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Implementing a Basal-Bolus Insulin Regimen Via a Manual Insulin Pump Device

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Abstract

Purpose: The purpose of this evidence-based practice project is to decrease glycated hemoglobin (HgbA1C) levels by initiating use of a manual insulin pump in patients with Type II Diabetes Mellitus (T2DM) with poor glycemic control who are on multiple daily insulin injections (MDII).

Background: Uncontrolled hyperglycemia is associated with a myriad of complications and co-morbidities that are generally associated with vascular changes that include nephropathy, neuropathy, blindness, stroke, and heart disease (Winter et al., 2015). Coronary artery disease and cerebrovascular disease alone accounts for approximately 65% of the deaths in diabetic patients (Molinaro & Dauscher, 2017). Achieving and maintaining therapeutic glycemic levels, blood pressure, and lipid control is essential in the prevention of these complications (Molinaro & Dauscher, 2017). A randomized clinical trial showed that initiation of a manual insulin pump in patients with T2DM with poor glycemic control reduced HgbA1C levels by ≥1% in 73% of patients (Lajara, Nikkel, et al., 2016). A meta-analysis study showed that at 6 months, HgbA1C levels decreased 1.1% with use of an insulin pump compared to a 0.4% reduction with MDII (Reznik et al., 2014).

Medical expenditures are approximately 2.3 times higher for people with diabetes than those without diabetes (American Association of Diabetes, 2018). Diabetic medications account for 43% of the medical burden with almost $15 billion spent on insulin alone, putting the total estimated cost of diabetes in the U.S. at $327 billion (ADA, 2018).

Outcomes: The goal for this project is ≥1% reduction in HgbA1c.

Process: Patients with T2DM in a southern California underserved community health center were assessed and identified for eligibility for placement of a manual insulin pump device. Data collection included HgbA1C levels prior to initiation of the pump and post-initiation per clinic protocols and provider orders. Patients were followed up for ongoing education and assessment as needed by the clinical pharmacist and clinic providers.

Results: Use of the insulin pump showed a mean significant decrease of -1.26% in HgbA1C levels.

Implications for Clinical Practice: The implementation of a simple insulin delivery system that improves glycemic controls in patients with T2DM is an evidence-based strategy providers can use to help patients manage uncontrolled diabetes, improve national diabetes score outcomes, lessen complications, increase treatment persistency and decrease harmful sequelae resulting from poorly controlled glycemic indexes.

Conclusions: Delivery via a basal-bolus regimen is still the gold standard for insulin therapy, and innovations in insulin delivery systems have helped patients achieve therapeutic glycemic levels. Initiating simple insulin delivery systems into eligible diabetic patient populations who have failed other pharmacological therapy may decrease financial expenditures, complications, and comorbidities associated with this disease.

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Background and Evidence for the Problem

Since 1980, the number of people in the United States (US) with diabetes has increased fourfold (Carls et al., 2017). The Center for Disease Control (CDC) estimates that in 2018, the U.S. had 1.5 million new cases of diabetes in the adult population (Center for Disease Control, 2020). In 2017, an estimated 24.7 million people in the US had a diagnosis of diabetes estimating the cost of diabetes at $327 billion, a figure that includes direct health care expenditures, lost productivity, disability related unemployment, and premature mortality (ADA, 2018).

Annually, the average medical expenses for a person with diabetes is about $16,750 - approximately 2.3 times higher for people with diabetes than for those without diabetes. Diabetic medications alone are accountable for 43% of the medical burden and include an almost $15 billion price tag for insulin alone. In 2017, approximately 25% of the projected 162 million hospital inpatient days, 25% nursing home and residential facility days, and 50% of outpatient office visits, emergency department (ED) visits, and physician office visits were incurred by patients with diabetes (ADA, 2018).

Uncontrolled hyperglycemia is associated with a myriad of complications and co-morbidities that are generally associated with vascular changes that include nephropathy, neuropathy, blindness, stroke, and heart disease (Winter et al., 2015). Coronary artery disease and cerebrovascular disease alone accounts for approximately 65% of the deaths in patients with diabetes (Molinaro & Dauscher, 2017). Achieving and maintaining therapeutic glycemic levels, blood pressure, and lipid control is essential in the prevention of these complications (Molinaro & Dauscher, 2017).

