Learning Objectives

- Identify diabetes-related nutritional needs and gaps in diabetes care
- Discuss relevant guidelines for the nutrition care of patients with diabetes
- Evaluate evidence to support nutritional therapies and technologies in the inpatient and outpatient setting for diabetes management

Pathophysiology of Diabetes Mellitus (DM)

CHARACTERISTICS OF TYPE 1 DIABETES (T1DM)

- Genetic predisposition & environmental factors play a role[1]
- Autoimmune disease characterized by the destruction of the beta-cells of the pancreas, resulting in a **loss of insulin production**[1]
  - T cells play a role in the destruction due to an abnormal activation of cellular immunity
- Glucose fails to enter cells & accumulates in the blood[2]

CHARACTERISTICS OF TYPE 2 DIABETES (T2DM)

- Individuals exhibit **insulin resistance, beta-cell dysregulation**, and a disrupted feedback loop between beta-cells and insulin-sensitive tissues[3]
- Genetics and the environment also play a role in the development of T2DM[3]
  - Environmental factors such as increased caloric intake, decreased energy expenditure, and nutrition composition of the diet may impact beta-cell responsiveness[3]
  - Body adiposity genes and their interaction with environmental factors affect insulin resistance[3]
- The microbiome may also play a role in the development of T2DM[3]

1. Wang Z, et al. *Clin Rev Allergy Immunol*. 2017;52(2):273-286.
2. Guthrie RA, Guthrie DW. *Crit Care Nurs Q*. 2004;27(2):113-125.
3. Kahn SE, et al. *Lancet*. 2014;383(9922):1068-1083.

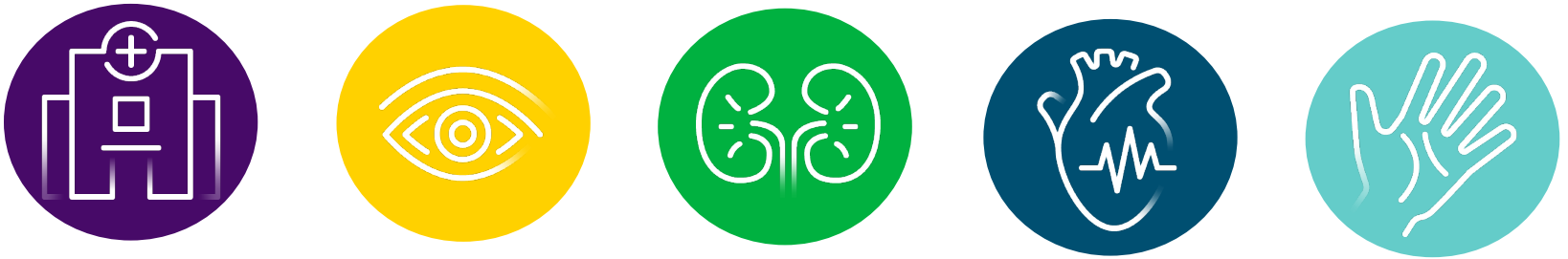
The Prevalence of Diabetes and the Relevant Cost in Patient Care in the United States

- **38.4 million (11.6%) of the U.S. population have diabetes[1]**
  - Of those, 8.7 million (22.6%) are undiagnosed
  - 90-95% of all diagnosed diabetes is T2DM
- The total cost of diagnosed diabetes was estimated at **$413 billion** in 2022[1]
  - $307 billion for direct medical costs
  - $106 billion for reduced productivity
- The prevalence of diabetes is upwards of **37% in individuals with obesity** whereas the prevalence of diabetes is **5.6% in individuals of normal weight[2]**

1. Centers for Disease Control and Prevention. National Diabetes Statistics Report. https://www.cdc.gov/diabetes/php/data-research/?CDC_AAref_Val=https://www.cdc.gov/diabetes/data/statistics-report/index.html; Accessed July 23, 2024.
2. Wang L, et al. *JAMA*. 2021;326(8):1-13.

Coexisting Conditions and Complications of Diabetes

Hospitalizations	Retinopathy	Nephropathy	Cardiovascular Disease	Neuropathy



Among patients with diabetes, the most recent CDC data reported 160,000 lower extremity amputations among hospital discharges in 2020

CDC: Centers for Disease Control and Prevention

Centers for Disease Control and Prevention. National Diabetes Statistics Report. https://www.cdc.gov/diabetes/php/data-research/?CDC_AAref_Val=https://www.cdc.gov/diabetes/data/statistics-report/index.html; Accessed July 23, 2024.

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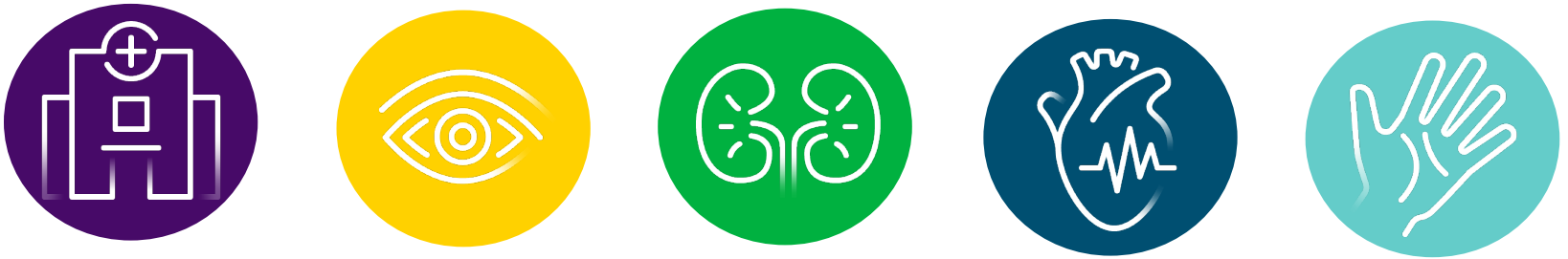
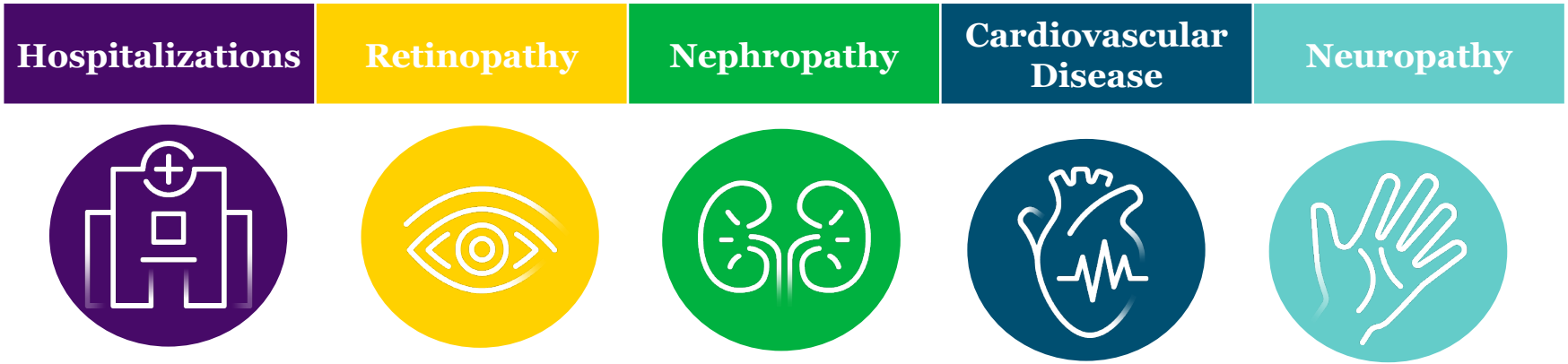


"Diabetes is the leading cause of new cases of blindness among adults aged 18-64 years"

Centers for Disease Control and Prevention. National Diabetes Statistics Report. https://www.cdc.gov/diabetes/php/data-research/?CDC_AAref_Val=https://www.cdc.gov/diabetes/data/statistics-report/index.html; Accessed July 23, 2024.

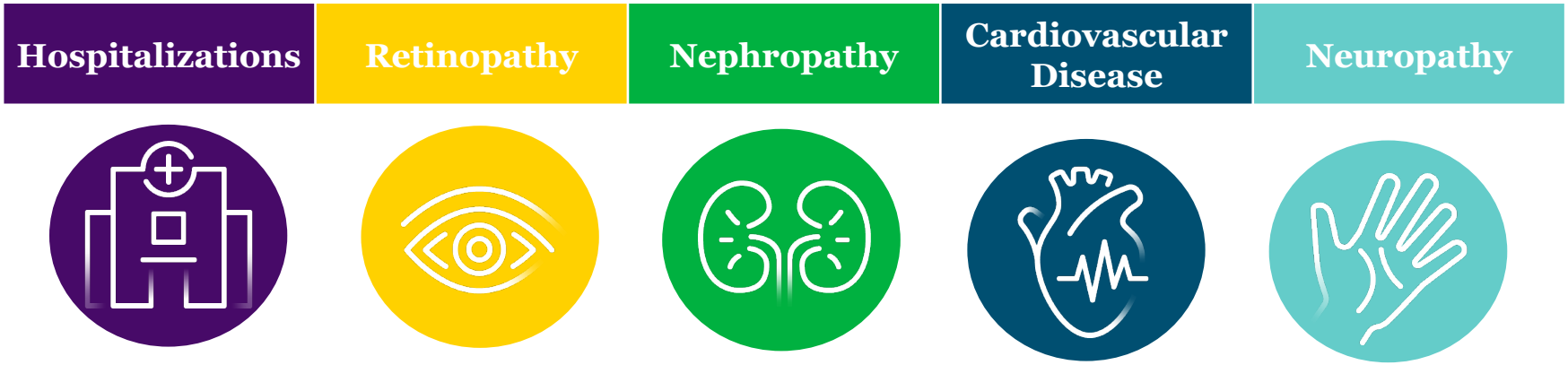
Coexisting Conditions and Complications of Diabetes



"Among US adults with diabetes, 39.2% had chronic kidney disease (stages 1-4), of which 15.7% had moderate to severe chronic kidney disease (stage 3 or 4)"

Centers for Disease Control and Prevention. National Diabetes Statistics Report. https://www.cdc.gov/diabetes/php/data-research/?CDC_AAref_Val=https://www.cdc.gov/diabetes/data/statistics-report/index.html; Accessed July 23, 2024.

Coexisting Conditions and Complications of Diabetes



Cardiovascular disease (including ischemic heart disease and stroke) is the leading cause of hospitalization in patients with diabetes

Centers for Disease Control and Prevention. National Diabetes Statistics Report. https://www.cdc.gov/diabetes/php/data-research/?CDC_AAref_Val=https://www.cdc.gov/diabetes/data/statistics-report/index.html; Accessed July 23, 2024.

