4-21-2019

Technology and the management of diabetes in older adults - cost effectiveness

Shannon Pitt

Technology and the management of diabetes in older adults - cost effectiveness

Shannon Pitt

University of North Dakota

Independent Study

NURS 997

Jana Zwilling

April 12, 2019

PERMISSION

Title Technology and the Management of Diabetes in Older Adults - Cost-effectiveness

Department Nursing

Degree Master of Science

In presenting this independent study in partial fulfillment of the requirements for a graduate degree from the University of North Dakota, I agree that the College of Nursing & Professional Disciplines of this University shall make it freely available for inspection. I further agree that permission for extensive copying or electronic access for scholarly purposes may be granted by the professor who supervised my independent study work or, in his/her absence, by the chairperson of the department or the dean of the Graduate School. It is understood that any copying or publication or other use of this independent study or part thereof for financial gain shall not be allowed without my written permission. It is also understood that due recognition shall be given to me and to the University of North Dakota in any scholarly use which may be made of any material in my independent study.

Signature _____

Date 3-23-2019

Abstract

Diabetes management has evolved significantly over the past century, from starvation diets to smart insulin and devices the can continually read glucose levels and adjust insulin accordingly. Lana is an older adult who presents to the clinic with worsening type 2 diabetes. She lacks understanding of her disease and hasn't adopted self-management tools to control her diabetes. She would be a good candidate for utilizing technological devices such as continuous glucose monitoring (CGM) or a closed loop insulin pump (CLIP) to manage her diabetes more effectively. Although it would be ideal to initiate CGM early in the disease, those over 65 years are by far the most expensive to manage in the healthcare system. The current medical model promotes reactive and escalating degrees of intervention with diabetes, depending on a worsening trend in glucose management. This is generally evaluated every three months with a hemoglobin A1C. Consideration of the financial burden of diabetes, especially in the older adult, may prompt the use of technology early in the disease, such as continuous glucose monitoring and closed loop insulin pumps. These methods provide high-quality glucose management and could reduce exacerbations, comorbidities, and complications. Having the ability to utilize more complex regimens with a programmed device also allows the provider to work within the framework of the slowing cognitive function of the older adult who often fails with multiple daily insulin injections and self-glucose monitoring. This research and understanding of the older adult with diabetes should prompt insurers to consider approval of these devices in early diabetes management. The overall financial burden of diabetes management would be reduced with early technology use in the diabetes care plan by providing intensive control.

Background

Diabetes management has significantly changed over the past century. There are numerous options to improve diabetes outcomes, direct care, and ultimately help people live long and healthy lives with diabetes. In 1910, insulin was identified as a factor in diabetes by Sir Sharpey-Schafer (American Diabetes Association [ADA], 2019), and in 1922, the first human was treated with insulin (same reference?). The first noted synthetic alteration to insulin was an attempt to "simplify" the regimen by extending its action with Novolin N (NPH) insulin, which occurred in 1950 (ADA, 2019). In 1974, the first continuous glucose monitor and closed-loop insulin infusion became available (ADA, 2019). This monitor was the size of a refrigerator, and therefore not user-friendly to the active individual. Continuous glucose monitoring would become easier in the late 1970s and early 1980s when wearable devices became available (ADA, 2019). Now, new technologies, including continuous glucose monitoring (CGM) and closed-loop insulin pumps (CLIP), can reduce treatment complexity while improving adherence. The net result is lower overall healthcare costs and better patient outcomes. Adding technology to the regimen often comes with an upfront financial burden, and high-level technologies are regularly not covered by insurers. However, the reactive nature of diabetes management may cost considerably more than a proactive strategy, especially in older adults.

With all of the advancements in the care of diabetes over the past century, a considerable expense remains. There are more than 11 million adults over 65 years old living with diabetes (ADA, 2018). In 2017, the annual average cost for those with diabetes was over $13,000 per person (ADA, 2018). Twenty-five percent of those over 65 years old live with

diabetes at a cost of $145 billion annually in the US alone (Cannon, Handelsman, Heile, & Shannon, 2018).

