



## GERIATRIC MEDICINE | CASE REPORT

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# Using advanced diabetes technologies in patients with dementia in assisted living facilities: Case studies

Nancy A. Allen<sup>1\*</sup>, Michelle L. Litchman<sup>1</sup> and Alisyn L. May<sup>2</sup>

**Abstract:** *Introduction:* Older adults with dementia and diabetes are at increased risk of complications, hospitalizations, and adverse events. This vulnerable patient population may have high glucose variability and an increased risk of low and high glucose numbers. Diabetes technology exists, including insulin pumps and continuous glucose monitors, which may be effective in optimally managing blood sugar in this patient population. *Case Presentation:* We detail two older adults with diabetes living in assisted living facilities. The first case study describes the successful use of an insulin pump in an older adult with type 1 diabetes and dementia. The second case study demonstrates successful use of continuous glucose monitoring in an older adult with type 1 diabetes and dementia. *Discussion:* These case studies provide initial evidence that insulin pump and continuous glucose monitoring technologies can successfully be used by older adults with dementia and used to assist in diabetes management in an assisted living facility. *Clinical Implications:* Use of wearable diabetes technology improves the care of patients with diabetes. These case studies demonstrate initial evidence supporting improvement in the care of older adults with diabetes by the use of technology.

### ABOUT THE AUTHORS

Nancy A. Allen, PhD, ANP-BC is an assistant professor and an Adult Nurse Practitioner at the Cognitive Disorders Clinic. She completed a Mini-Fellowship in Cognitive Disorders after 17 years of practice and research in diabetes. She researches the use of technology in older adults to effect behavior changes.

Michelle L. Litchman PhD, FNP, FANP is an assistant professor and Family Nurse Practitioner at the Utah Diabetes and Endocrinology Center. She developed and directed a diabetes specialty house call program servicing older adults for several years. Her program of research is focused on how individuals manage their diabetes in the context of technology and peer health support.

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### PUBLIC INTEREST STATEMENT

Older adults with dementia and diabetes are at increased risk of complications, hospitalizations, and adverse events. This vulnerable patient population may have high glucose variability and an increased risk of low and high glucose numbers. Diabetes technology exists, including insulin pumps and continuous glucose monitors, which may be effective in optimally managing blood glucose in this patient population. Insulin pumps deliver rapid acting insulin 24 h/day and can be customized to fit patient's need. Continuous glucose monitors measure glucose every 5 min and present glucose readings in real-time. This case study details initial evidence of the successful use of insulin pump and CGM technologies in two older adults with dementia. Older adults with diabetes are living longer and will expect to take their insulin pumps and CGM devices with them to assisted care facilities. More research is needed in this population.

**Subjects: Bioscience; Behavioral Sciences; Education; Information Science; Medicine, Dentistry, Nursing & Allied Health**

**Keywords: caregivers; technology; assisted living facility < long-term care; dementia < neurological disorders**

### 1. Introduction

Diabetes affects about 30.3 million Americans and is associated with complications of myocardial infarction, cerebrovascular accidents, retinopathy, neuropathy, nephropathy (Center for Disease Control & Prevention, 2017), hypoglycemia and hypoglycemia unawareness (Weinstock et al., 2015) and in older adults, dementia (Lin & Sheu, 2013; Meneilly & Tessier, 2016). Diabetes incidence is rising (Imperatore et al., 2012), as is the number of older adults ( $\geq 65$  years old) (American Association of Retired Persons, 2016), Indeed, 8,000 baby boomers turned 70 every day in 2016 (American Association of Retired Persons, 2016). Individuals with diabetes are now living 15 years longer than those diagnosed in 1950–1960 (Miller, Secrest, Sharma, Songer, & Orchard, 2012).