Coexisting Conditions and Complications of Diabetes

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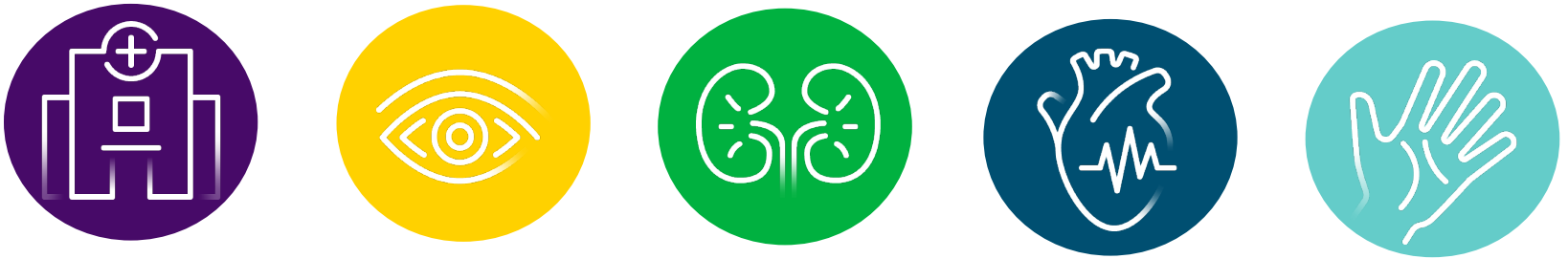


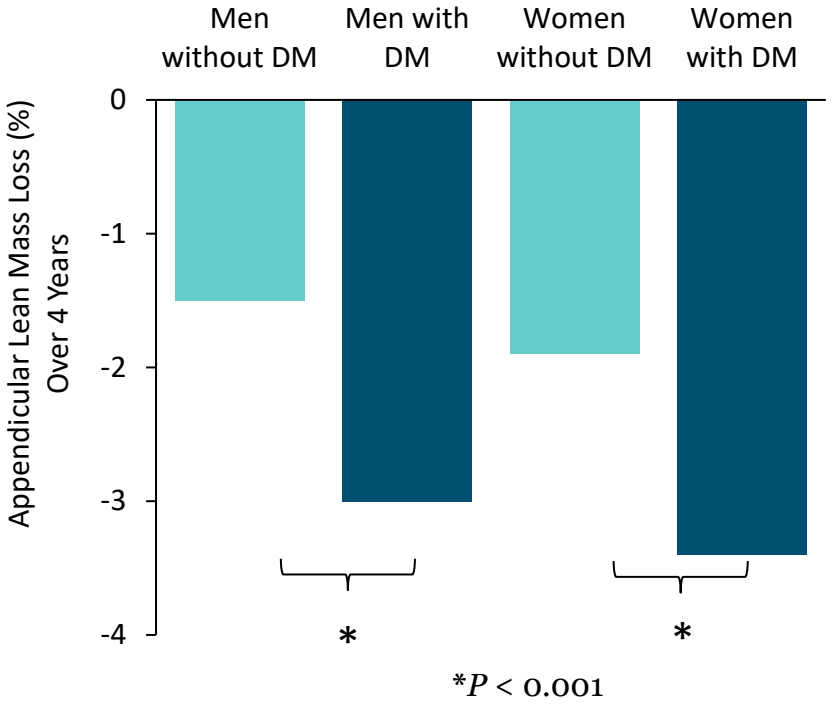
Nerve damage is one of the most common diabetes complications that can result in numbness or pain

Centers for Disease Control and Prevention. National Diabetes Statistics Report. https://www.cdc.gov/diabetes/php/data-research/?CDC_AAref_Val=https://www.cdc.gov/diabetes/data/statistics-report/index.html; Accessed July 23, 2024.

Older Individuals with Diabetes Have Greater Loss of Lean Body Mass Over Time

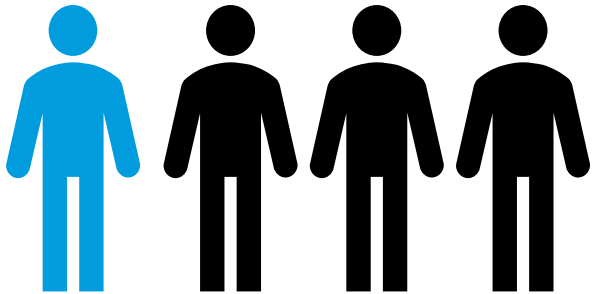
IN A STUDY OF 3,553 ADULTS (≥65 YRS OLD):

- Men with diabetes had significantly higher BMIs and body fat % than men without diabetes at baseline ($P < .001$)
  - No difference was seen between these subgroups in women ($P = 0.104$, $P = 0.629$ for BMI and total body fat mass [kg], respectively)
- Men and women with diabetes experienced accelerated lean body mass loss over 4 years



BMI: Body Mass Index
DM: Diabetes Mellitus
Lee JSW, et al. *Diabetic Med*. 2010;27(12):1366-1371.

Persistent Gaps Exist in the Diabetes Care Cascade



Less than 1 in 4 adults met the combined glycemic, blood pressure, cholesterol, and nonsmoking target goals

- **Diabetes treatment goals*** included the following factors:
  - A1C levels between 7.0% and 8.5%
  - Blood pressure of <140/90 mmHg
  - LDL level treatment targets <100 mg/dL
  - Smoking cessation
- Adults who received diabetes care, compared to adults not linked or diagnosed had better:
  - LDL cholesterol level control <100 mg/dL:
    57% (95% CI: 51%-62%) vs 30% (95%CI: 21%-39%)
  - Achievement of composite goals (22% vs 15%)
- Disparities in care exist among groups
  - Non-Hispanic black vs. non-Hispanic white had lower odds of achieving composite target (aOR, 0.57; 95% CI, 0.39-0.83)
  - Having health insurance was the strongest predictor of diabetes care (aOR, 3.96; 95% CI, 2.34-6.69)

A1C: Glycated Hemoglobin
LDL: Low-Density Lipoprotein
aOR: Adjusted Odds Ratio
*Diabetes treatment goals in this study were based on the 2018 American Diabetes Guidelines

Kazemian P, et al. *JAMA Intern Med.* 2019;179(10):1376–1385.

Factors Associated with a Greater Risk of Diabetes-Related Complications

- Overweight and obesity
- Physical inactivity
- High cholesterol
- Smoking
- Elevated A1C
- High blood pressure

Centers for Disease Control and Prevention. National Diabetes Statistics Report. https://www.cdc.gov/diabetes/php/data-research/?CDC_AAref_Val=https://www.cdc.gov/diabetes/data/statistics-report/index.html; Accessed July 23, 2024.

Factors Associated with the Prevention of Diabetes-Related Complications

Having an HCP to provide diabetes care

Physical activity

Weight management

Statin treatment

Meeting ABCs criteria

- ***A1C*** <7.0%
- ***B***lood pressure <140/90mmHg
- ***C***holesterol - Non-HDL cholesterol <130mg/dL
- Nonsmoker

Non-HDL is the total cholesterol minus your HDL. It includes LDL and other types of cholesterol

HCP: Healthcare Provider

ABC: A1C, Blood Pressure, Cholesterol

Centers for Disease Control and Prevention. National Diabetes Statistics Report. https://www.cdc.gov/diabetes/php/data-research/?CDC_AAref_Val=https://www.cdc.gov/diabetes/data/statistics-report/index.html; Accessed July 23, 2024.

National Library of Medicine. Cholesterol Levels: What You Need to Know. https://medlineplus.gov/cholesterollevelswhatyouneedtoknow.html. Accessed July 23, 2024.

Diabetes Care Management Strategies Target Various Pathways

Lifestyle management

- DSMES
- MNT
- Assessment of psychosocial/emotional health concerns

Pharmacologic therapy

- Therapies to influence cardiovascular and kidney disease risk factors
- Weight management

Diabetes education and medical specialists

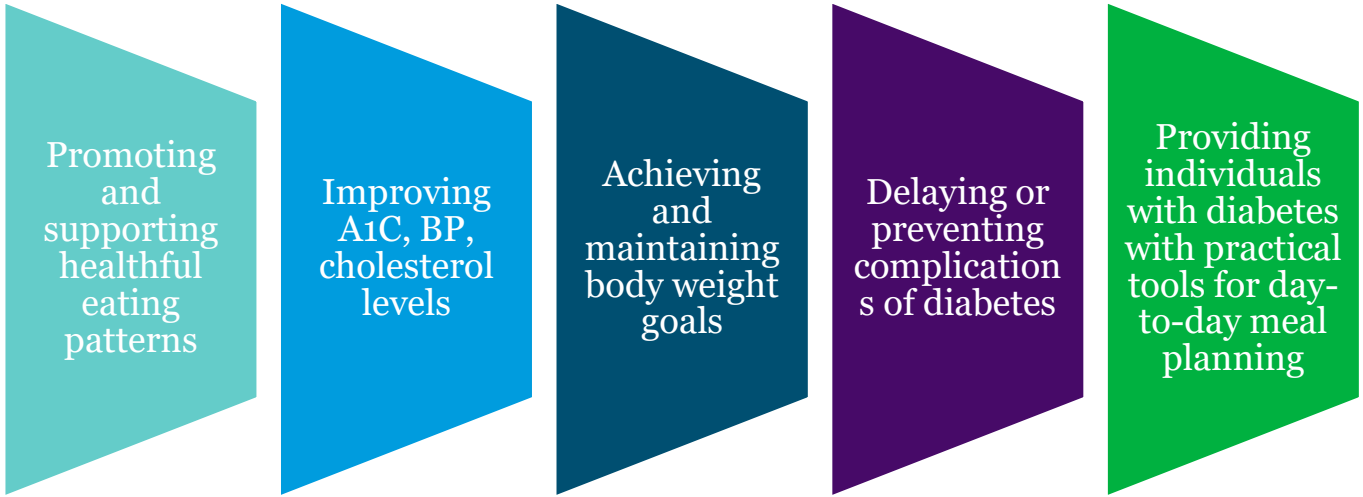
Use of glucose monitoring and insulin delivery devices

DSMES: Diabetes Self-Management Education and Support
MNT: Medical Nutrition Therapy
CVD: Cardiovascular Disease

American Diabetes Association. *Diabetes Care*. 2024;47(Suppl 1):S52-S67.
Rines AK, et al. *Nat Rev Drug Discov*. 2016;15(11):786-804.

Diabetes Care Management Strategies Target Various Pathways

- A consensus report highlighted that the use of diabetes-focused MNT be provided to patients with goals of:



BP: Blood Pressure

Evert AB, et al. *Diabetes Care*. 2019;42(5):731-754.

Hormones and Nutrients Involved in Influencing Diabetes Progression

Hormones Involved in the Development of Diabetes

Islet α and β-cells: produce glucagon and insulin

Insulin

- Promotes glucose uptake into cells[1]
- Reduces circulating blood glucose levels[1]

Glucagon

- During fasted conditions, stimulates hepatic glucose production[2]

GLP-1

- Stimulates glucose uptake in adipose/muscle[3]
- Has been shown to impact postprandial and fasting glucose and A1C[4,5]

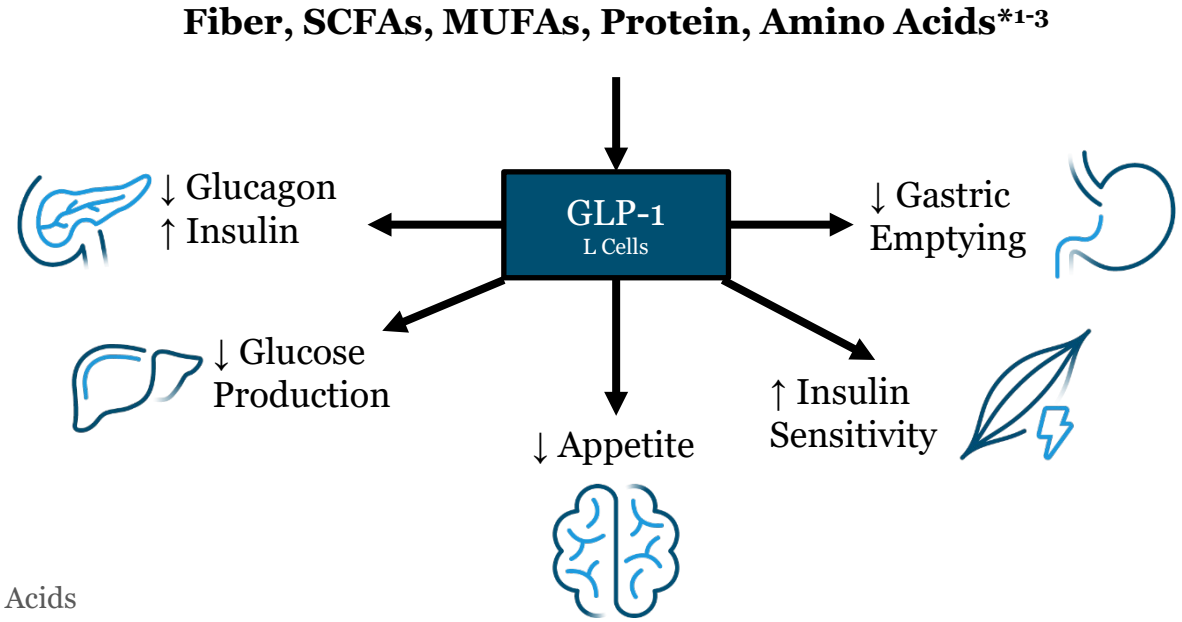
GIP

- Stimulates glucagon secretion from islet alpha-cells[6]
- Its effect may be muted relative to GLP-1 in persons with T2DM[6-8]

GLP-1: Glucagon-Like Peptide 1
GIP: Glucose-Dependent Insulinotropic Polypeptide

1. Khan AH, Pessin JE. *Diabetologia* 2002;45(11):1475-1483.
2. Aronoff SL, et al. *Diabetes Spectr*. 2004;17(3):183-190.
3. Baggio LL, Drucker DJ. *Gastroenterology*. 2007;132(6):2131-2157.
4. Mansour A, et al. *Nutrition*. 2013;29(6):813-820.
5. Peters A. *Am J Med*. 2010;123(3 Suppl):S28-S37.
6. El K, et al. *Sci Adv*. 2021;7(11):eabf1948.
7. Mentis N, et al. *Diabetes*. 2011;60(4):1270-1276.
8. Grespan E, et al. *Metabolism*. 2021;114:154415.