Treatment of older adults must account for the increased cognitive decline in older adults (Murman, 2015), which is accelerated by uncontrolled diabetes (Thein, Nyunt, Gao, Wee, & Ng, 2018) and the increased complexity of treatment as the disease progresses (ADA 2019). Furthermore, older adults may have difficulty self-managing a complex diabetic regimen (Yeh, Shah-Manek, & Lor, 2016). This makes good glucose management difficult when following the ADA guideline algorithm.

The cost-effectiveness of using technology to treat diabetes in older adults, despite an initial financial burden, is discussed in this review.

Case Report

Lana is a 65-year-old female who presented to the clinic for a 6-month diabetes follow-up. She has a ten-year history of diabetes, hypertension, hyperlipidemia, and a demonstrated lack of follow through with her health interventions. She has minimal complaints physically, including pertinent negatives of no polyphagia, polydipsia, or polyuria. She endorses no pain or shortness of breath, or any concerning cardiovascular issues beyond mildly elevated blood pressure. She has gained ten pounds since her last visit; her blood pressure is over goal at 146/90 mmHg and is managed with Toprol XL (50 mg daily) and lisinopril (10 mg daily). She is on a moderate intensity statin of Zocor (20mg daily) and ASA (81 mg daily), which was replaced by a high-intensity statin to improve her lipid profile and cardiovascular risk. She is afebrile and, has a normal pulse and respiratory pattern. Her physical exam is unremarkable, including normal sensation with monofilament foot exam. There is no obvious retinopathy with a limited

non-dilated eye exam today. Five years ago, she was prescribed Janumet 50-1000 mg twice daily for type 2 diabetes; at her most recent visit six months prior, added Glipizide 10 mg daily. She insists she takes this daily; however, she has elevated glucose of 324 mg/dL, and her A1C has increased to 9.5% from 8.1% six months ago. Because her A1C has significantly increased over the past six months, it is important to assess her understanding and adherence with the prescribed regimen.

This visit evolves into an annual exam because her history reveals she is due for many interventions beyond diabetes. These include overdue vaccinations of Prevnar 13, and subsequent Prevnar 23, Tetanus, and Shingrix. She is at least 11 years overdue for a colonoscopy with a history of a colon polyp. She has normal renal function demonstrated by normal microalbumin, eGFR, and creatinine. The rest of her chemistry is normal. Her hypertension was addressed by increasing her lisinopril to 20 mg daily with a two week follow up and possible medication adjustment. She requires high-quality diabetes education, and intensive management of her diabetes with elevating glucose levels. Lana has good insights into her health and seems eager to engage with her provider in understanding her role in the management of her chronic diseases. Despite this interest, she apparently lacks the ability to plan, act, and follow-through on these plans, which is demonstrated by the ongoing decline in her health status. With her health declining, the complexity is likely to rise over time. In fact, at this visit, insulin is added to her regimen: she is now on oral Janumet and Lantus insulin once daily. She is not eligible for continuous glucose monitoring (CGM) or closed loop insulin pump (CLIP) because she checks her glucose about once daily and injects insulin once daily (Medicare, n.d.). Her ASCVD score is 16.7% for the next 10 years, likely due to her poorly managed diabetes

(MD Calc, 2013). With optimally managed disease, she could reduce this to four percent (MD Calc, 2013). With the potential reduction of risk with a well-managed disease, an expected four-fold reduction of cardiovascular event cost would also occur. These cost savings would likely cross to other diseases related to poorly controlled diabetes, such as renal disease, peripheral vascular disease, and ocular disorders.