Individuals with diabetes are 2–4 times more likely to develop dementia than those individuals without diabetes even when controlling for age and other comorbidities (McCrimmon, Ryan, & Frier, 2012; Umegaki et al., 2013). Patients with diabetes who develop cognitive impairment are at a significantly increased risk of a subsequent hospitalization for hypoglycemia (Punthakee et al., 2012; Yaffe et al., 2013). Hypoglycemia is a common and dangerous complication for older adults living with diabetes as it can cause cardiac events, loss of consciousness, falls, seizures, and hospitalizations (Desouza, Salazar, Cheong, Murgo, & Fonseca, 2003; Meneilly & Tessier, 2016; Schwartz et al., 2008). Older adults with diabetes are more prone to episodes of severe hypoglycemia due to impaired counter-regulation and impaired awareness of hypoglycemia (Meneilly & Tessier, 2016). Moreover, older adults with dementia have many dietary changes that can affect their glucose control. These changes can range from passivity, distraction, and a refusal to eat resulting in significant weight loss to hyperphagia and a preference towards eating sweets (Cipriani, Carlesi, Lucetti, Danti, & Nuti, 2016), all which can impact insulin resistance/sensitivity and timing of medications. Other factors that can influence glucose control in older adults with dementia are the behavioral and psychological symptoms of dementia. These behaviors include agitation, aberrant motor behavior, anxiety, elation, irritability, depression, apathy, disinhibition, delusions, hallucinations, and sleep changes (Cerejeira, Lagarto, & Mukaetova-Ladinska, 2012). The combination of dementia along with changes associated with counter-regulation, diet, physical activity, sleep and stress levels contribute to glucose variability making diabetes challenging to manage this vulnerable patient population. Two technologies provide promise in the management of diabetes in older adults with cognitive impairment and are presented in these original case studies. These case studies were identified in the clinical setting. Ethics review was not required for either case study because both patients noted below are now deceased from causes unrelated to diabetes.

### 2. Background

In the first case study, we describe the use of an insulin pump in an older adult with dementia in an assisted living facility. Insulin pumps are typically used in individuals with type 1 diabetes but can also be used in individuals with type 2 diabetes that require insulin therapy. The insulin pump contains a reservoir that is filled with insulin, is operated by a battery, and is run by a computer chip that permits the user to decide how much insulin to be delivered (MedicineNet.com, 2017). The insulin pump is attached to a thin plastic tube through which the insulin passes through. There is a soft plastic cannula that is left under the skin following insertion with a tiny needle. The cannula is changed every 2–3 days. The pump provides continuous insulin delivery, 24 h a day, and is referred to as the basal rate. The amount of basal insulin varies depending on variables such as exercise, stress, sleep, etc. The user also directs the pump to deliver a “bolus” of insulin before/during meals to cover the carbohydrates that are being ingested and to correct for any elevated glucose. There are many manufacturers of insulin pumps with a variety of features.

In the second case study, we describe the use of a real-time continuous glucose monitor (RT-CGM) in an older adult with dementia in an assisted living facility. A tiny glucose sensor is inserted under the skin with a small needle, once the needle retracts, the sensor stays in place with adhesive. Sensors are approved by the Federal Drug Administration (FDA) to be worn on the abdomen, although have been known to be placed in alternative location (Litchman & Woodruff, 2017). This sensor measures glucose levels in the interstitial fluid. The sensor is connected to a small transmitter that sends the glucose information via wireless radio frequency to a monitoring display device. The user(s) can set alarms to notify them if the glucose level is reaching a high or low limit. The monitor can display the current glucose level and historical glucose graphs.

### **2.1. Case presentation #1**

The patient was an 85 year old female with comorbid type 1 diabetes (diagnosed at age 32), hypertension, hypothyroidism and dementia. She resided in a 15-bed assisted living facility that provided medication management of her oral medications and meal preparation. Home health nurses visited three times daily, at meal times, to administer insulin. This patient was on less than 12 units of total daily insulin and she was prescribed prandial insulin in 0.5 unit increments (0.5 unit for every 18 carbohydrates consumed; correction factor of 0.5 unit for every 40 points greater than 150 mg/dl). Her weight was 96 lb and her diet varied. Following a dietary consult, the assisted living facility started to provide high calorie, high protein meals. Further, it was decided that the patient would be given insulin after meals given variability in her dietary intake. The main patient concerns were related to glucose variability, with fluctuations ranging between 39–476 mg/dl, hypoglycemia unawareness, and frequent dizziness episodes.