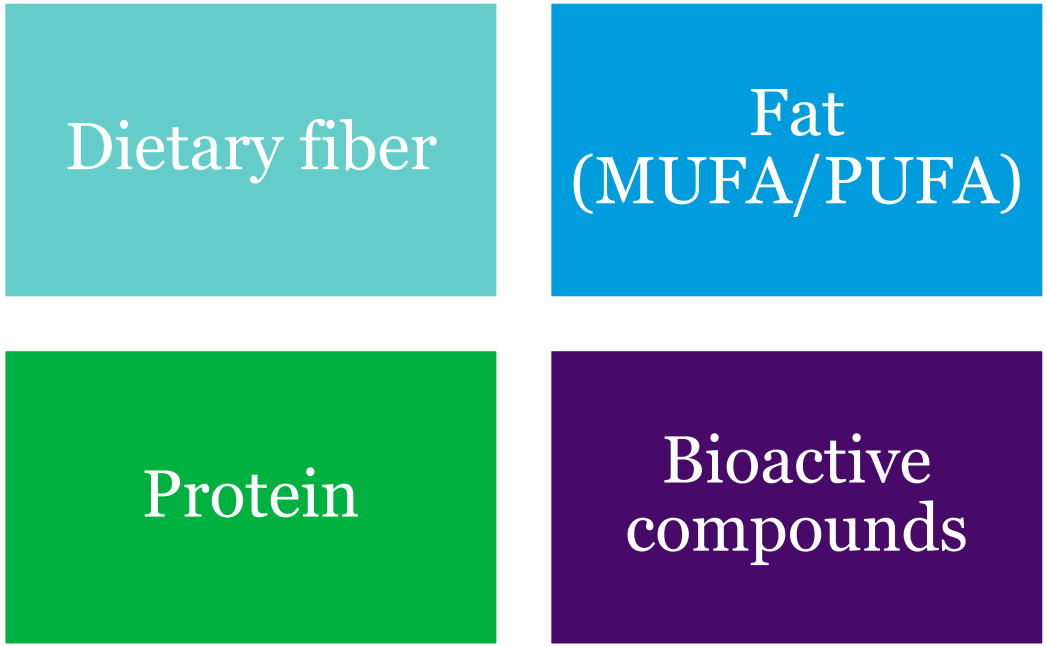
Nutrients Influence Various Nutritional Pathways Involved in Diabetes Progression



SCFA: Short-Chain Fatty Acids
MUFA: Monounsaturated Fatty Acids
*Image adapted from: Drucker DJ. *Nat Clin Pract Endoc*. 2005;1(1):22-31 and Bodnaruc AM, et al. *Nutrition & Metab*. 2016;13(1):92.

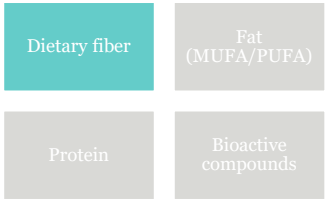
1. Drucker DJ. *Nat Clin Pract Endoc*. 2005;1(1):22-31.
2. Bodnaruc AM, et al. *Nutrition & Metab*. 2016;13(1):92.
3. Mansour A, et al. *Nutrition*. 2013;29(6):813-820.

Nutrients Matter: Dietary Factors Influencing the Progression and Treatment of Diabetes



PUFA: Polyunsaturated Fatty Acids

Most Common Fiber Types in Clinical Nutrition & Classification of Fiber Based on Physicochemical Characteristics



SOLUBLE

- Acacia gum
- PHGG
- Insulin (nonviscous)
- Pectin
- Oat fiber
- FOS (nonviscous)

INSOLUBLE

- Cellulose (nonviscous)
- Resistant starch
- Hemicellulose B

FERMENTABLE

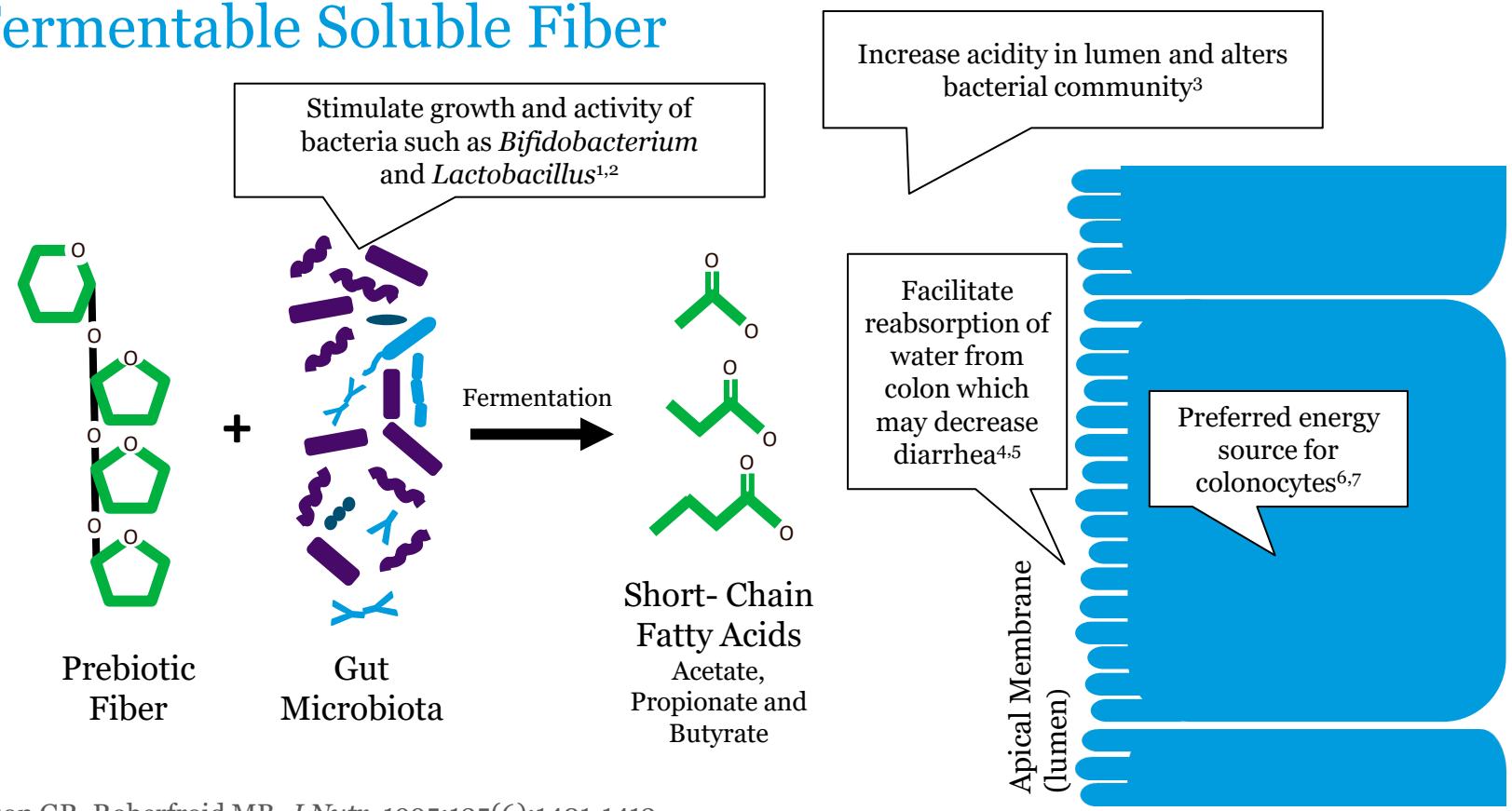
- Insulin
- FOS
- Resistant starch
- Pectin (viscous)

NONFERMENTABLE

- Cellulose
- Outer pea fiber

PHGG: Partially Hydrolyzed Guar Gum
FOS: Fructooligosaccharides
Klosterbuer A, et al. *Nutr Clin Pract*. 2011;26(5):625-635.

Fermentable Soluble Fiber



1. Gibson GR, Roberfroid MB. *J Nutr*. 1995;125(6):1401-1412.
2. Round JL, Mazmanian SK. *Nat Rev Immunol*. 2009;9(5):313-323.
3. Gibson GR. *Br J Nutr*. 1998; 80(4):S209-S212.
4. Meier R, Gassull MA. *Clin Nutr Suppl*. 2004;1:73-80.
5. Bowling TE, et al. *Lancet*. 1993; 342(8882):1266-12688.
6. Roberfroid M. Crit *Rev Food Sci Nutr*. 1993;33(2):103-148.
7. Scheppach W. *Gut*. 1994;35(1 Suppl):S35-8.

Nutrients Matter: Dietary Factors Influencing the Progression and Treatment of Diabetes

Dietary fiber

Insoluble fiber may reduce insulin resistance[1,2]

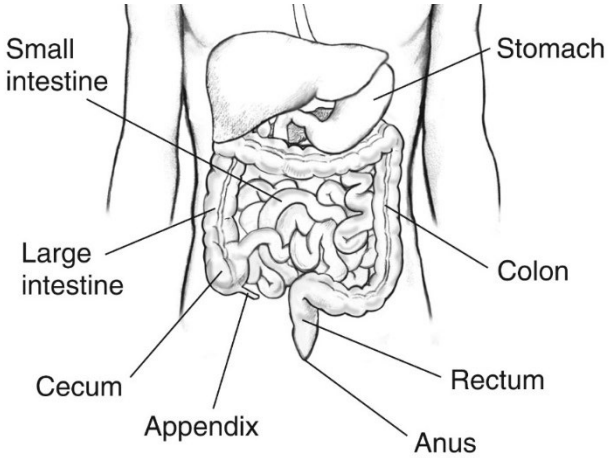
Influence on GLP-1[3] and improvement of A1C[3,4]

A high fiber diet promotes production of SCFAs[4]

1. Evert AB, et al. *Diabetes Care*. 2019;42(5):731-754.
2. Weickert MO, Pfeiffer AFH. *J Nutr*. 2018;148(1):7-12.
3. Bodinham CL, et al. *Endocr Connect*. 2014;3(2):75-84.
4. Zhao L, et al. *Science*. 2018;359(6380):1151-1156.

Potential Influences of SCFAs on the Gut

- **The most abundant SCFAs include butyrate, acetate, and propionate**
- **Evidence from *in vitro* and *in vivo* models suggest SCFAs may:**
  - Stimulate epithelial cell proliferation and differentiation in the intestinal tract[1]
  - Increase blood flow to the gut[2]
  - Improve motility[2]
  - Enhance absorption of electrolytes and minerals such as calcium and iron[2-4]
  - Have anti-inflammatory properties[5,6]
  - Aid maintenance of intestinal barrier integrity[6]
  - Influence satiety[7]



1. Blottiere HM, et al. *Proc Nutr Soc*. 2003;62(1):101-106.
2. Tazoe H, et al. *J Physiol Pharmacol*. 2008;59 Suppl 2:251-262.
3. Trinidad TP, et al. *Am J Clin Nutr*. 1996;63(4):574-578.
4. Bouglé D, et al. *Scand J Gastroenterol*. 2002;37(9):1008-1011.
5. Segain JP, et al. *Gut*. 2000;47(3):397-403.
6. Lewis K, et al. *Inflamm Bowel Dis*. 2010;16:1138-1148.
7. Ruijschop RMAJ, et al. *Int Dairy J*. 2008;18(9):945-950.