Literature Review

Management of the older adult with diabetes mellitus via continuous glucose monitoring and closed loop insulin systems can promote health and wellness, control healthcare costs, and be managed with the expected slowing cognition associated with aging and diabetes. Initially, a PubMed search was conducted to gather up-to-date research on technology use in older adults with type 2 diabetes. The search terms used were “insulin and continuous glucose monitoring type 2 older adults” with a filter of the last five years and studies on humans. This search resulted in 17 studies. Additional studies and resources were obtained from these results and their resource lists. Manual searches were also conducted in Cochrane review and Pubmed regarding CGM and CLIP using keywords of “type 2,” “closed-loop insulin pump,” and “continuous glucose monitoring.” Statistical data were obtained from the American Diabetes Association (2019), to inform background and disease cost analysis. Finally, general retail information was obtained from sites that inform true retail costs of medications/insulin, and continuous glucose monitors, via goodRx (2019) and ScriptSave (2019), which are commonly used for uninsured or underinsured patients.

Cognition and Complexity

During the aging process, there is a general loss of both grey and white matter of the brain and slowing of neuronal processing, resulting in some slowing of executive function and processing speed (Harada, Natelson Love, & Triebel, 2013). "It is estimated that at least half of older people with diabetes will become cognitively impaired and functionally disabled" (Hopkins, Shaver, & Weinstock, 2016, para. 2). Executive function is needed for self-care, which as discussed below is a requirement for successful diabetes management (Grundberger et al., 2018). It is also widely known that diabetes worsens cardiovascular disease (National Institute of Diabetes and Digestive and Kidney Diseases, n.d.), which is tied to a decline in cognitive function and processing speed (Dixon et al., 2019). With the notable cognitive decline in aging diabetics, many older diabetics are not capable of a complex diabetic regimen, even if it were to be clinically indicated (Yeh et al., 2016). Complex regimens (medication management with numerous daily interventions, injections, or medications) prove repeatedly overwhelming, which increases the medical frailty and cognitive impairment of the uncontrolled diabetic (Ruedy, Parkin, Riddlesworth, & Graham, 2017; Yeh et al., 2016). Retroactive control of diabetes, blood pressure, or cholesterol does not improve cognitive function if present; however, it is hypothesized that prevention of the poor control would reduce cognitive dysfunction in the long term (Williamson et al., 2015). It is therefore essential that treatment regimens in the older adult are as simple as possible, and new technologies are making that possible.

Continuous Glucose Monitoring and Glucose Control

Continuous glucose monitoring (CGM) can provide excellent regimen details and does not require fingerstick measurements (Grundberger et al., 2018). CGM can more accurately depict trends more frequently than the every-three-month A1C (Bergenstal et al., 2018). Healthcare providers often depend on patients to adhere to fingerstick measurements and keep a glucose diary to get more regular insight as to regimen effectiveness. Using CGM as an early intervention may greatly reduce the comorbidities of other diseases associated with diabetes management failure.

The American College of Endocrinology and the American Association of Clinical Endocrinology (2016) have recently published a consensus statement to inform medical payors, and medical providers of the importance of the CGM in the regular and earlier management of diabetes care. CGM allows individuals to intervene, or seek help with critically out of range values, and informs the medical provider of the success of the regimen in a fluid manner. CGM can provide a reading every five minutes (Grundberger et al., 2018). This level of detail would be valuable when needing urgent interventions and reassessment after an intervention.

In one study, CGM identified hypoglycemia in older men overnight (Li et al., 2017). Having a system that can alarm and alert an individual to low glucose levels, so they can intervene before it becomes severe, would reduce hospitalizations from hypoglycemic events (Li et al., 2017). This intensity of glucose monitoring has demonstrated improved quality of life, fewer hypoglycemic episodes, and less worry about diabetes in older adults (Polonsky, Peters, & Hessler, 2016). Additionally, there is evidence that CGM with multiple daily injections lowers A1C levels more significantly than with fingerstick and multiple daily injections (MDI) (Ruedy,

Parkin, Riddlesworth, & Graham, 2017). The American Association of Clinical Endocrinologists and American College of Endocrinology recommend CGM in all individuals requiring insulin (Grundberger et al., 2018).