After consultation with the patient, family and health care team, insulin pump therapy was deemed useful to prevent hypoglycemia and to provide guidance on insulin dosing to decrease glucose variability problems. The home health nurses, assisted living facility staff, patient, and patient's daughter were all trained on the insulin pump therapy multiple times over a several week period. Given the patient's dementia, the initial 1-week insulin pump trial used saline only, in order to identify any concerns about the patient's ability to use the pump. There was concern that the patient would pull the pump site out or press the buttons on the pump. To avoid any concerns related to the patient wearing the insulin pump, a soft waist belt with a pocket was used to keep the insulin pump out of the patient's view. The safety lock was on the pump at all times to avoid accidental bolus. The staff checked the saline insulin pump site frequently.

Next insulin was placed in the insulin pump. The basal rate was calculated to give 70% of the Lantus dose over a 24 h period, 0.175 units per hour (standard of care is 80% of the basal insulin over a 24 h period), to avoid risk of hypoglycemia. The same insulin to carbohydrate ratio and correction factor was programmed into the pump. The patient's hypoglycemia mostly resolved, resulting in a glucose range between 108–276 mg/dl on a consistent basis; some hypoglycemia awareness returned, although not completely; and her dizziness resolved. The patient only experienced three failed insulin pump sites during her 4 years on an insulin pump. An insulin pump site failure occurs when the insulin site does not adequately infuse the insulin, usually because the catheter is dislodge or is inserted in hardened tissue. These site failure were identified by the assisted living facility staff and addressed immediately by home health nurses. The patient's overall wellbeing during her last 4 years of life, was improved by the use of an insulin pump by supporting the resolution of dizziness secondary to glycemic variability and avoidance of hypoglycemia.

### **2.2. Case presentation #2**

The patient was a 67 year old male with type 1 diabetes (diagnosed at age 24), dementia, hypertension, hyperlipidemia, and gastroesophageal reflux disease. His wife had supported him in making diabetes-related decisions when the patient needed extra support due to his dementia. After his wife's passing and with the encouragement of his primary care provider, he moved into lock-down unit at an assisted living facility. Subsequently, he began experiencing glucose variability and hypoglycemia. The assisted living facility provided meals, management of oral medications, and a gym

where the patient could exercise. Home health nurses visited the patient at meal time to administer insulin. He was taking Lantus 46 units at bedtime and Novolog before meals: 12 units with breakfast, 16 units with lunch, and 14 units with dinner. Additionally, he was taking a correction of 1 additional unit for every 40 points greater than 150.

The patient had glucose variability difficulties. It was decided that CGM would be useful to prevent hypoglycemia and to provide guidance on insulin dosing. The patient, daughter, assisted living facility staff and home health nurses were trained on CGM multiple times over a several week period. Sensor changes occurred every 7-days and CGM calibration every 12 h. The patient's primary care provider was consulted to remove acetaminophen from the PRN medication list to avoid interaction with the CGM readings. The patient wore CGM continuously. Although he had dementia, his long-term memory was intact and he was able to appropriately treat hypoglycemia based on the CGM glucose reading and arrow trends. While he was not permitted to give himself insulin due to his cognition, he was able to ingest rapid-acting carbohydrates when his glucose was trending low and avoid carbohydrates when his glucose was trending high. He monitored his CGM during his exercise routines, which included a stationary bicycle and free weights. Overall, the patient had fewer overall episodes of hypoglycemia and improved glucose variability that improved his wellbeing until he passed away five years after starting CGM.

### 3. Discussion

Our case studies provide initial evidence that Insulin pump and CGM technology can be successfully worn by older adults with cognitive impairments and can be used to assist in diabetes management. Both of these cases involved patients in assisted living facilities with professional home health nursing staff and family members that were supportive and engaged. Complications with this technology were minimal. There were only 3 failed insulin sites in a 4-year period in the first case study and no complications in the second case study. Both patients benefited from a reduction in hypoglycemia which is a well-known and serious problem in older adults with diabetes (Meneilly & Tessier, 2016).