Nutrients Matter: Dietary Factors Influencing the Progression and Treatment of Diabetes

Fat (MUFA/ PUFA)

May influence beta-cell proliferation[1]

Potential influence on GLP-1 secretion[2,3]

Omega-3 fatty acids may have protective effects on diabetes parameters such as reducing fasting BG and insulin resistance[4]

1. Maedler K, et al. *Diabetes*. 2001;50(1):69-76.
2. Mansour A, et al. *Nutrition*. 2013;29(6):813-820.
3. Hauge M, et al. *Mol Metab*. 2014;4(1):3-14.
4. Delpino FM, et al. *Crit Rev Food Sci Nutr*. 2022;62(16):4435-4448.

Nutrients Matter: Dietary Factors Influencing the Progression and Treatment of Diabetes

Dietary fiber | Fat (MUFA/PUFA) | **Protein** | Bioactive compounds

Protein

High protein diets had no effect on FPG and A1C but **may lower LDL, TC, TG, and HOMA-IR**[1]

- This suggests improvement in insulin resistance and lipid metabolism

Protein stimulates GLP-1 and influences insulin secretion[2,3]

- Whey protein sources may slow gastric emptying and may suppress appetite[4]

Protein or lipid preload ingested **before** a carbohydrate source improves glucose tolerance[5]

1. Yu Z, et al. *Clin Nutr*. 2020;39(6):1724-1734.
2. Jakubowicz D, Froy O. *J Nutr Biochem*. 2013;24(1):1-5.
3. Sridonpai P, et al. *J Nutr Sci*. 2021;10:e49.
4. Nouri M, et al. *Diabetes Metab Syndr*. 2022;16(7):102540.
5. Tricò D, et al. *Diabetologia*. 2015;58(11):2503-2512.

FBG: Fasting Blood Glucose
TC: Total Cholesterol
TG: Triglycerides
HOMA-IR: Homeostatic Model Assessment for Insulin Resistance

Nutrients Matter: Dietary Factors Influencing the Progression and Treatment of Diabetes

Bioactive Compounds

Certain phytochemicals may influence glucose transporters to increase glucose influx in cells[1]

Bioactive peptides may inhibit enzymes involved in digesting carbohydrates[2]

1. Zhao C, et al. *Crit Rev Food Sci Nutr*. 2019;59(6):830-847.
2. Patil P, et al. *Eur J Nutr*. 2015;54(6):863-880.

Nutrition Therapy for Patients with Diabetes

Nutrition Therapy Provides an Impact in Various Ways

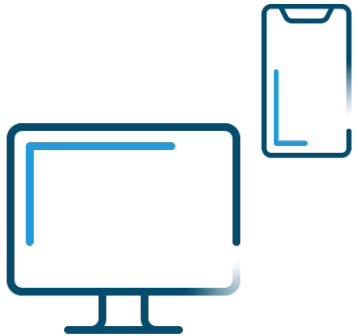
- **MNT has been associated with up to 2% decreases in A1C in T2DM and up to 1.9% in T1DM at 3-6 months[1]**
- Diet may play a role in reducing the production of advanced glycation end products (AGEs) and reducing inflammation markers and oxidative stress markers in patients with T2DM[2,3]
- Weight loss can lead to an improvement in insulin sensitivity[4]

1. Evert AB, et al. *Diabetes Care*. 2019;42(5):731-754.
2. Uribarri J, et al. *Diabetes Care*. 2011;34(7):1610-1616.
3. Luévano-Contreras C, et al. *J Clin Biochem Nutr*. 2013;52(1):22-26.
4. Kelley DE, et al. *J Clin Endocrinol Metab*. 1993;77(5):1287-1293.

Diabetes Self-Management Education and Support (DSMES) is Recommended to Influence Behavior Change

"Strongly encourage all people with diabetes to participate in **diabetes self-management education** and support (DSMES) to facilitate informed decision-making, self-care behaviors, problem-solving, and active collaboration with the health care team."

(Recommendation 5.1, Grade level: A)



"Consider offering DSMES via **telehealth and/or digital interventions** to address barriers to access and improve satisfaction."

(Recommendation 5.5, Grade level: B)

American Diabetes Association. *Diabetes Care*. 2024;47(Suppl 1):S77-S110.

2020 Consensus Report Highlights the Importance of DSMES and MNT

Characteristics of DSMES

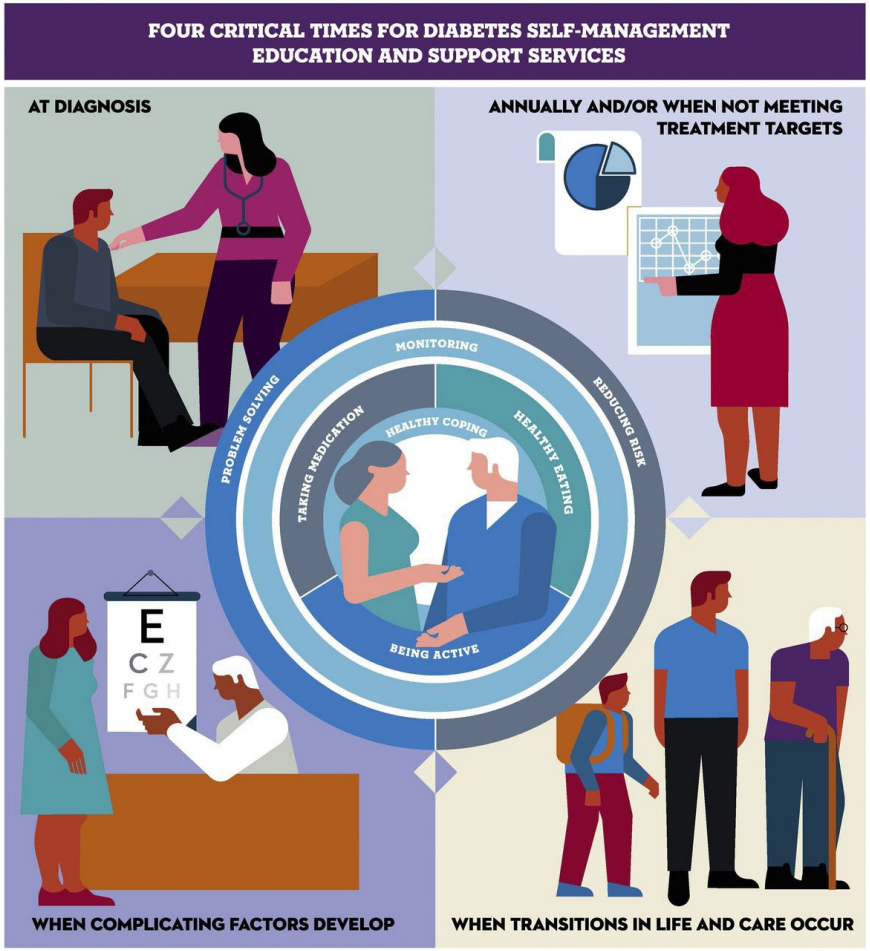
- Formal series of didactic classes
- Technology-based services
- Family and peer support

Characteristics of MNT for reducing A1C by 0.5-2% for T2DM

- 3-6 encounters during the first 6 months of diagnosis
- Follow-ups based on needs
- Focus areas reflecting topics of purchasing food, preparing meals

Consensus recommendation:
"Providers should ensure coordination of the medical nutrition therapy plan with the overall management strategy, including the DSMES plan, medications, and physical activity on an ongoing basis"

Powers MA, et al. *Diabetes Care*. 2020;43(7):1636-1649.



Powers MA, et al. *Diabetes Care*. 2020;43(7):1636-1649.

MNT Recommendations from the *Standards of Medical Care in Diabetes – 2024* and ADA 2019 Consensus Report

- In prediabetes, the weight loss goal is **5-7%** for all individuals to prevent progression to T2DM[1,2]
- In T2DM, 5% weight loss is recommended to achieve benefit but the goal for an optimal outcome is **15% or more** when needed and can be feasibly and safely accomplished[1]
- For all patients affected by overweight or obesity, lifestyle modifications to achieve and maintain a **minimum weight loss of 5%** is recommended for all patients with diabetes and prediabetes[1,2]

Consensus Statements:[1]

"… the evidence does not identify one eating plan that is clearly superior to others"

"Individualized eating plans should support calorie reduction (e.g., employing use of appropriate portion sizes, meal replacements, and/or behavioral interventions) in the context of a lifestyle program…"

1. Evert AB, et al. *Diabetes Care*. 2019;42(5):731-754.
2. American Diabetes Association. *Diabetes Care*. 2024;47(Suppl 1):S77-S110.

MNT Recommendations from the *Standards of Care – 2024*

8.12 "When short-term nutrition intervention using structured, very-low-calorie meals (800–1,000 kcal/day) is considered, it should be prescribed to carefully selected individuals by trained practitioners in medical settings with close monitoring. Long-term, comprehensive weight maintenance strategies and counseling should be integrated to maintain weight loss" (Grade level: B)[1]

16.14 "A structured discharge plan should be tailored to the individual with diabetes" (Grade level: B)[2]

1. American Diabetes Association. *Diabetes Care*. 2024;47(Suppl 1):S145-S157.
2. American Diabetes Association. *Diabetes Care*. 2024;47(Suppl 1):S295-S306.

Personalized Meal Plans Can Aid in Weight Loss with Patients with Diabetes

- "Studies have demonstrated that a variety of eating plans, varying in macronutrient composition, can be used effectively and safely in the short term (1-2 years) to achieve weight loss in people with diabetes"
  - "These plans include structured low-calorie meal plans with meal replacements, a Mediterranean eating pattern, and low-carbohydrate meal plans with additional support"

American Diabetes Association. *Diabetes Care*. 2024;47(Suppl 1):S77-S110.

MNT in the Hospital Setting

2024 Standards of Medical Care in Diabetes: MNT in the Hospitals

- The goals of nutrition therapy for all people with diabetes: “To promote and support healthful eating patterns, emphasizing a variety of nutrient-dense foods in appropriate portion sizes, to improve overall health and:
  - achieve and maintain body weight goals
  - attain individualized glycemic, blood pressure, and lipid goals
  - delay or prevent the complications of diabetes”

- “Regardless of the amount of carbohydrate in the meal plan, focus should be placed on high-quality, nutrient-dense carbohydrate sources that are high in fiber and minimally processed.”

American Diabetes Association. *Diabetes Care*. 2024;47(Suppl 1):S77-S110.

Blood Glucose Management in Hospitalized Patients

ASPEN/SCCM Recommendation:[1]

- Target blood glucose range: "We recommend a target blood glucose range of **140 or 150–180 mg/dL** for the general ICU population; ranges for specific patient populations (post cardiovascular surgery, head trauma) may differ and are beyond the scope of this guideline" (Quality of evidence: Moderate)

American Diabetes Association Clinical Practice Recommendations:[2]

- **16.4** "Insulin and/or other therapies should be initiated or intensified for treatment of persistent hyperglycemia starting at a **threshold of ≥180 mg/dL (≥10.0 mmol/L) (confirmed on two occasions within 24 h)** for noncritically ill (non-ICU) individuals." (Grade level: A)

- **16.5b** "**More stringent glycemic goals, such as 110–140 mg/dL (6.1–7.8 mmol/L),** may be appropriate for selected critically ill individuals and are acceptable if they can be achieved without significant hypoglycemia." (Grade level: B)

ASPEN: American Society for Parenteral and Enteral Nutrition
SCCM: Society of Critical Care Medicine

1. McClave, SA et al. *JPEN J Parenter Enteral Nutr*. 2016;40(2):159-211.
2. American Diabetes Association. Diabetes Care. 2024;47(Suppl 1):S295-S306.