Having CGM at the time of diagnosis, offers the patient significant information during the learning phase in adopting a diabetic care plan. CGM can reveal the effects of lifestyle on glucose levels, thereby empowering patients and improving success within diabetes management (Lawton et al., 2018). Because of these lifestyle changes, CGM affects a patient's overall metabolic profile, which is a significant factor in the ability to manage diabetes including obesity, hypertension, hyperlipidemia (American Heart Association [AHA], 2015). Using the pump alone without CGM did not alter other metabolic components, such as body mass or lipids (Chlup et al., 2018). CGM may also reduce the overall need or quantity of medication required as noted by the independent effects of CGM on diabetes (Chlup et al., 2018). Initial management with CGM could be partnered with intensive health coaching, which has been shown to further affect lifestyle patterns and overall metabolic status (Wolever et al., 2010).

Closed Loop Insulin Pumps and Glucose Control

Insulin pumps have been available for about forty years (ADA, 2019). Having continuous information regarding glucose levels paired with the ability to provide continuous insulin can significantly simplify the regimen of the older adult with diabetes. There are 3 main types of pumps: (1) standard pump that is set for a specific amount of continuous insulin daily regardless of glucose measurements; (2) sensor-augmented pump that the user can adjust a bolus beyond the set basal level depending on carbohydrates and activity; and (3) closed-loop-insulin pump (CLIP), which is adjusted in algorithmic fashion by the device based on glucose

levels and requires minimal intervention by the user when in auto mode. This discussion will be limited to CLIP.

Device developers, such as Medtronic, have made their devices more intuitive and easily adjusted to provide pancreas-like control (Grundberger et al., 2018). These devices can also include alarms sent for remote monitoring to a smartphone of a caregiver. Complex regimens can be auto-programmed into insulin pumps to more thoroughly manage the disease while simplifying the day to day requirements of the patient (Grundberger et al., 2018). CLIP was shown to improve total time within the target glucose range for insulin-naive individuals without adjusting for meal specific carbohydrate quantities (Kumareswaran et al., 2014). This study is promising for the safety and utilization; however, it was small with only 12 participants (Kumareswaran et al., 2014).

Forthcoming is a "smart insulin" that adjusts specifically to the patients' activities and food ingestion, which likely will make the continuous infusion of insulin a safer option earlier in the disease (Rege, Phillips, & Weiss, 2018). Use of CLIP is currently recommended for type 1 diabetes and encouraged for consideration for type 2 diabetes by The American Association of Clinical Endocrinologists and American College of Endocrinology (Grundberger et al., 2018). This consensus statement, however, does indicate that patient capacity for self-management is necessary to be successful (Grundberger et al., 2018).

A major study (OPT2mise), conducted by Reznik, Habteab, Castenada, Shin, & Joubert (2018), failed to demonstrate that continuous insulin infusions controlled glucose and reduced A1C better than basal-bolus with multiple daily injections (Reznik et al., 2018). It was noted however, to require reduced quantities of insulin via pump to effectively manage diabetes

compared to MDI (Reznik et al., 2018). The results focused on the overall glucose regulation, not the information provided to the participant (Reznik et al., 2018). The study does not discuss any factors outside CLIP (lifestyle changes or diabetic education) that influenced values. Furthermore, the study did not specify if participants had CGM information available to them, and the subgroup cohort was small (Reznik et al., 2018). The importance of this study is that it informs much of current practice and coverage regarding insulin pumps. With the above limits of the study, further research would be warranted. The factors affecting the use of CLIP in the older adult with declining cognition is their ability to understand how to use it and when to intervene (Grundberger et al., 2018). There are no studies that have determined safety or efficacy of CLIP devices in those with established cognitive decline using remote alert to caregivers.

Healthcare Costs

These studies show the effectiveness of technology in diabetes management. Although the American Endocrinology Association recommends CGM early in the disease, coverage is a barrier (Grundberger et al., 2018; Medicare, n.d.). Medicare does cover these monitors, but only if there is a need to check glucose levels at least four times a day or receive at least three insulin injections daily (Medicare, n.d.).