The efficacy of insulin pump therapy has been shown in meta-analyses (Benkhadra et al., 2017; Pickup, Reznik, & Sutton, 2017) but only a few studies have been conducted in older adults on insulin pump therapy. In Type 1 diabetes, insulin pump therapy in older adults improves glycemic control and severe hypoglycemia rates (Rizvi, Petry, Arnold, & Chakraborty, 2001; Siegel-Czarkowski, Herold, & Golland, 2004). In Type 2 diabetes, insulin pump therapy reduces the time spent in hyperglycemia without an increase in the time spent in hypoglycemia (Herman et al., 2005; Reznik et al., 2014). Additionally, approximately 38% of participants with type 2 diabetes in the Optimize Study had mild cognitive impairment suggesting that insulin pump therapy can be used by older patients with cognitive impairments (Reznik et al., 2014). Older adults can benefit from insulin pump therapy in terms of glucose stability, but most notably in terms of reducing hypoglycemia episodes.

Three recent studies have shown the benefits of CGM in older adults. The Diamond Trial examined the effectiveness of RT-CGM in 116 adults  $\geq 60$  years of age with type 1 or type 2 diabetes using multiple daily insulin injections. The results showed a greater HbA1c reduction in the RT-CGM group than the control group ( $-0.9 \pm 0.7\%$  vs.  $-0.5 \pm 0.7\%$ ;  $p < .001$ ) and less glycemic variability in the RT-CGM group. Importantly, CGM use was high indicating that older adults were willing to use this technology in order to derive the metabolic benefits. Conversely, studies of younger adults and middle aged adults have shown low sensor use (Little et al., 2014; Tamborlane et al., 2008). A second study showed that older adults wearing RT-CGM had less severe hypoglycemia and less hypoglycemia resulting in a fall or inability to operate a motor vehicle (Litchman & Allen, 2017) when compared to older adults wanting to use this technology. Three themes were reported: (1) RT-CGM facilitates feeling of safety by preventing hypoglycemia, (2) RT-CGM improves well-being, and (3) access to RT-CGM for older adults is a barrier to use (Litchman & Allen, 2017). Finally, a third study showed that CGM use in older adults,  $\geq 65$  years with type 1 or type 2 diabetes, had greater reductions in severe hypoglycemia, ER visits and paramedic visits, better quality of life and less hypoglycemia fear and

diabetes distress when compared to those not using CGM (Polonsky, Peters, & Hessler, 2016). Our case study and these recent studies suggest promise for using CGM in older adults.

Older adults with diabetes may have vision loss from retinopathy, normal age-related decline, or other factors; decreased hand dexterity related to neuropathy, arthritis, weakness, or other factors; and hearing loss related to normal age-related decline or other factors. For older adults with vision loss, it is important to consider CGM and pump devices that have a dark font with a bright colorful screen. Older adults could greatly benefit from technology with remote monitoring capabilities that allow viewing on a larger device such as a tablet or large smartphone, a limitation under the current Center for Medicare and Medicaid Services (Center For Medicaid & Medicare Services, 2016). These larger tablets can also be useful for individuals with dexterity problems, who may have difficulty pushing the buttons on the CGM receiver. For blind users or those with dexterity problems, CGM technology can be set up to communicate with Alexa technology. Alexa technology can then be used to audibly tell the individual the glucose reading from the CGM monitor and the glucose trend direction (high or low) (Alexa Dexcom, 2017). For those with hearing loss, technology that use vibrations for alarms can be valuable, however, desirable future technology should include flashing lights for alarms as another means for alerting the hearing impaired. Beyond the development of and access to diabetes technologies for older adults, health systems that provide support to older adults, including assisted living facilities, long-term care facilities, and hospitals, must consider that individuals using diabetes technology now may want to continue their use of technology into older age. Workforce training may be necessary to support continuity of technology use in aging patients with diabetes.