Blood Glucose Management in Surgical Patients: Perioperative Care

American Diabetes Association Clinical Practice Recommendations*	
1	A preoperative risk assessment should be performed for people with diabetes who are at high risk for ischemic heart disease and those with autonomic neuropathy or renal failure
2	The A1C goal for elective surgeries should be <8% (<63.9 mmol/L) whenever possible
3	The blood glucose goal in the perioperative period should be 100–180 mg/dL (5.6–10.0 mmol/L) within 4 h of the surgery. CGM should not be used alone for glucose monitoring during surgery
4	Metformin should be held on the day of surgery
5	SGLT2 inhibitors should be discontinued 3–4 days before surgery
6	Hold other oral glucose-lowering agents the morning of surgery or procedure and give one-half of NPH dose or 75–80% doses of long-acting analog insulin or adjust insulin pump basal rates based on the type of diabetes and clinical judgment

*Based on expert consensus (ungraded)
SGLT2: Sodium-Glucose Cotransporter-2
CGM: Continuous Glucose Monitor
NPH: Neutral Protamine Hagedorn
American Diabetes Association. *Diabetes Care*. 2024;47(Suppl 1):S295-S306.

Blood Glucose Management in Surgical Patients: Perioperative Care

American Diabetes Association Clinical Practice Recommendations*	
7	Monitor blood glucose at least every 2–4 h while the individual takes nothing by mouth and dose with short- or rapid-acting insulin as needed
8	There are **little data on the safe use and/or influence of GLP-1 receptor agonists** on glycemia and delayed gastric emptying **in the perioperative period**
9	Stricter perioperative glycemic goals are not advised, as perioperative glycemic goals stricter than 80–180 mg/dL (4.4–10.0 mmol/L) may not improve outcomes and are associated with more hypoglycemia
10	Compared with usual dosing, a reduction by 25% of basal insulin given the evening before surgery is more likely to achieve perioperative blood glucose goals with a lower risk for hypoglycemia
11	In individuals undergoing noncardiac general surgery, basal insulin plus premeal short- or rapid-acting insulin (basal-bolus) coverage has been associated with improved glycemic outcomes and lower rates of perioperative complications compared with the reactive, correction-only short- or rapid-acting insulin coverage alone with no basal insulin dosing

*Based on expert consensus (ungraded)

American Diabetes Association. *Diabetes Care*. 2024;47(Suppl 1):S295-S306.

Recommendations from the ESPEN Expert Group Endorse Use of DSF for Nutritional Support of Patients with Obesity and Diabetes

The ESPEN expert group emphasize the unique properties of diabetes-specific formulas (DSF) such as:

- Lower carbohydrate content than standard formulas
- Higher proportion of complex carbohydrates that are slowly digestible to reduce blood glucose spikes
- Modified maltodextrin, starch, fructose, isomaltulose, and sucromalt, rather than the maltodextrin, starch, and sucrose found in standard formulas
- Fat content enriched in unsaturated fatty acids, especially monounsaturated fatty acids, in higher proportion than in standard formulas
- Fiber content higher than in standard formulas

"Based on the available evidence, the ESPEN expert group endorses the utilization of DSFs for nutritional support of people with obesity and diabetes"

ESPEN: European Society for Parenteral and Enteral Nutrition
Barazzoni R, et al. *Clin Nutr*. 2017;36(2):355-363.

ESPEN Guidelines on Clinical Nutrition in the ICU

Recommendation 27:

The amount of glucose (PN) or carbohydrates (EN) administered to ICU patients should not exceed 5 mg/kg/min

- Grade of recommendation: GPP – strong consensus (100% agreement)

"The use of diabetic-specific enteral formula in ICU patients suffering from type 2 diabetes mellitus decreases the requirement for insulin"

ICU: Intensive Care Unit
GPP: Good Point of Practice
Singer P, et al. *Clin Nutr*. 2023;42(9):1671-1689.

Patients in the ICU with Type 2 Diabetes: Clinical and Economic Impact of Diabetes-Specific Enteral Formula

Retrospective analysis

- 5-year period (2009-2013)
- Evaluated records of patients who received DSF vs non-DSF over 5 days or more
  - DSF group: N=158,
  - Non-DSF group: N=794

Primary outcomes

- Mortality, ICU LOS, diabetes-related medications, total costs of care

Results

- DSF group had significantly **lower mortality** (5.1% vs 12.3%; $P < 0.0118$) and **reduced need for insulin prescription** (29.1% vs 38.4%; $P = 0.0269$)
- ICU LOS shorter for DSF,no significant differences ($P = 0.1843$)
- Lower total ICU costs with DSF usage ($6700 USD vs. $9200 USD, $P < .001$)

LOS: Length of Stay

Han YY, et al. *Clin Nutr*. 2017;36(6):1567-1572.

TIME IN RANGE

Managing Hyper- and Hypoglycemic Events

Assessment of Glycemic Status

Assessment Strategies

- Regular A1C testing
- Continuous glucose monitoring (CGM) using time in range (TIR) and/or glucose management indicator (GMI)
- Blood glucose monitoring (BGM)

Patients with Glycemic Variability

- Glycemic status best evaluated by a combination of results from BGM/CGM and A1C

Time in Range (TIR)

- **6.4**: "**Time in range** is associated with the risk of microvascular complications and can be used for assessment of glycemic status. Additionally, time below range and time above range are useful parameters for the evaluation of the treatment plan"
  – Grade of recommendation: C

American Diabetes Association. *Diabetes Care*. 2024;47(Suppl 1):S111-S125.

Why is Time In Range Important?

Clinical Use of Time in Range is widely endorsed by:

American Diabetes Association.

AACE

AADE American Association of Diabetes Educators

JDRF

EASD European Association for the Study of Diabetes

ISPAD International Society for Pediatric and Adolescent Diabetes

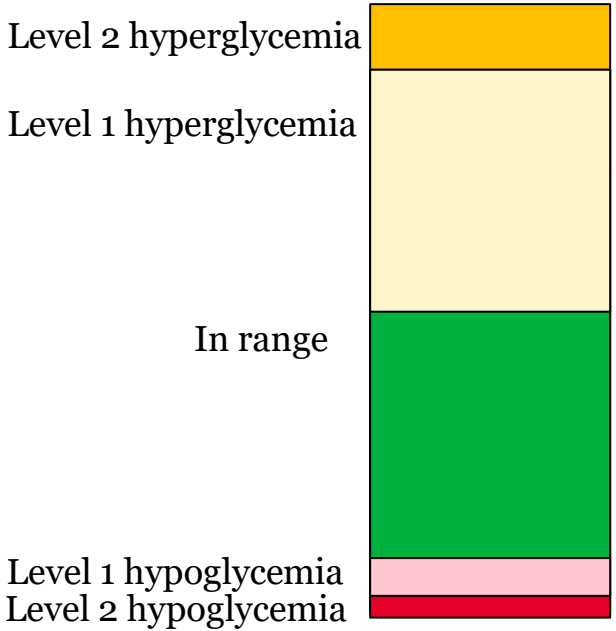
Every 10% change in TIR is associated with a 0.8% change in HbA1c[1]

Each 5% increase in TIR is clinically significant[2]

Every 10% decrease can increase retinopathy occurrence by 64% and microalbuminuria occurrence by 40%[2]

1. Vigersky RA, et al. *Diabetes Technol Ther*. 2019;21(2):81-85.
2. Beck R, et al. *Diabetes Care*. 2019;42(3):400-405.

Metrics from CGM for Clinical Care: Nonpregnant Adults (Type 1/Type 2) and Older Adults



>250 mg/dL

181-250 mg/dL

TAR

TIR: 70-180 mg/dL

54-69 mg/dL

<54 mg/dL mg/dL

TBR

Goal for nonpregnant adults for TAR is <25%

Goal for older adults for TAR is <10% at >250 mg/dL

Goal for many nonpregnant adults is TIR of >70%

Goal for many older adults is TIR of >50%

Goal for nonpregnant adults of TBR <4% and time <54 mg/dL <1%

Goal for older adults of TBR <70 mg/dL of <1%

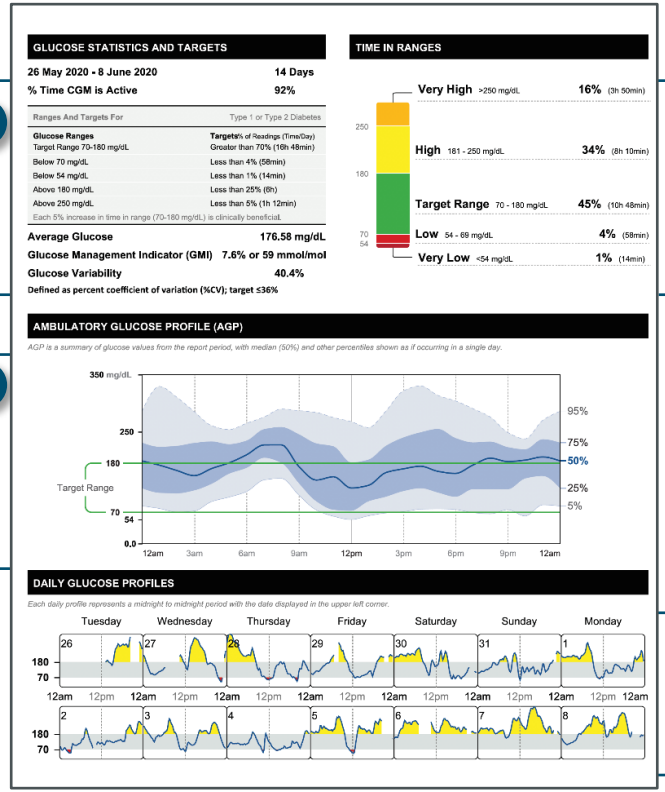
CGM: Continuous Glucose Monitoring
TAR: Time Above Range
TIR: Time in Range
TBR: Time Below Range

1. Battelino T, et al. *Diabetes Care*. 2019;42(8):1593-1603.
2. American Diabetes Association. *Diabetes Care*. 2024;47(Suppl 1):S111-S125.

Ambulatory Glucose Profile (AGP) Report

- Standardized, single-page report based on the International Consensus Report, endorsed by the ADA as the standard of care reporting tool for CGM
- Accessible to both members and providers via cloud-based portals
- Shared decision-making tool provides a simplified way to assess glucose patterns and trends by converting glucose readings into detailed pictures
- Provides individualized actionable data that can not be obtained by an HbA1c
- Gives visibility to the extent and causes of blood glucose variability

REPORT COMPONENTS



Simulated data are for illustrative purposes only; does not represent real patient or data.

Battelino T, et al. *Diabetes Care*. 2019;42(8):1593-1603.

Strategies for Older Adults

Older Adults May Require Additional Screening

Older adults with diabetes are at greater risk of conditions such as:

- Polypharmacy
- Cognitive impairment
- Urinary incontinence
- Injuries
- Falls
- Persistent pain
- Frailty

These conditions may impact an older adult's self-management capabilities and diminish quality of life

Recommendation 13.1: Consider the assessment of **medical**, **psychological**, **functional** (self-management abilities), and **social domains** in older adults to provide a framework to determine targets and therapeutic approaches for diabetes management (Grade Level: B)

QOL: Quality of Life

American Diabetes Association. *Diabetes Care*. 2024;47(Suppl 1):S244-S257.

Hypoglycemic Risks in Older Adults & Management Strategies

Insight:
Mitigate hypoglycemic risk by determining if patient is skipping meals, or inadvertently repeating doses of their medications

13.4. "Because older adults with diabetes have a greater risk of hypoglycemia, especially when treated with hypoglycemic agents (sulfonylureas, meglitinides, and insulin), than younger adults, episodes of hypoglycemia should be ascertained and addressed at routine visits" (Grade of recommendation: B)

13.5. "For older adults with type 1 diabetes, **continuous glucose monitoring** is recommended to reduce hypoglycemia" (Grade of recommendation: A)

- This may also be helpful for older adults with physical or cognitive limitations who may require monitoring by a surrogate

13.8a "**Older adults who are otherwise healthy** with few and stable coexisting chronic illnesses and intact cognitive function and functional status should have lower glycemic goals (such as A1C <7.0–7.5% [53–58 mmol/mol])." (Grade of recommendation: C)

13.8b "**Older adults with diabetes and intermediate or complex health** are clinically heterogeneous with variable life expectancy. Selection of glycemic goals should be individualized, with less stringent goals (such as A1C <8.0% [<64 mmol/mol]) for those with significant cognitive and/or functional limitations, frailty, severe comorbidities, and a less favorable risk-to-benefit ratio of diabetes medications." (Grade of recommendation: C)

American Diabetes Association. *Diabetes Care*. 2024;47(Suppl 1):S244-S257.