Because diabetes infiltrates so many other disease processes, tight management is difficult to quantify financially. It is widely known that well-controlled diabetes reduces heart disease, kidney disease, and retinopathy risk. If poorly controlled, these comorbidities can contribute to hospital, clinic, and emergency room visits. In terms of older adult and healthcare costs, if there is substantial time with elevated glucose levels, their cognition will more rapidly

decline, and frailty will increase (Thein et al., 2018). This will ultimately increase illness exacerbations and mortality (Murman, 2015; Thein et al., 2018). As Medicare has already identified, readmissions and exacerbations of chronic diseases are costly and the basis of their Hospital Readmission Reduction Program (Centers for Medicare and Medicaid Services [CMS], 2019). Using CLIP in the older adult could provide control of expensive comorbidities and therefore reduce costs. These systems (CGM) can cost around $350 dollars a month (GoodRx, 2019) but allow for glucose readings every five minutes if necessary. From a financial perspective, there were fewer hospitalizations and ER visits related to hypoglycemia with CGM reducing the financial burden of the disease (Polonsky et al., 2016). Additionally, the expected lifestyle changes from CGM would further reduce exacerbations and comorbidities.

Having fewer complications, fewer comorbidities, and less uncontrolled diabetes would cost less. An opposing idea comes from a study conducted in Spain by Garcia-Lorenzo et al. (2018), who found that CGM was not cost-effective, mainly due to the gap in the cost of self-glucose monitoring and CGM devices and a minimal extension of quality of life years. The study in Spain, however, ignores emergency and hospital costs in its assessment (Garcia-Lorenzo et al., 2018). They do note a significant improvement in glucose management, which would be assumed to also decrease complications with diabetes and therefore fewer hospital admissions (Garcia-Lorenzo et al., 2018). This logic and conclusion lack the whole cost assessment. True cost-effectiveness information must include emergency and hospital care, as this is nearly 30% of diabetes cost in the United States (American Diabetes Association, 2018).

Summary

Four main themes were obtained from the literature review. First, self-management with complex regimens often result in an increase in cognitive decline, further exacerbating diabetes and its many comorbidities. Second, continuous glucose monitoring (CGM) is effective at improving A1C and diabetes management. Third, closed-loop insulin pumps can provide tighter control of glucose levels, which reduces adverse effects from diabetes. Finally, regimen failures, hospitalizations, and exacerbations of diabetes or related diseases are far costlier than the expense of a monitoring or CLIP device in diabetes care (Yeh et al., 2016). It is therefore possible to suggest that improving diabetes management with CGM or CLIP would reduce comorbidities and therefore reduce healthcare costs

Limitations of the discussed studies leave open several research questions. Much of the research evaluates either CGM or pumps separately and not together or focused solely on type 1 diabetes, indicating newly proposed research should focus on type 2 diabetes. There is currently a study underway with older adults using CLIP with type 2 diabetes, but the results are not available at this time (Clinical Trials.gov, 2018). Small (100-150) study groups are an ongoing limitation in these technology studies. Many studies initiate CGM or CLIP as a late intervention and not at disease onset, which limits understanding of long term effects and cost analysis. Future research questions will include, does intervening with CGM or CLIP at disease onset improve management and stability over time? Does CGM reduce exacerbations of diabetes or other comorbidities over the remainder of one's life? Finally, does the use of CGM or CLIP improve long term outcomes and reduce healthcare costs? Comparing groups with the current reactive model of care concurrently with proactive groups using CGM and CLIP would

provide significant insight into the true cost as participants could be tracked over their lifetime. Having insight on true reductions in cognitive decline, stroke, cardiovascular events, and hospitalizations would reveal the true cost of both management plans.

Lana is a prime example of a person who lacks understanding regarding her disease and wants to engage in her health, but who has limited ability to successfully self-manage her diabetes. Providing her a CGM earlier in her disease and subsequently adding a closed loop insulin pump would have allowed her real-time glucose assessments, with immediate insulin response. A reduction of a single hospital admission annually ($10,000+), would have likely covered the entire cost of the device, around $350/month ($4200/year), (ScriptSave, 2019). Had Lana had a device that could improve her glucose control, follow her lifestyle choices on glucose management, and alerted her to severe abnormalities, the outcomes could have been life-changing.