#### 4. Limitations

With any technology, there are limitations to its use. Both assisted living facilities and home health agencies had time intensive training for the staff, in addition to the patient and family, to safely and successfully use these technologies. Insulin pump and CGM training should include multiple patient stakeholders and will likely take more time than a standard insulin pump or CGM training. A future study to examine the cost benefit analysis of insulin pump therapy and CGM in older adults and in assisted living facilities is necessary.

#### 5. Conclusion

We presented two case studies involving the use of an insulin pump and CGM in an older adults with dementia in assisted living facilities. Both patients benefited from reduced glucose variability and hypoglycemia. Recent research has supported the use of these technologies in older adults and have shown a high adherence rate to wearing the insulin pump and CGM. Moreover, a recent trial has shown that older adults with mild cognitive impairment can successfully use insulin pump therapy. Older adults with diabetes are living longer and will expect to take their insulin pumps and CGM devices with them to assisted care facilities. Since Medicare recently began coverage for CGM in adults over the age of 65, more research is needed in this population, including older adults residing in assisted living facilities. Our case studies provides initial evidence that older adults with diabetes and dementia residing in assisted living facilities can benefit from the use of insulin pump and CGM therapies.

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#### Competing Interests

The authors declare no competing interest.

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#### Cover image

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## References

- Alexa Dexcom. (2017). Retrieved from <https://www.youtube.com/watch?v=kP4ticipsaU>
- American Association of Retired Persons. (2016). *Boomers turn 70*. Retrieved from <http://www.aarp.org/politics-society/history/info-2016/baby-boomers-turning-70.html>
- Benkhadra, K., Alahdab, F., Tamhane, S. U., McCoy, R. G., Prokop, L. J., & Murad, M. H. (2017). Continuous subcutaneous insulin infusion versus multiple daily injections in individuals with type 1 diabetes: A systematic review and meta-analysis. *Endocrine*, 55(1), 77–84. doi:10.1007/s12020-016-1039-x
- Center for Disease Control and Prevention. (2017). *National diabetes statistic report, 2017*. Retrieved from <https://www.cdc.gov/diabetes/pdfs/data/statistics/national-diabetes-statistics-report.pdf>
- Center For Medicaid and Medicare Services. (2016). *Glucose monitor-policy article*. Retrieved from [https://www.cms.gov/medicare-coverage-database/shared/handlers/highwire.ashx?url=https://www.cms.gov/medicare-coverage-database/details/article-details.aspx@@@articleId\\$\\$\\$52464\\$\\$\\$ver\\$\\$\\$6\\$\\$\\$NCDId\\$\\$\\$222\\$\\$\\$ncdver\\$\\$\\$1\\$\\$\\$SearchType\\$\\$\\$Advanced\\$\\$\\$CoverageSelection\\$\\$\\$Both\\$\\$\\$NCSelection\\$\\$\\$NCA%7CCAL%7CNCND%7CMEDCAC%7CTA%7CMCD\\$\\$\\$ArticleType\\$\\$\\$Ed%7CKey%7CSAD%7CFAQ\\$\\$\\$PolicyType\\$\\$\\$Final\\$\\$\\$s\\$\\$\\$All\\$\\$\\$KeyWord\\$\\$\\$Glucose+monitor\\$\\$\\$KeyWordLookup\\$\\$\\$Title\\$\\$\\$KeyWordSearchType\\$\\$\\$And\\$\\$\\$kq\\$\\$\\$true\\$\\$\\$bc\\$