Nutritional Considerations for Management in the Long-Term Care Setting

Nutritional considerations:

- May have irregular, unpredictable meal consumption
- Undernutrition
- Anorexia
- Impaired swallowing

13.19. "People with diabetes residing in long-term care facilities need careful assessment to establish individualized glycemic goals and to make appropriate choices of glucose-lowering agents and devices based on their clinical and functional status"

- (Grade of recommendation: E)[1]

Main considerations are to **avoid hypoglycemia and the complications of hyperglycemia**[2]

- Hypoglycemic risk increased by: impaired cognitive and renal function, variable appetite, polypharmacy, variable appetite and nutritional intake, slowed intestinal absorption[2]

"However, patients with poorly managed diabetes may be subject to acute complications of diabetes, including dehydration, **poor wound healing**, and hyperglycemic hyperosmolar coma. Glycemic goals should, at a minimum, avoid these consequences"[1]

1. American Diabetes Association. *Diabetes Care*. 2024;47(Suppl 1):S244-S257.
2. Munshi MN, et al. *Diabetes Care*. 2016;39(2):308-318.

Consideration for Diabetes Management Goals in LTC and Skilled Nursing Facilities

Patient characteristics/ health status	Special considerations	Rationale	A1C	Fasting and premeal blood glucose targets	Glucose monitoring
Community-dwelling patients receiving care in a skilled nursing facility for short-term rehabilitation	• Rehabilitation potential • Goal to discharge home	• Need optimal glycemic control after recent acute illness	• Avoid relying on A1C due to recent acute illness • Follow current glucose trends	• 100-200 mg/dL	• Monitoring frequency based on complexity of regimen
Patients residing in LTC	• Limited life expectancy • Frequent changes in health impacting glucose levels	• Limited benefits of intensive glycemic control • Focus need to be on better QOL	• <8.5% (69 mmol/mol) • Use caution in interpreting A1C due to presence of many conditions that interfere with A1C levels	• 100-200 mg/dL	• Monitoring frequency based on complexity of regimen and risk of hypoglycemia

LTC: Long-Term Care

Munshi MN, et al. *Diabetes Care*. 2016;39(2):308-318.

Use of Technology in Long-Term Care Facilities

- Capillary point-of-care monitoring is the standard of care (before meals/at bedtime)
- In recent years, CGM has been utilized to provide a better assignment of glycemic control and hypoglycemia detection
  - Further research is needed to determine the benefits of CGM in preventing hypoglycemia

Idrees T, et al. *BMJ Open Diabetes Res Care*. 2022;10(4):e002705.

Managing Wounds in Patients with Diabetes

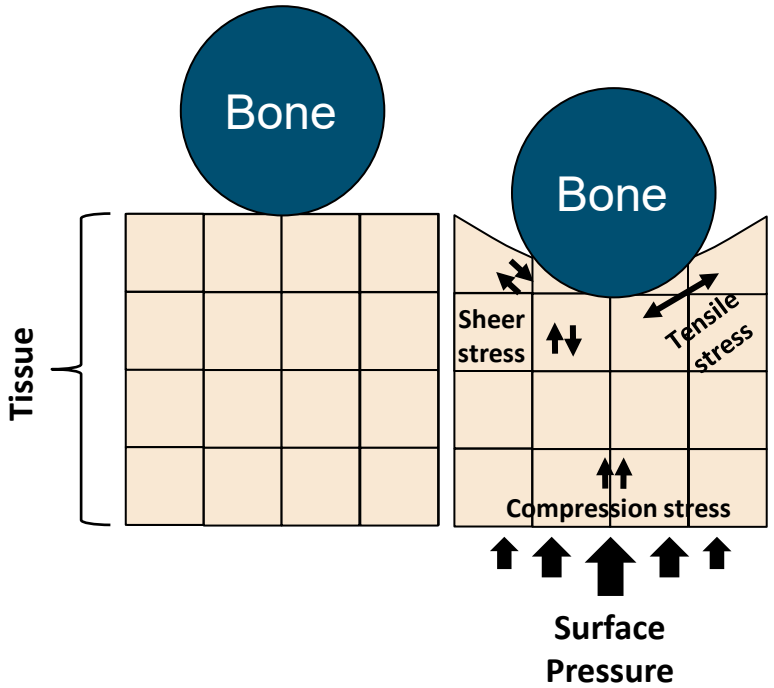
Factors That Influence Wound Healing

A **pressure injury** is defined as localized damage to the skin and/or underlying tissue, as a result of pressure or pressure in combination with sheer[1]

- Pressure injuries usually occur **over a bony prominence** but may also be related to a medical device or other object

Global pooled prevalence in hospitalized patients from 2008 to 2018, **was 12.8%** and the **pooled incidence rate was 5.4 per 10,000 patient days**[2]

- LTAC has the highest prevalence of PI (28.8%) compared to acute care (8.8%)[3]



LTAC: Long-Term Acute Care

1. European Pressure Ulcer Advisory Panel, National Pressure Ulcer Advisory Panel and Pan Pacific Pressure Injury Alliance. Prevention and Treatment of Pressure Ulcers/Injuries: Clinical Practice Guideline. The International Guideline. 3rd ed. Haesler E, ed. 2019.
2. Li Z, et al. *Int J Nurs Stud*. 2020;105:103546.
3. VanGilder C, et al. *J Wound Ostomy Continence Nurs*. 2017;44(1):20-28.

Who is At-Risk of Pressure Injuries?

Individuals at higher risk of pressure injuries

Those with:[1]

- Limited mobility, limited activity, high potential for friction and shear
- **Diabetes**
- Perfusion, circulation and oxygenation deficits
- Malnutrition
- Extremes of BMI
- Moisture
- Older age
- Impaired sensory perception
- Are in long-term care homes or community care
- Individuals with a **category/stage 1** are at risk of developing a stage 2 or greater PI

Hyperglycemia leads to osmotic diuresis and dehydration, which can result in **decreased perfusion and oxygenation**[2-4]

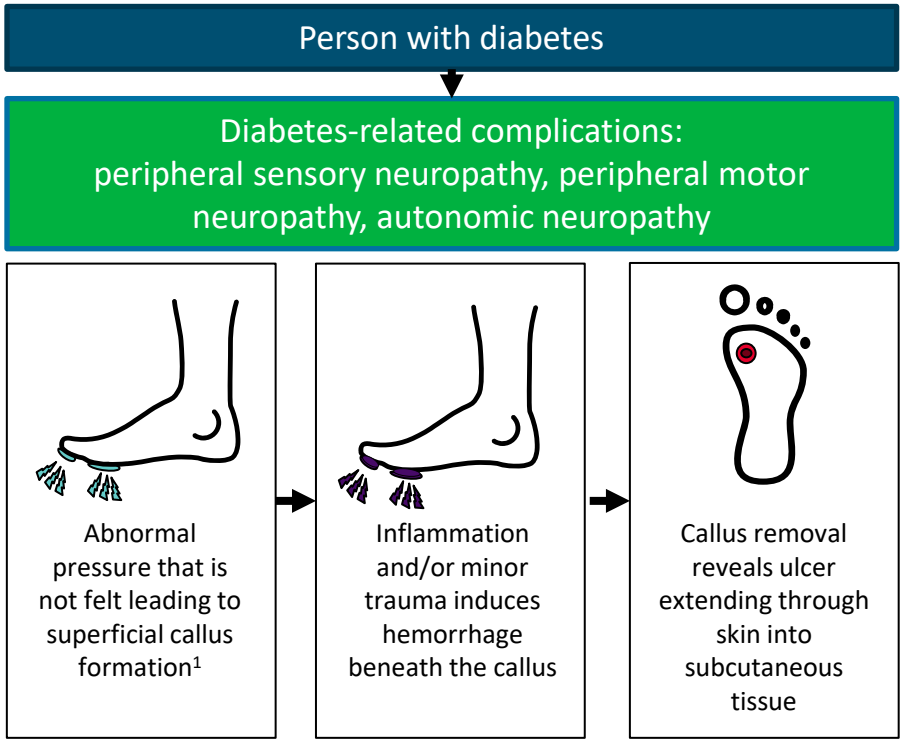
Surgery-related: Time from admission to surgery and duration of surgery

ICU-related: Length of ICU stay, mechanical ventilation, use of vasopressors, APACHE II Score

APACHE II: Acute Physiology and Chronic Health Evaluation

1. European Pressure Ulcer Advisory Panel, National Pressure Ulcer Advisory Panel and Pan Pacific Pressure Injury Alliance. Prevention and Treatment of Pressure Ulcers/Injuries: Clinical Practice Guideline. The International Guideline. Emily Haesler (Ed.) EPUAP/NPIA/PPPIA: 2019.
2. Stechmiller JK. *Nutr Clin Pract*. 2010;25(1):61-68.
3. Khan MN. *Diabet Foot*. 2005;8(3)144.
4. Posthauer ME, Marion M. Chapter 21: Wound Healing. In: Mueller CM, ed. *The ASPEN Adult Nutrition Core Curriculum*. 3rd ed. Silver Spring, MD: American Society for Parenteral and Enteral Nutrition; 2017:419-434.

Development of Diabetic Foot Ulcers and Risk Factors



Up to approximately 34% of people with type 1 or 2 diabetes develop a foot ulcer during their lifetime[2]

- Up to approximately 20% of people with a DFU require hospitalization[3]

Risk factors include[4]:

- Peripheral vascular disease
- Neuropathy
- Poor glycemic control
- **Malnutrition**
- Smoking
- Diabetic nephropathy
- Previous foot ulcerations/amputations

1. Armstrong DG, et al. *JAMA*. 2023;330(1):62-75.
2. Armstrong DG, et al. *N Engl J Med*. 2017;376(24):2367-2375.
3. Skrepnek GH, et al. *PLoS One*. 2015;10(8):e0134914.
4. Mezra Z, Tesfaye S. *The Foot*. 2003;13:125-129.

2021 American Limb Preservation Society Expert Consensus on Nutrition for Adults with Diabetic Foot Ulcers

Patients with Type 2 Diabetes	Protein Recommendations
No risk of malnutrition	**0.8-1.0 g/kg/d of ABW** or use IBW if patient is obese
Have or are at risk of malnutrition	**1.25-1.5 g/kg/d of ABW** or use IBW if patient is obese
During stress or illness	Up to **2 g/kg/d of ABW** or use IBW if patient is obese
Critically ill with BMI 30-40	Up to **2 g/kg/d of IBW**
Critically ill with BMI >40	Up to **2.5 g/kg/d of IBW**

Arginine

- "For patients with existing diabetic wounds with adequate protein intake, the **recommended dose of arginine is 4.5 g/day.**"

Glutamine

- "**Recommended glutamine doses range from 20-40 g daily** depending on the condition being treated."

HMB

- "When supplementing with HMB, current evidence suggests… **a total of 3 g of HMB daily** (or 38 mg/kg of body weight)."

Vitamin C | **Zinc** | **Vitamin E** | **Vitamin D** | **Fat: MUFA/PUFA**

Armstrong DG, et al. Nutrition Interventions in Adults with Diabetic Foot Ulcers: Expert Consensus and Guidance. http://eguideline.guidelinecentral.com/i/1428995-nutrition-in-dfu-guidelines-advisory-pocket-guide/0. Updated December 19, 2021. Accessed September 18, 2023.