Health practitioners need to utilize the simplest and most effective method of managing diabetes in the older adult to enhance the quality and consistency of management. This helps the patient succeed in their regimen. Insurers should re-evaluate their reactive perspective to the management of diabetes coverage. They should offer a trial of early CGM and CLIP management. Having older adults under good glucose control would reduce the cost of diabetes on our healthcare system and improve their quality of life. Utilizing strategies proven to control diabetes such as CGM or CLIP early in the diabetes management plan, will reduce overall healthcare costs by reducing uncontrolled diabetes as well as comorbidities. The average adult under 65 with diabetes costs around $6000-$8000 per annum. If the costs of

those over 65 could be brought down to this level, annual cost savings would be nearly 77 billion dollars.

Learning Points

- Continuous glucose monitoring could be a cost-effective intervention early in diabetes rather than later.
- Closed-loop insulin systems can closely manage glucose levels and be automatically programmed for complicated regimens making it simple for the individual to use.
- Management of diabetes in the older adult diabetes will increase in complexity over time, and patient understanding and compliance will decrease with the current medical model.
- Combining continuous glucose monitoring and closed loop insulin early in the diabetes management of the older adult may reduce health costs and improve quality of life.
- Healthcare providers need to use CGM and CLIP when possible, which will demonstrate the higher quality diabetes management and likely inform coverage on a broader scale in the future.

References

American Diabetes Association (2018). Economic costs of diabetes in the U.S. in 2017. *Diabetes Care*, 1-12. https://doi.org/https://doi.org/10.2337/dci18-0007

American Diabetes Association (2019). *Diabetes Care* [Standards of medical care in diabetes-2019]. Diabetes Care, *42*, s1-s204. Retrieved from Medication Regimen Complexity and A1C Goal Attainment in Underserved Adults With Type 2 Diabetes: A Cross-sectional Study

American Diabetes Association. (2019). Timeline. Retrieved from http://www.diabetes.org/about-us/75th-anniversary/timeline.html?loc=75

American Heart Association. (2015). Understand your risk for diabetes. Retrieved from https://www.heart.org/en/health-topics/diabetes/understand-your-risk-for-diabetes

Bergenstal, R. M., Beck, R. W., Close, K. L., Grundberger, G., Sacks, D. B., Kowalski, A., ... Cefalu, W. T. (2018). Glucose management indicator(gmi): a new term for estimating a1C from continuous glucose monitoring. *Diabetes Care*. https://doi.org/https://doi.org/10.2337/dc18-1581

Bergenstal, R. M., Tamborlane, W. V., Ahmann, A., Buse, J. B., Dailey, G., Davis, S. N., ... STAR 3 Study Group (2010). Effectiveness of sensor-augmented insulin-pump therapy in type 1 diabetes. *New England Journal of Medicine*, *363*, 311-320. https://doi.org/10.1056/NEJMoa1002853

Borba, A., Marques, A., Ramos, V., Leal, M., Arruda, I., & Ramos, R. (2018). Factors associated with elderly diabetic adherence to treatment in primary health care. *Ciencia and Saude Coletiva*, *23*, 953-961. https://doi.org/10.1590/1413-81232018233.03722016

Bullard, K. M., Cowie, C. C., Lessem, S. E., Saydah, S. H., Menke, A., Geiss, L. S., ... Imperatore, G. (2016). Prevalence of diagnosed diabetes in adults by diabetes type- United Stated, 2016. *Morbidity and Mortality Weekly Report*, *67*, 359-361. https://doi.org/10.15585/mmwr.mm6712a2

Cannon, A., Handelsman, Y., Heile, M., & Shannon, M. (2018). Burden of illness in type 2 diabetes mellitus. *Journal of Managed Care and Specialty Pharmacy*, *24*(9-a), s5-s13.