Evidence-Based Intervention and Benchmark

Optimal Insulin Therapy Regimen

Diabetic treatment is generally guided by HgbA1C levels and is used by multiple organizations as a measure of quality of care for Type 2 Diabetes Mellitus (T2DM) including the National Quality Forum, and is also utilized in Medicare star ratings, and the Healthcare Effectiveness Data and Information Set. Both the American Diabetes Association (ADA) and the European Association for the Study of Diabetes (EASD) utilize the HgbA1C levels as a target for clinical guidelines (Carls et al., 2017).

The ADA, EASD, and the American Association of Clinical Endocrinologists all acknowledge the efficacy of utilizing a multi-drug, individualized approach to achieve HgbA1C goals in the absence of therapeutic glycemic control. Most often when a patient has failed to reach A1C goals on oral therapies, the first step recommended in insulin therapy is initiation of basal insulin. This is often effective for controlling fasting plasma glucose (FPG) but does not usually achieve adequate postprandial plasma glucose (PPG) levels (Hinnen, 2015). There are inherent risks associated with adding mealtime insulin to a patient's regimen including hypoglycemia, weight gain, and the burden of frequent glucose self-monitoring. Despite these risks, basal-bolus insulin therapy remains the gold standard for insulin therapy, and allows doses to be altered and individualized to achieve therapeutic glycemic control (Hinnen, 2015).

Compliance with MDI

Initiating insulin therapy in patients with T2DM often presents with significant barriers to achieving treatment adherence and persistence. Depending on the patient population studied and the standard of measurement used, rates of compliance for insulin use vary from 30% to 86% (Guerci et al., 2019). As a patient's medication regimen becomes more complex, including,

notably, an increase in frequency of insulin injections, so too does the risk of nonadherence and poor treatment persistence (Guerci et al., 2019). Common adherence barriers identified by patients with T2DM include injection site reactions, time consuming and complicated insulin therapy regimen, number of required insulin injections, requirement for dosing at specific times, travelling, fear of hypoglycemia, and interference with lifestyle, weight gain, forgetfulness, embarrassment of injections in public, and sick days (Sarbacker & Urteaga, 2016). Missing only four prandial insulin injections per week over three months has been correlated with an almost 1% increase in HgbA1C levels (Lajara, Nikkel, et al., 2016). Up to 57% of patients on MDI report missing injections with up to 20% of these patients report missing injections regularly (Lajara, Davidson et al., 2016).

Nonadherence to insulin therapy is associated with an increase in hospitalizations, ED visits, worse health outcomes, and an increased all-cause mortality (DiBonaventura et al., 2014). A significant economic burden of nonadherence to insulin therapy is also primarily associated with increased hospital and ED admissions. A study involving a large cohort of patients showed that an increase in medication compliance decreased hospitalizations or ED visits by 13% resulting in an annual cost-savings of $4.68 billion (Kennedy-Martin et al., 2017).

Benefits of Continuous Subcutaneous Insulin Infusion vs Multiple Daily Insulin Injections

Finding ways of mitigating nonadherence and addressing barriers is essential to achieving optimal medication compliance and therapeutic glycemic control. Continuous subcutaneous insulin infusion (CSII) can be more effective than multiple daily insulin injections (MDII) in the treatment of Type 1 Diabetics (T1DM) and T2DM with poor glycemic control (Pickup et al., 2017).

Initiation of a manual insulin pump in patients with T2DM with poor glycemic control has been shown to reduce HgbA1C levels by ≥1% in 73% of patients (Lajara, Nikkel, et al., 2016). Of a cohort of patients who previously did not achieve glycemic targets despite intense medication therapies, 71% of those placed on the CSII achieved glycemic targets (Lajara, Nikkel, et al., 2016). A meta-analysis study of 590 poorly controlled T2DM patients showed HgbA1C levels decreased 1.1% with use of an insulin pump compared to a 0.4% reduction with MDII (Reznik et al., 2014). Further, patients utilizing a manual insulin pump to deliver CSII therapy also achieved better glycemic control while using less insulin (Lajara, Davidson, et al., 2016; Pickup et al., 2017).