\\$\\$IAAACAAAAAAA\\$\\$\\$\\$\\$\\$&session=1gfnkmis4g24awzuv2nrvbw&kq=1176506763](https://www.cms.gov/medicare-coverage-database/shared/handlers/highwire.ashx?url=https://www.cms.gov/medicare-coverage-database/details/article-details.aspx@@@articleId$$$52464$$$ver$$$6$$$NCDId$$$222$$$ncdver$$$1$$$SearchType$$$Advanced$$$CoverageSelection$$$Both$$$NCSelection$$$NCA%7CCAL%7CNCND%7CMEDCAC%7CTA%7CMCD$$$ArticleType$$$Ed%7CKey%7CSAD%7CFAQ$$$PolicyType$$$Final$$$s$$$All$$$KeyWord$$$Glucose+monitor$$$KeyWordLookup$$$Title$$$KeyWordSearchType$$$And$$$kq$$$true$$$bc$$$IAAACAAAAAAA$$$$$$&session=1gfnkmis4g24awzuv2nrvbw&kq=1176506763)
- Cerejeira, J., Lagarto, L., & Mukaetova-Ladinska, E. B. (2012). Behavioral and psychological symptoms of dementia. *Frontiers in neurology*, 3, 73. doi:10.3389/fneur.2012.00073
- Cipriani, G., Carlesi, C., Lucetti, C., Danti, S., & Nuti, A. (2016). Eating behaviors and dietary changes in patients with dementia. *American Journal of Alzheimer's Disease & Other Dementias*, 31(8), 706–716. doi:10.1177/1533317516673155
- Desouza, C., Salazar, H., Cheong, B., Murgo, J., & Fonseca, V. (2003). Association of hypoglycemia and cardiac ischemia: A study based on continuous monitoring. *Diabetes Care*, 26(5), 1485–1489. <https://doi.org/10.2337/diacare.26.5.1485>
- Herman, W. H., Ilag, L. L., Johnson, S. L., Martin, C. L., Sinding, J., Al Harthi, A., ... Raskin, P. (2005). A clinical trial of continuous subcutaneous insulin infusion versus multiple daily injections in older adults with type 2 diabetes. *Diabetes Care*, 28(7), 1568–1573. doi:10.2337/diacare.28.7.1568
- Imperatore, G., Boyle, J. P., Thompson, T. J., Case, D., Dabelea, D., Hamman, R. F., ... Standiford, D. (2012). Projections of type 1 and type 2 diabetes burden in the U.S. population aged < 20 years through 2050: Dynamic modeling of incidence, mortality, and population growth. *Diabetes Care*, 35(12), 2515–2520. doi:10.2337/dc12-0669
- Lin, C. H., & Sheu, W. H. (2013). Hypoglycaemic episodes and risk of dementia in diabetes mellitus: 7-Year follow-up study. *Journal of Internal Medicine*, 273(1), 102–110. doi:10.1111/joim.12000
- Litchman, M. L., & Allen, N. A. (2017). Real-time continuous glucose monitoring facilitates feelings of safety in older adults with type 1 diabetes: A qualitative study. *Journal of Diabetes Science and Technology*, 1932296817702657. doi:10.1177/1932296817702657
- Litchman, M. L., & Woodruff, W. (2017). *Photosurveillance of Non-FDA approved activity in the diabetes online community*. Paper presented at the 44th Annual meeting of the American Association of Diabetes Educators, Indianapolis, IN.
- Little, S. A., Leelarathna, L., Walkinshaw, E., Tan, H. K., Chapple, O., Lubina-Solomon, A., ... Shaw, J. A. (2014). Recovery of hypoglycemia awareness in long-standing type 1 diabetes: a multicenter 2 x 2 factorial randomized controlled trial comparing insulin pump with multiple daily injections and continuous with conventional glucose self-monitoring (HypoCOMPaSS). *Diabetes Care*, 37(8), 2114–2122. doi:10.2337/dc14-0030
- McCrimmon, R. J., Ryan, C. M., & Frier, B. M. (2012). Diabetes and cognitive dysfunction. *The Lancet*, 379(9833), 2291–2299. doi:10.1016/S0140-6736(12)60360-2
- MedicineNet.com. (2017). *Medical definition of insulin pump*. Retrieved from <http://www.medicinenet.com/script/main/art.asp?articlekey=22443#>