ABW: Actual Body Weight
IBW: Ideal Body Weight
HMB: β-hydroxy-β-methylbutyrate

NUTRITION INTERVENTIONS

Diabetes-Specific Formulas (DSFs)

Diabetes Specific Formulas (DSFs) are Different in Composition from Standard Nutritional Formulas

Standard Nutritional Formulas	Diabetes-Specific Formulas
May compromise glycemic control in patients with diabetes	Defined nutrient composition to enable better glycemic control
Typically, high in rapidly digested carbohydrates (high glycemic index)	Modified carbohydrates (low glycemic index)
Variable fat content	Favors monounsaturated fatty acids fats
May require more attention to maintain glucose control	May reduce need for additional insulin to maintain good glycemic control[1,2]
Limited efficacy demonstrated in people with diabetes	Clinically demonstrated efficacy in people with diabetes[3]

1. Elia M, et al. *Diabetes Care*. 2005;28(9):2267-2279.
2. Mesejo A, et al. *Crit Care*. 2015;19:390.
3. Sanz-París A, et al. *Clin Nutr*. 2020;39(11):3273-3282.

Diabetes Specific Formulas (DSFs) are Different in Composition from Standard Nutritional Formulas

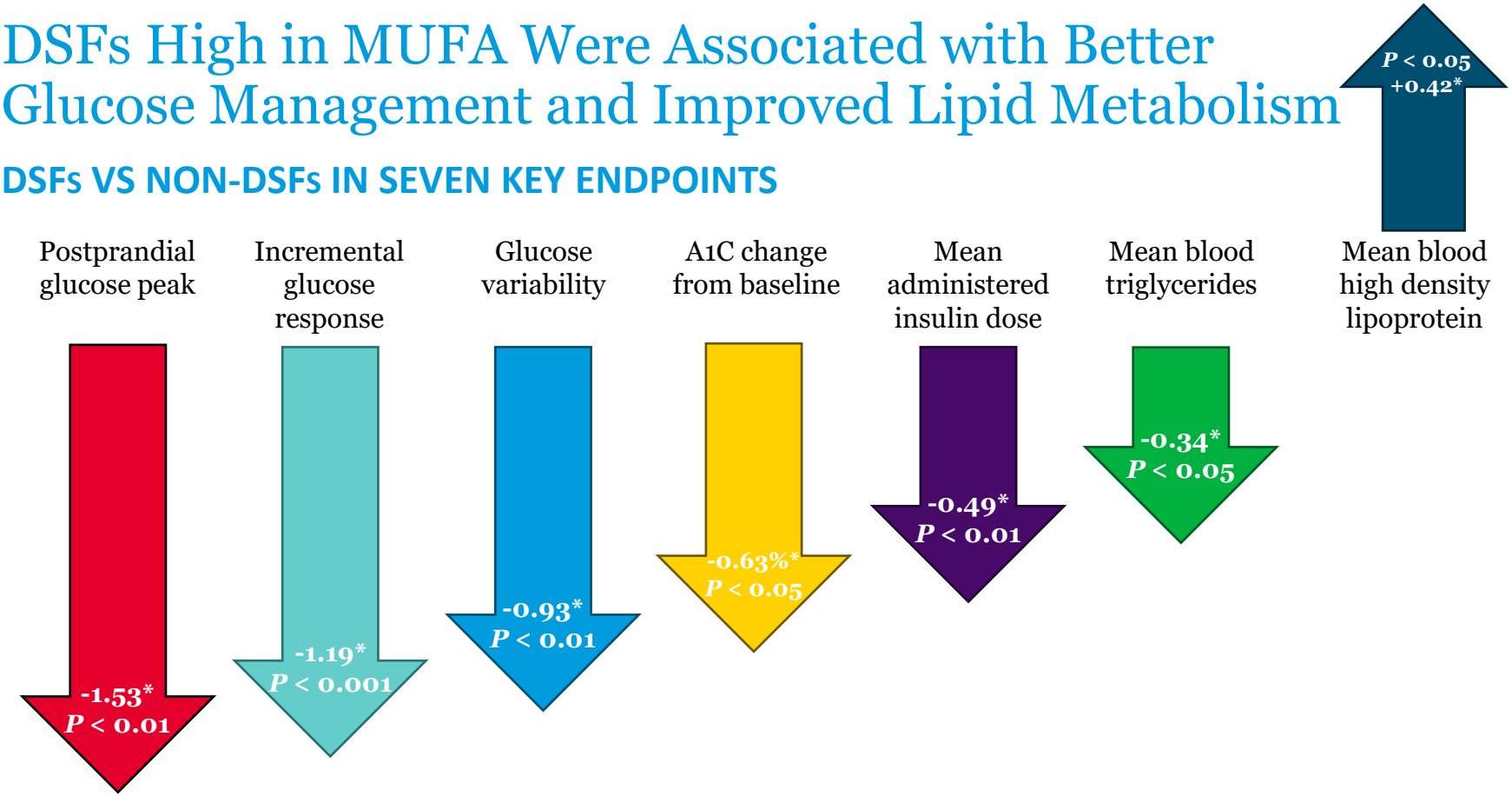
- 18 studies met inclusion criteria, N=845 adults, evaluating high MUFA DSF versus non-DSF
  - In 8 postprandial response studies, 2 were provided via tube feed, and 6 were administered orally
- Significant findings were found for DSF versus non-DSF in patients with diabetes

Metabolic Parameter	Studies/Participants	SMD, 95% CI
Peak postprandial glucose	4, 163	-1.53 (-2.44 to -0.61)
Incremental glucose response	4, 172	-1.19 (-1.71 to -0.68)
Plasma insulin after intake (iAUC)	3, 111	-0.65 (-1.03 to -0.27)

SMD: Standardized Mean Difference
iAUC: Incremental Area Under the Curve
Sanz-París A, et al. *Clin Nutr*. 2020;39(11):3273-3282.

DSFs High in MUFA Were Associated with Better Glucose Management and Improved Lipid Metabolism

DSFs VS NON-DSFs IN SEVEN KEY ENDPOINTS



*Values represent standardized mean difference

Sanz-París A, et al. *Clin Nutr*. 2020;S0261-5614(20)30100-X.

Diabetes-Specific ONS Were Associated with Favorable Effects on Glucose and Hunger Hormones

IN PATIENTS WITH DIABETES AND OBESITY OR OVERWEIGHT:

- Diabetes-specific ONS vs. instant oatmeal[1]
  - ↓ postprandial glucose (AUC) by 38% (*P*< .0001)
  - ↑ postprandial GLP-1 (AUC) by 280% (*P*< .0001)
- Diabetes-specific ONS vs. oatmeal[2]
  - ↓ postprandial glucose (AUC) by 13% (*P*< .001)
  - ↑ postprandial GLP-1 (AUC) by 222% (*P*< .001)
- Diabetes-specific ONS vs. oatmeal[3]
  - ↑ postprandial glucagon (AUC) by 222% (*P*< .001)
  - ↑ postprandial PYY (AUC) by 222% (*P*< .001)
  - No difference in amylin, leptin, cholecystokinin, or ghrelin
    - Impact on 2 satiety hormones may be due to the specific macronutrient composition of diabetes-specific ONS

*Percentage values on this slide represent relative changes in the outcomes specified

1. Devitt AA, et al. *Diabetes Res & Clin Metab*. 2012;1:20.
2. Mottalib A, et al. *Nutrients*. 2016;8(7):443.
3. Mottalib A, et al. *Nutrition & Diabetes*. 2019;9:26.

PYY: Peptide YY
ONS- Oral Nutrition Supplement

Studies Highlight the Use of DSF and Impact on Various Diabetes and Cardiometabolic Clinical Outcomes[1]

Clinical Scenario	Design	Population	Findings Intervention vs. Control
Outpatient: Weight loss[2]	RCT	Patients with overweight and obesity N=5145	↓ Body weight in intensive lifestyle intervention group (included meal replacement shakes)
Weight loss and glycemic control[3]	RCT, 3 arms	Patients with overweight and obesity A1C 8.07± 1.05 N=108	↓ A1C, body weight, body fat %, waist circumference in intervention groups that included DSF in meal planning All P< .01; • Total serum cholesterol and LDL cholesterol did not change in any of the 3 groups • Fasting serum insulin and insulin sensitivity improved in the group with nutrition therapy and weekly phone support compared to baseline, but differences were not significant between the groups
Glycemic control[4]	RCT, 2 arms	Patients with T2DM N=123	Improved outcomes: SDBG (P= .005), CV (P= .002), MAGE (P= .016) and AUCpp (P< .001), SBP (P< .046) in the LI + liquid formula meal replacement compared with LI alone

1. Mechanick JI, et al. *Nutrients*. 2020;12(12):3616.
2. The Look AHEAD Research Group. *Obesity (Silver Spring)*. 2014;22(1):5-13.
3. Mottalib A, et al. *Nutr J*. 2018;17(1):42.
4. Peng J, et al. *Brt J Nutr*. 2019;121(5):560-566.

SDBG: Standard Deviation of Blood Glucose
CV: Coefficient of Variation
MAGE: Mean Amplitude of Glycemic Excursions
AUCpp: Area Under Curve of postprandial blood glucose
SBP: Systolic Blood Pressure
LI: Lifestyle Intervention

Studies Highlight the Use of DSF and Impact on Various Diabetes and Cardiometabolic Clinical Outcomes

Clinical Scenario	Design	Population	Findings
Varied settings DSF vs. standard enteral nutrition formula[2]	Meta-analysis 4 RCTs +1 parallel design	Patients with T2D +/- complications. N=270	↓FBG, A1C ↑HDL-c For patients receiving DSF vs. STD; All P≤ .01 • No significant differences were found between groups for total cholesterol, LDL and TG levels
High MUFA DSF vs. standard formula[3]	Meta-analysis 18 RCTs	Patients with T2D, T1D, or stress-induced DM on enteral nutrition N=845	↓ PG, PPG, AUC-G, A1C, and insulin requirement vs. baseline. Individual results all P< .05 • Non-significant differences were found for tolerance
Community or nursing home Malnourished older patients 1 year pre- and post-DSF oral nutrition[4]	1-year retrospective, 1-year prospective observational study	Patients with T2D N=93	↓hospital admissions (-54.7%*, P< .001), hospital days (-64.1%*, P< .001), emergency visits (57.7%*, P< .001), healthcare costs (-65.6%*, P< .001) year to year for patients receiving hypercaloric diabetes-specific formula (HDSF)

1. Mechanick JI, et al. *Nutrients*. 2020; 12(12):3616.
2. Ojo O, et al. *Nutrients*. 2019;11(8):1905.
3. Sanz-París A, et al. *Clin Nutr*. 2020;39(11):3273-3282.
4. Sanz-Paris A, et al. *Nutrients*. 2016;8(3):153.

*Relative Percent Change
FBG: Fasting Blood Glucose
PPG: Postprandial Plasma Glucose
PG: Plasma Glucose

Use of DSF to Replace a Daily Breakfast and Afternoon/Evening Snack Improves Glycemic Responses

Study Design: Randomized, multicenter, open label, parallel, three-group pilot study (N=81), 14 days

2 phases: **Phase 1**: baseline (days 1-6) where participants consumed habitual self-selected diets (SSD) **Phase 2**: intervention (days 7-14)

- 2 daily servings of DSF at different times, breakfast, and an afternoon or evening (pre-bed) snack
- Glycemic responses assessed by continuous glucose monitoring (CGM)
- Participant's glucose data was assessed during baseline (days 1-6)

Group 1 (*n*=32)	Group 2 (Bkfst/AS) (*n*=24)	Group 3 (Bkfst/PBS) (*n*=25)
No DSF, self-selected diet	Drank DSF as breakfast meal replacement and 2nd DSF as mid-afternoon snack	Drank DSF as a breakfast meal replacement and drank second as a pre-bed snack

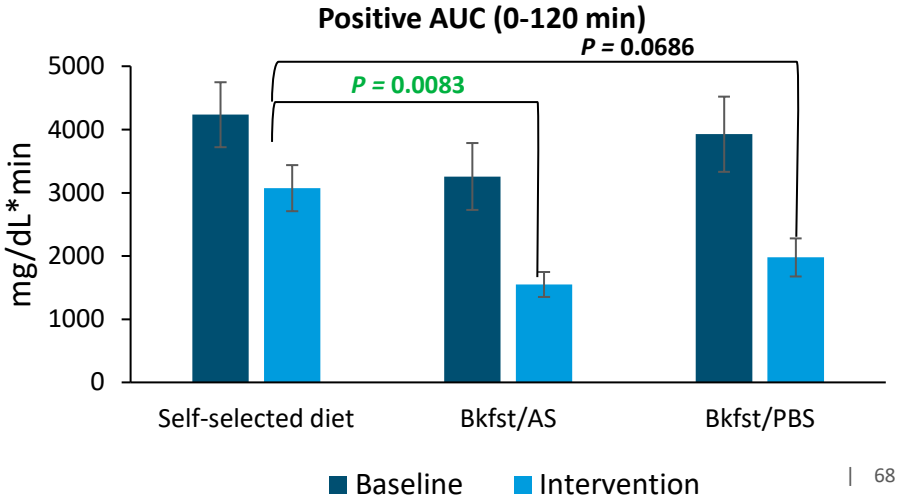
Bkfst: Breakfast
AS: Afternoon Snack
PBS: Prebed Snack

Mustad VA, et al. *BMJ Open Diabetes Res Care*. 2020;8(1):e001258.