Requiring one daily insulin injection versus four results in significantly higher treatment adherence rates of 78.3% vs 60.8% (Guerci et al., 2019). Manual insulin pumps may be a solution that obviates the need for MDI, addressing many of the barriers to adherence as identified by the T2DM patient population.

Benchmark

Every 1% in HbgA1C reduction is associated with a 37% reduction in microvascular complications, a 14% reduction in myocardial infarctions, and a 21% reduction in diabetes-associated death rates (Lajara, Nikkel, et al., 2016). Initiating use of CSII via use of a manual insulin pump has shown significant reduction of ≥1% HgbA1C levels in patients who previously had achieved no therapeutic change despite aggressive pharmacological interventions (Lajara, Nikkel, et al., 2016). The benchmark for this project is a ≥1% reduction in HgbA1C levels.

Evidence-Based Practice Question (PICO)

Does implementing the use of a manual basal-bolus insulin pump for patients with insulin dependent T2DM compared to multiple daily insulin injections (MDII) result in lower HgbA1C levels?

Project Plan Process

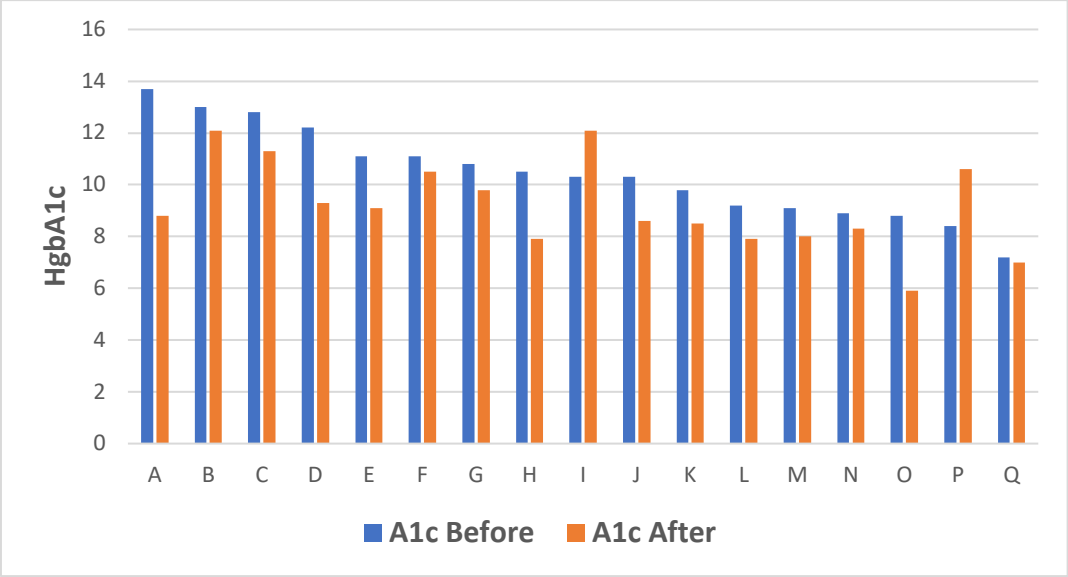
The site for this project was a southern California underserved community health center. Stakeholder buy-in, administration permission, and IRB approval were obtained prior to initiation of the implementation of the project and data collection. Patients with T2DM with uncontrolled HgbA1C levels who had failed previous pharmacological therapy were identified for placement of a manual insulin pump device. Data collection included HgbA1C levels prior to initiation of the pump and post-initiation per clinic protocols and provider orders. Patients were followed up for ongoing education and assessment as needed by the clinical pharmacist and clinic providers.

Evaluation Results

Data were collected and analyzed on a sample population of 17 adult male and female patients. There was a significant decrease in HgbA1C levels in all but two patients who were placed on the manual insulin pump. Data are presented in Figure 1. The mean difference in HgbA1C levels was -1.26% which meets the anticipated benchmark of a reduction of ≥1% for this project.