Centers for Medicare and Medicaid Services. (2019). Hospital readmissions reduction program. Retrieved from https://www.cms.gov/medicare/medicare-fee-for-service-payment/acuteinpatientpps/readmissions-reduction-program.html

Chlup, R., Runzis, S., Castenada, J., Lee, S. W., Nguyen, X., & Cohen, O. (2018). Complex assessment of metabolic effectiveness of insulin pump therapy in patients with type 2 diabetes beyond hba1c reduction. *Diabetes Technology and Therapeutics*, *20*, 153-159. https://doi.org/10.1089/dia.2017.0283

Clinical Trials.gov. (2018). Closed-loop control of glucose levels (artificial pancreas) for 24 hours in adults with type 2 diabetes under intensive insulin therapy. Retrieved from https://clinicaltrials.gov/ct2/show/NCT02490085

Dixon, K., LaMonica, H., Duffy, S. L., Phillips, C. L., Grunstein, R. R., Naismith, S. L., & Hoyos, C. M. (2019). Arterial stiffness relates to executive dysfunction in later life. *Neuropshychology, development and cognitiong. Section B, aging, neuropsychology and cognition*, 1-12. https://doi.org/10.1080/13825585.2019.1597009

Garcia-Lorenzo, B., Rivero-Santana, A., Vallejo-Torres, L., Castilla-Rodriguez, I., Garcia-Perez, S., Garcia-Perez, L., & Perestelo-Perez, L. (2018). Cost-effectiveness analysis of real-time continuous monitoring glucose compared to self-monitoring of blood glucose for diabetes mellitus in Spain. *Journal of evaluation in clinical practice*, *24*, 772-781. https://doi.org/10.1111/jep.12987

GoodRx. (2019). Dexcom G6. Retrieved from https://www.goodrx.com/dexcom-g6

Grundberger, G., Handelsman, Y., Bloomgarden, Z., Fonseca, V., Garber, A., Haas, R., ... Umpierrez, G. (2018). American association of clinical endocrinologists and american college of endrocrinology 2018 position statement on integration of insulin pumps and continuous glucose monitoring in patients with diabetes mellitus. *Endocrine Practice*, *24*, 302-308. https://doi.org/10.4158/PS-2017-0155

Harada, C. N., Natelson Love, M. C., & Triebel, K. (2013). Normal cognitive aging. *Clinical Geriatric Medicine*, *29*, 737-752. https://doi.org/10.1016/j.cger.2013.07.002

Hopkins, R., Shaver, K., & Weinstock, R. S. (2016). Management of adults with diabetes and cognitive problems. *Diabetes Spectrum*, *29*, 224-237. https://doi.org/10.2337/ds16-0035

Kumareswaran, K., Thabit, H., Leelarathna, L., Caldwell, K., Elleri, D., Allen, J. M., ... Hovorka, R. (2014). Feasibility of closed-loop insulin delivery in type 2 diabetes: a randomized controlled study. *Diabetes Care*, *37*, 1198-1203. https://doi.org/https://doiorg.ezproxylr.med.und.edu/10.2337/dc13-1030

Lawton, J., Blackburn, M., Allen, J., Campbell, F., Elleri, D., Leelarathna, L., ... Hovorka, R. (2018). Patients' and caregivers' experiences of using continuous glucose monitoring to support diabetes self-management: qualitative study. *Endocrine Disorders*, *18*. https://doi.org/https://doi.org/10.1186/s12902-018-0239-1

Li, F., Liu, B., Zhu, H., Li, T., Zhang, W., Su, X., ... Ma, J. (2017). Continuous glucose monitoring in the newly diagnosed type 2 diabetes patients reveals a potential risk of hypoglycemia in older men. *Journal of Diabetes Research*. https://doi.org/https://doi.org/10.1155/2017/2740372