Patients Consuming DSF at Breakfast and as an Afternoon Snack Had Lower Postprandial Blood Glucose

Variable and treatment groups	Baseline (5±0.1days)	Intervention	Change versus baseline	P-value versus baseline	P-value versus self-selected diet
Self-selected diet	4237±514	3074±364	-1162±422	0.0100	-
DSF breakfast/afternoon snack	3258±529	1551±198	-1708±496	0.0002	0.0083
DSF breakfast/prebed snack	3928±596	1978±301	-1950±582	0.0027	0.0686

As measured by CGM, replacing a usual breakfast and snack (afternoon or pre-bed) was associated with a **50 to 52% relative decrease** in PBG after breakfast and self-selected diet exhibited a 27% relative decrease of PBG compared to baseline



Mustad VA, et al. *BMJ Open Diabetes Res Care*. 2020;8(1):e001258.

Positive Outcomes Related to the Use of Diabetes-Specific Formulas for Enterally Fed Patients

WHEN COMPARED TO NON-DIABETES SPECIFIC FORMULAS, DIABETES- SPECIFIC FORMULAS:

- Reduced mean glucose[1,2]
- Reduced glycemic variability[1,2]
- Reduced hyperglycemic events[1]
- Lowered insulin requirements[2,3,4]
- Lowered ventilator-associated pneumonia incidence rate[2]
- Lowered total ICU costs[3]
  - $6,700 USD vs. $9,200 USD, $P < .0001$
- Lowered mortality[3]
  - 5.1% vs. 12.3%, $P = .01$

Retrospective study assessed 158 patient records in the DSF group with data covering a 5-year period (2009-2013)

1. Mori Y, et al. *European J Clin Nutr Metab*. 2011;6(2):e68-73.
2. Mesejo A, et al. *Crit Care*. 2015;19(1):390.
3. Han YY, et al. *Clin Nutr*. 2017;36(6):1567-1572.
4. van Steen SC, et al. *JPEN J Parent Enteral Nutr*. 2018;42(6):1035-1045.

Diabetes-Specific Enteral Formulas May Be Beneficial on Glycemic Control and Clinical Outcomes in Adult/Elderly Critically Ill Patients

Systematic review and meta-analysis conducted and assessed effects of glycemic-control enteral formulas in adults and elderly critically ill patients

- Meta-analysis, 10 studies

  (12 reports, N=685 patients)

- The prevalence of previous diabetes was ≤50% in 7 studies, 3 studies included no patients with diabetes

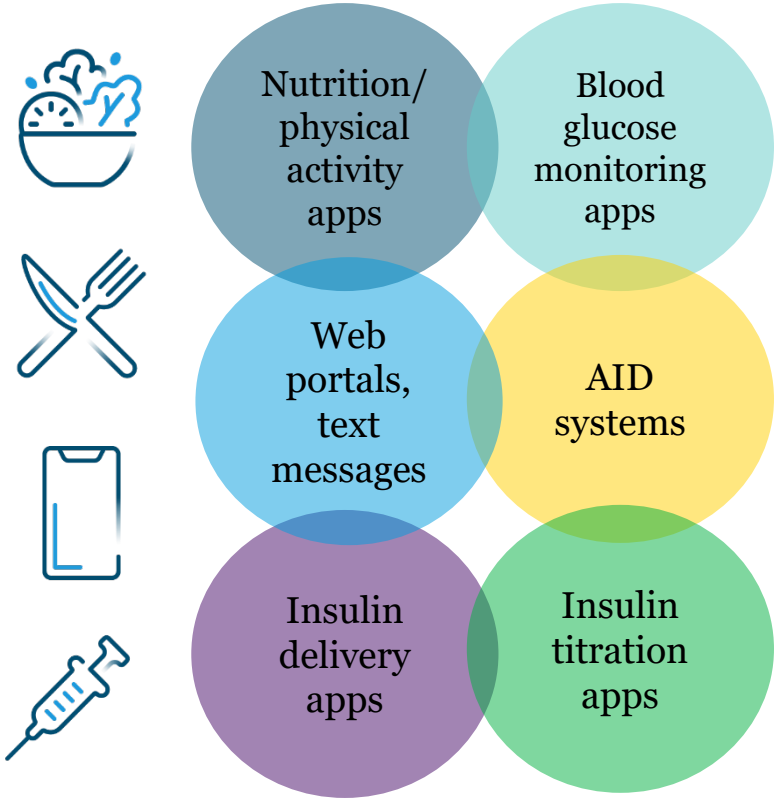
Primary Outcome	
Outcome	**Diabetes-specific specific formula vs standard formula**
Reduced BG levels	WMD, -16.06 mg/dL; 95% CI, -23.48 to -8.68 mg/dL; P < .001
Lower glucose CV	WMD, -6.85%; 95% CI, -13.5 to -0.11; *P* = .05
Secondary Outcomes and Subgroup Analyses	
Outcome	**Glycemic-control specific formula vs standard formula**
Glycemic control	Greater effect among patients with diabetes and higher baseline levels of glucose
MV, LOS in the ICU, Mortality	No significant association was observed

WMD: Weighted Mean Difference
MV: Mechanical Ventilation
Eckert I, et al. *Clinical Nutrition*. 2021;40(6):3940-3949.

NUTRITIONAL INTERVENTIONS & SELF MONITORING

Impact on Outcomes for Patients with Diabetes

Different Technologies are Available for Managing Diabetes



A consensus report among EASD and ADA highlighted recommendations relating to digital health and noted that HCPs should:

- Be knowledgeable of digital health apps and their strengths and weaknesses
- Support and inform people with diabetes on the use of digital health apps to augment diabetes management and lifestyle modification
- Use health data to improve quality of care and health outcomes

Kitsiou S, et al. *PLOS ONE. 2017;*12(3):e0173160.
Fleming GA, et al. *Diabetes Care*. 2020;43(1):250-260.

AID: Automated Insulin Delivery
EASD: European Association for the Study of Diabetes

A Systematic Review Highlights the Impact of Technology for Significant Impact to Glucose Control

- 25 studies included in analysis
  - Studies utilized mobile phones, secure messaging, and web-based information
- Outcomes measured: healthy eating, being active, metabolic monitoring
- 18 out of 25 studies reported significant reductions in A1C (0.1% to 0.8% reduction)

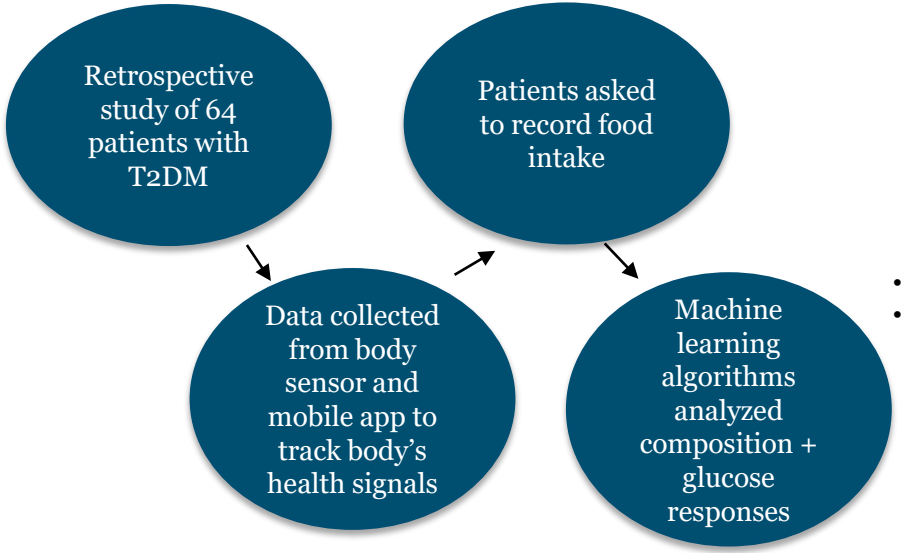
Four key elements to improving A1C:

Communication	Patient-generated health data	Education	Feedback

Greenwood DA, et al. *J Diabetes Sci Technol*. 2017;11(5):1015-1027.

Available Digital Technologies Can Be Integrated with Nutrition Counseling for a Coordinated Approach

A precision nutrition program incorporated CGM, artificial intelligence methods, and precision nutrition guidance to patients with diabetes and evaluated impact after 90-day participation



Nutrition counseling provided

- Via telephone or through app
- Specific food recommendations provided to avoid glucose spikes

After 90-day follow up:

- A1C decreased from 8.8 ± 2.2% to 6.9 ± 1.1% ($P < 0.001$)
- Change in the percentage of patients with A1C <6.5% from 9.4% to 39.7% ($P < 0.003$)
- Mean body weight decreased from 79.0 (16.2) kg at baseline to 74.2 (14.7) kg at 90 days ($P < 0.001$)
- Significant changes in FBG, HOMA-IR, mean glucose from CGM, C-peptide, RHR, and number of steps ($P < 0.01$). No changes in sleep

RHR: Resting Heart Rate

Shamanna P, et al. *Diabetes Therapy*. 2020;11(11):2703-2714.

Available Digital Technologies Can Be Integrated with Nutrition Counseling for a Coordinated Approach

Single-arm retrospective study including digital diabetes intervention program with remote coaching for 12 weeks then monthly:[1]

- Biomarker tracking
- Educational content
- Data analysis
- Structured logging capabilities for intake and physical activity were available
- Encouraged self-monitoring of glucose

Nutrition feedback:

- Counseling sessions
- Lessons
- Motivational interviewing strategies
- Individualized wellness plan

Reduction of A1C of -0.81 points between baseline (8.68 ± 1.7) and follow up (7.88± 1.7) ($P < 0.001$)

Patients who completed at least one counseling session with provider had a **greater decrease in A1C** (-1.00± 1.66) **compared to those who never completed a session** (-0.44± 0.65) (t=2.63, $P < 0.001$)

Zimmermann G, et al. *JMIR Diabetes*. 2021;6(2):e28033.

Dietitians Can Consider Integrating Mobile Technologies into the Nutrition Care Process

Nutrition care

+

Digital health technologies

- Physical activity information
- Anthropometric measures
- Daily blood glucose levels
- Comparison to standards
- Patient-provider communication
- Patient compliance to recommendations
- Remote monitoring of patient progress
- Feedback on performance
- Goal-setting
- Nutrition education
- Social support
- Patient self-monitoring
- Energy and nutrient intake information

Integration may:

- Streamline nutrition assessment and allow more time for education and nutrition counseling[1]
- Increase accuracy, efficiency, and quality of clinical-decision making[1]

Has promising outcomes for:

- A1C[2]
- Systolic blood pressure[3]
- Diabetes self-efficacy[3]
- Physical activity behaviors[3]

1. Chen J, et al. *Patient Educ and Couns*. 2018;101(4):750-757.
2. Hou C, et al. *Diabetes Care*. 2016;39(11):2089.
3. McDaniel CC, et al. *Patient Educ and Couns*. 2021;S0738-3991(21)00496-1.

Summary

- Diabetes is a complex condition that is associated with a wide array of complications
- Diabetes management strategies exist that support self-management
- Guidelines/recommendations highlight the importance of nutrition strategies to mitigate factors affecting diabetes
- The use of technology may be a plausible method of integrating diabetes care and assessing glucose management

Questions?

Thank you!

Visit anhi.org today for evidence-based nutrition education and resources