Figure 1

Pre/Post Hemoglobin A1C Levels



Note. N= 17. **Significant reduction in HgbA1c after placement of insulin pump (Mean Difference -1.26, *t* = 3.12, *p* < .01).**

Overall, patients' comments about what they liked about the pump included not needing multiple daily injections, not feeling the pump needle, and an increased level of flexibility and freedom. Patients' caregivers reported the pump's ease of use for their elderly patients. Patients reported disliking the pump for a variety of reasons including feeling it on the abdomen when they sleep, feeling the needle when they move, trouble with needle retraction when removing the device, difficulty removing the pump, and confusion with the prescribed therapy.

Barriers

Barriers identified during this project included language and socio-economic factors contributing to comprehension difficulties regarding the pump device and prescribed therapy and non-adherence of follow-up visits. Very few insurance barriers were identified as both Medi-Cal and Medicare insurances covered the pump.

Cost-Benefit Analysis

Evidence from real-world studies shows that patients who switch from MDI therapy to a manual insulin pump often require less insulin resulting in pharmacy savings up to $119.30 per month (Lajara, Nikkel, et al., 2016). Persistence use of a manual insulin pump vs MDI demonstrated cost-effectiveness by an incremental pharmacy cost-savings of $695.61 per every 1% decrease in HgbA1C (Everitt et al., 2018). Research also suggests that decreased compliance, as has been documented with MDI therapy vs CSII therapy, results in worse health outcomes and increased overall healthcare costs (ADA, 2018; DiBonaventura et al., 2014; Guerci et al., 2019).

Implications for Clinical Practice (Sustainability)

Initiating use of a manual insulin pump into an outpatient primary care or endocrine clinic setting has a high level of sustainability. Trained healthcare providers supported by company representatives facilitate patient education and adherence with follow-up visits. The pump is a simple manual device and has no tubing, complicated settings, or batteries resulting in few, if any, documented device malfunctions or complications. The pump requires only one type of insulin and patients do not require increased follow-up visits after initial education and device check visits. The pump is usually covered by insurance companies including Medicare along with reimbursement and insurance guidance offered by the manufacturer and company representatives (Zealand Pharma, 2020).

Facilitating factors contributing to successessful implementation of manual insulin pumps was the clinic buy-in. The clinical pharmacist met individually with all patients for education and follow-up visits. Additionally, the clinic opened a diabetes clinic where patients were able to obtain follow up visits and care rather than waiting to see their primary care provider for any diabetes-related concerns or questions. The implementation of a simple insulin delivery system

that improves glycemic controls in T2DM is an evidence-based and sustainable strategy primary care providers can use to help patients manage uncontrolled diabetes, improve national diabetes score outcomes, lessen complications, and decrease harmful sequelae resulting from poorly controlled glycemic indexes.

Conclusion

Diabetes is a world-wide epidemic disease that is only increasing in numbers creating an enormous economic and healthcare burden globally (da Rocha Fernandes et al., 2016). Therapeutic glycemic control is of paramount importance in decreasing adverse effects associated with diabetes. Improvements and innovations in insulin delivery systems have helped patients achieve therapeutic glycemic levels and improved quality of life. Initiating insulin delivery systems based on the latest literature evidence into eligible diabetic patient populations may have lasting impact on quality of life, financial expenditures, and comorbidities associated with this disease.

There are multiple factors to consider in the treatment of diabetes, including patients' preferences and lifestyle, body mass index (BMI), severity of disease, and glycemic control (Hinnen, 2015). Initiation of a manual insulin pump that delivers a basal-bolus insulin regimen into the populations with T2DM who have failed MDI and aggressive pharmacological therapy has been shown to be an effective way of lowering HgbA1C levels while addressing many patient concerns that contribute to failed MDI therapy.

Results of this evidence-based practice project showed 88% of patients achieving a mean decreased HgbA1C levels of -1.26%. Limitations of this study include a small sample size and a short duration of time. Further studies would be helpful in measuring compliance, sustainability, and HgbA1C scores over a greater length of time with a larger sample size.