- Meneilly, G. S., & Tessier, D. M. (2016). Diabetes, Dementia and Hypoglycemia. *Canadian Journal of Diabetes*, 40(1), 73–76. doi:10.1016/j.jcjd.2015.09.006
- Miller, R. G., Secrest, A. M., Sharma, R. K., Songer, T. J., & Orchard, T. J. (2012). Improvements in the life expectancy of type 1 diabetes: The Pittsburgh Epidemiology of Diabetes Complications study cohort. *Diabetes*, 61(11), 2987–2992. doi:10.2337/db11-1625
- Pickup, J. C., Reznik, Y., & Sutton, A. J. (2017). Glycemic control during continuous subcutaneous insulin infusion versus multiple daily insulin injections in type 2 diabetes: Individual patient data meta-analysis and meta-regression of randomized controlled trials. *Diabetes Care*, 40(5), 715–722. doi:10.2337/dc16-2201
- 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*. doi:10.1177/1932296816643542
- Punthakee, Z., Miller, M. E., Launer, L. J., Williamson, J. D., Lazar, R. M., Cukierman-Yaffee, T., ... Gerstein, H. C. (2012). Poor cognitive function and risk of severe hypoglycemia in type 2 diabetes: Post hoc epidemiologic analysis of the ACCORD trial. *Diabetes Care*, 35(4), 787–793. doi:10.2337/dc11-1855
- Reznik, Y., Cohen, O., Aronson, R., Conget, I., Runzis, S., Castaneda, J., & Lee, S. W. (2014). Insulin pump treatment compared with multiple daily injections for treatment of type 2 diabetes (OpT2mise): A randomised open-label controlled trial. *The Lancet*, 384(9950), 1265–1272. doi:10.1016/S0140-6736(14)61037-0
- Rizvi, A. A., Petry, R., Arnold, M. B., & Chakraborty, M. (2001). Beneficial effects of continuous subcutaneous insulin infusion in older patients with long-standing type 1 diabetes. *Endocrine Practice*, 7(5), 364–369. doi:10.4158/ep.7.5.364
- Schwartz, A. V., Vittinghoff, E., Sellmeyer, D. E., Feingold, K. R., Rekenire, N., Strotmeyer, E. S., ... Harris, T. B. (2008). Diabetes-related complications, glycemic control, and falls in older adults. *Diabetes Care*, 31(3), 391–396. doi:10.2337/dc07-1152
- Siegel-Czarkowski, L., Herold, K. C., & Goland, R. S. (2004). Continuous subcutaneous insulin infusion in older patients with type 1 diabetes. *Diabetes Care*, 27(12), 3022–3023. <https://doi.org/10.2337/diacare.27.12.3022>
- Tamborlane, W. V., Beck, R. W., Bode, B. W., Buckingham, B., Chase, H. P., Clemons, R., ... Xing, D. (2008). Continuous glucose monitoring and intensive treatment of type 1 diabetes. *New England Journal of Medicine*, 359(14), 1464–1476. doi:10.1056/NEJMoa0805017
- Umegaki, H., Hayashi, T., Nomura, H., Yanagawa, M., Nonogaki, Z., Nakshima, H., & Kuzuza, M. (2013). Cognitive dysfunction: An emerging concept of a new diabetic complication in the elderly. *Geriatrics & Gerontology International*, 13(1), 28–34. doi:10.1111/j.1477-0594.2012.00922.x
- Weinstock, R. S., DuBose, S. N., Bergenstal, R. M., Chaytor, N. S., Peterson, C., Olson, B. A., ... Hirsch, I. B. (2015). Risk factors associated with severe hypoglycemia in older adults with type 1 diabetes. *Diabetes Care*. doi:10.2337/dc15-1426
- Yaffe, K., Falvey, C. M., Hamilton, N., Harris, T. B., Simonsick, E. M., Strotmeyer, E. S., ... Schwartz, A. V. (2013). Association between hypoglycemia and dementia in a biracial cohort of older adults with diabetes mellitus. *JAMA Internal Medicine*, 173(14), 1300–1306. doi:10.1001/jamainternmed.2013.6176



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