MD Calc. (2013). ASCVD 2013 risk calculator from aha/acc. Retrieved from https://www.mdcalc.com/ascvd-atherosclerotic-cardiovascular-disease-2013-risk-calculator-aha-acc

Medicare. (n.d.). Therapeutic continuous glucose monitors. Retrieved from https://www.medicare.gov/coverage/therapeutic-continuous-glucose-monitors-cgms

Murman, D. L. (2015). The impact of age on cognition. *Seminars in Hearing*, *36*, 111-121. https://doi.org/10.1055/s-0035-1555115

National Institute of Diabetes and Digestive and Kidney Diseases. (n.d.). Diabetes, heart disease and stroke. Retrieved from https://www.niddk.nih.gov/health-information/diabetes/overview/preventing-problems/heart-disease-stroke

Polonsky, W. H., Peters, A. L., & Hessler, D. (2016). The impact of real-time continuous glucose monitoring in patients 65 years and older. *Journal of Diabetes Science and Technology*, *10*, 892-897. https://doi.org/10.1177/1932296816643542

Rege, N. K., Phillips, N. F., & Weiss, M. A. (2018). Development of glucose-responsive "smart" insulin systems. *Current Opinion of Endocrinology Diabetes and Obesity*, *24*, 267-278. https://doi.org/10.1097/MED.0000000000000345

Reznik, Y., Habteab, A., Castenada, J., Shin, J., & Joubert, M. (2018). Contribution of basal and postprandial hyperglycemia in type 2 diabetes patients treated by an intensified insulin regimen: impact of pump therapy in the OPT2mise trial. *Diabetes Obesity and Metabolism*, *20*, 2435-2441. https://doi.org/10.1111/dom.13398

Ruedy, K. J., Parkin, C. G., Riddlesworth, T. D., & Graham, C. (2017). Continuous glucose monitoring in older adults with type 1 and type 2 diabetes using multiple daily injections of insulin: results from the DIAMOND trial. *Journal of Diabetes Science and Technology*, *11*, 1138-1146. https://doi.org/10.1177/1932296817704445

ScriptSave. (2019). Minimed 670g. Retrieved from https://www.wellrx.com/prescriptions/minimed%20670g/?address=56683

Thein, F. S., Nyunt, M., Gao, Q., Wee, S., & Ng, T. (2018). Physical frailty and cognitive impairment is associated with diabetes and adversely impact functional status and

mortality. *Postgraduate Medicine*, *130*(6), 561-567. Abstract retrieved from PubMed. (Accession No. 29949390)

Vigersky, R. A., Huang, S., Cordero, T. L., Shin, J., Lee, S. W., Chhabra, H., ... Cohen, O. (2018). Improved hba1c, total daily insulin dose, and treatment satisfaction with insulin pump therapy compared to multiple daily insulin injections in patients with type 2 diabetes irrespective of baseline c-peptide levels. *Endocrine Practice*, *24*, 446-452. https://doi.org/10.4158/EP-2017-0234

Williamson, J. D., Launer, L. J., Bryan, R. N., Coker, L. H., Lazar, R. M., Gerstein, H. C., ... Miller, M. D. (2015). Cognitive function and brain structure in persons with type 2 diabetes mellitus after intensive lowering of blood pressure and lipid levels. *JAMA Internal Medicine*, *174*, 324-333. https://doi.org/10.1001/jamainternmed.2013.13656

Wolever, R. Q., Dreusicke, M., Fikkan, J., Hawkins, T. V., Yeung, S., Wakefield, J., ... Skinner, E. (2010). Integrative health coaching for patients with type 2 diabetes: a randomized clinical trial. *The Diabetes Educator*, *36*. https://doi.org/10.1177/0145721710371523

Yeh, A., Shah-Manek, B., & Lor, K. B. (2016). Medication regimen complexity and A1c goal attainment in underserved adults with type 2 diabetes: a cross-sectional study. *Annals of Pharmacotherapy*, *51*, 111-117. https://doi.org/https://doi-org.ezproxylr.med.und.edu/10.1177/1060028016673652