References

American Diabetes Association (2018). Economic costs of diabetes in the U.S. in 2017. *Diabetes Care*, dci180007. https://doi.org/10.2337/dci18-0007

Carls, G., Huynh, J., Tuttle, E., Yee, J., & Edelman, S. V. (2017). Achievement of glycated hemoglobin goals in the US remains unchanged through 2014. *Diabetes Therapy*, *8*(4), 863–873. https://doi.org/10.1007/s13300-017-0280-5

Centers for Disease Control and Prevention (2020). National diabetes statistics report. https://www.cdc.gov/diabetes/data/statistics/statistics-report.html

da Rocha Fernandes, J., Ogurtsova, K., Linnenkamp, U., Guariguata, L., Seuring, T., Zhang, P., Cavan, D., & Makaroff, L. E. (2016). IDF Diabetes atlas estimates of 2014 global health expenditures on diabetes. *Diabetes Research and Clinical Practice*, *117*, 48–54. https://doi.org/10.1016/j.diabres.2016.04.016

DiBonaventura, M., Wintfeld, N., Huang, J., & Goren, A. (2014). The association between nonadherence and glycated hemoglobin among type 2 diabetes patients using basal insulin analogs. *Patient Preference and Adherence*, *8*, 873–882. PubMed. https://doi.org/10.2147/PPA.S55550

Everitt, B., Harrison, H. C., Nikkel, C., Laswell, E., & Chen, A. M. H. (2018). Clinical and economic considerations based on persistency with a novel insulin delivery device versus conventional insulin delivery in patients with type 2 diabetes: A retrospective analysis. *Research in Social and Administrative Pharmacy*. https://doi.org/10.1016/j.sapharm.2018.09.016

Guerci, B., Chanan, N., Kaur, S., Jasso-Mosqueda, J. G., & Lew, E. (2019). Lack of treatment persistence and treatment nonadherence as barriers to glycaemic control in patients with

type 2 diabetes. *Diabetes Therapy*, *10*(2), 437–449. https://doi.org/10.1007/s13300-019-0590-x

Hinnen, D. A. (2015). Therapeutic options for the management of postprandial glucose in patients with type 2 diabetes on basal insulin. *Clinical Diabetes: A Publication of the American Diabetes Association*, *33*(4), 175–180. PubMed. https://doi.org/10.2337/diaclin.33.4.175

Kennedy-Martin, T., Boye, K. S., & Peng, X. (2017). Cost of medication adherence and persistence in type 2 diabetes mellitus: A literature review. *Patient Preference and Adherence*, *11*, 1103–1117. PubMed. https://doi.org/10.2147/PPA.S136639

Lajara, R., Davidson, J. A., Nikkel, C. C., & Morris, T. L. (2016). Clinical and cost-effectiveness of insulin delivery with v-go® disposable insulin delivery device versus multiple daily injections in patients with type 2 diabetes inadequately controlled on basal insulin. *Endocrine Practice*, *22*(6), 726–735. https://doi.org/10.4158/EP151182.OR

Lajara, R., Nikkel, C., & Abbott, S. (2016). The clinical and economic impact of the v-go(®) disposable insulin delivery device for insulin delivery in patients with poorly controlled diabetes at high risk. *Drugs - Real World Outcomes*, *3*(2), 191–199. PubMed. https://doi.org/10.1007/s40801-016-0075-4

Molinaro, R., & Dauscher, C. (2017). Complications resulting from uncontrolled diabetes. *MLO: Medical Laboratory Observer*, *49*(2), 20–22. rzh. http://web.a.ebscohost.com.sandiego.idm.oclc.org/ehost/pdfviewer/pdfviewer?vid=2&sid=fc7100f1-864a-4efa-aa70-eb33b4b2926a%40sdc-v-sessmgr03

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. https://doi.org/10.2337/dc16-2201

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. https://doi.org/10.1016/S0140-6736(14)61037-0

Sarbacker, G. B., & Urteaga, E. M. (2016). Adherence to insulin therapy. *Diabetes Spectrum*, *29*(3), 166. https://doi.org/10.2337/diaspect.29.3.166

Winter, A., Lintner, M., & Knezevich, E. (2015). V-Go insulin delivery system versus multiple daily insulin injections for patients with uncontrolled type 2 diabetes mellitus. *Journal of Diabetes Science and Technology*, *9*(5), 1111–1116. https://doi.org/10.1177/1932296815580361

Zealand Pharma (2020). "Coverage and cost savings made simple". Retrieved April 3, 2020 from https://www.go-vgo.com/coverage-savings/overview/ .