Dominican Republic Diabetes Project: Insulin Delivery to a Rural Community and a Retrospective Review

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Scholarly Report Title: Dominican Republic Diabetes Project: Insulin delivery to a rural community and a retrospective review

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Abstract

Purpose:

A non-governmental organization (NGO) conducts short-term medical missions in the Dominican Republic. Diabetes (DM) diagnosis and treatment, including a recent pilot of insulin, is an important practice of the NGO clinic. Here we report on 1) initial outcomes of the insulin treatment program (clinical component) and 2) longer-term blood glucose control among patients diagnosed with DM (research component).

Methods:

In the clinical component, patients identified with uncontrolled DM had baseline HbA1c measurements drawn before starting insulin and were trained by community health workers (CHWs) to use insulin. The patients reported daily fasting blood glucose measurements to the CHWs for insulin dose titration. Follow-up was scheduled for three and six months after starting insulin.

In the research component, charts were reviewed at the NGO clinic for patients diagnosed with diabetes between 2004 and 2018. Researchers recorded baseline characteristics and outcome measurements of diabetic patients. We examined HbA1c over time, defining a "target" HbA1c measurement of 1% decrease compared to baseline or a measurement less than 8%. We estimated the proportion of measurements at which the target was met.

Results:

In the clinical component, four patients began insulin treatment in late June 2018. There were no episodes of hypoglycemia. Patients reported 93% of expected daily fasting blood glucose measurements. The median net change in HbA1c compared to baseline after three months of insulin was -0.7 (IQR: -1.9, 0.8) %. The median net change in HbA1c from baseline after six months was -1.1 (IQR: -2.9, 1.1) %. One patient discontinued insulin after five months.

In the research component, we found 170 patients with DM. 53.5% were female. The median age at DM diagnosis was 56 (IQR: 49, 67) years. DM patients had their disease followed at the NGO clinic for a median duration of 4.8 (IQR: 1.5, 7.4) years. 71% of diabetic patients had

hypertension. 51% of the patients had two or more comorbidities at the time of diagnosis. A median of 2 (IQR: 1, 5) follow-up HbA1c measurements were available per patient, 1 (IQR: 0, 3) measurement of which was at target. 56% of patients had at least one HbA1c measurement at target.

Conclusions:

The NGO was able to successfully and safely introduce insulin therapy in a rural setting. Increased frequency of HbA1c monitoring in diabetic patients and expanded insulin use are recommended. Follow-up among the diabetes patients is limited and may be more frequent among diabetes patients with better glycemic control.

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Glossary of Abbreviations (alphabetical order)

BMI: body mass index

CDC: Center for Disease Control

CHW: community health worker

DM: diabetes mellitus

DR: Dominican Republic

e.g.: for example

etc.: et cetera

FSBG: finger stick blood glucose

HbA1c: hemoglobin A1c

HLD: hyperlipidemia

HMS: Harvard Medical School

HTN: hypertension

IDF: International Diabetes Federation

i.e.: in other words

IQR: interquartile range

IRB: Institutional Review Board

iStat: iStat venous blood analyzer glucose measurements

kg/m^2: kilogram per meters-squared

LMIC: low and middle income countries

MD: Doctor of Medicine

mg/dL: milligrams per deciliter

MPH: Master of Public Health

NCD: non-communicable disease

NGO: non-governmental organization

NPH: neutral protamine Hagedorn

SA: Somos Amigos Medical Missions

Sc.D.: Doctor of Science

SFU: sulfonylurea

STMM: short-term medical missions

WHO: World Health Organization

Section 1: Introduction

Diabetes mellitus (DM) is a chronic, non-communicable disease (NCD) that affects millions of people worldwide. It is estimated that the prevalence of DM will increase greatly over the next decade [1]. This rise in the number of people with DM will correspond to a large increase in health expenditures [2]. While the number of people with DM is expected to rise, the International Diabetes Federation (IDF) estimates that over 200 million people ages 20-79 years with DM have not been diagnosed and remain unaware of their illness [3]. While prompt screening and diagnosis are important strategies to reduce diabetes at the population level, most treatments often fail to completely control blood sugars [4-6]. A World Health Organization (WHO) study found that more than 70% of patients with DM across seven different countries did not reach blood glucose treatment targets set by the IDF [4]. In low income patient populations, multiple studies have shown that access to health insurance correlates to better control of blood glucose [4, 6, 7].

Most new diagnoses of DM in adults will occur in low and middle income countries (LMICs) over the next decade [1]. Researchers estimate that by 2030, the number of people with DM in Latin America and the Caribbean will increase by 148% [8]. In the Dominican Republic (DR), the IDF estimates that the national prevalence of DM is 8.1%, including over 186,000 adults living with undiagnosed DM [3]. In the coming decades, the combination of rising prevalence of DM and increased diagnosis due to more readily available screening techniques presents a formidable challenge to diabetes management in the DR.

Although the Dominican government passed a law in 2008 to establish a national health insurance system, about 55-65% of the population lacks adequate coverage [9]. Accordingly, a 2016 World Bank assessment states that the inconsistent quality of public health services causes most households to pay out of pocket for private medical care [10]. With this understanding of the Dominican health system taken in account, one may anticipate that the average patient with diabetes in the DR may lack access to consistent, high quality treatment that will optimize his/her disease outcomes.

Somos Amigos Medical Missions (SA) is a non-governmental organization (NGO) that has operated a free primary care medical clinic in the rural farming community of El Naranjito,

DR for the past twenty years. The organization operates on a short-term medical missions (STMM) model – with groups of volunteer American physicians traveling to staff the clinic and treat patients for one week, four times per year (one week in January, April, July, and October months). The clinic is otherwise closed when not staffed by American physicians. While there are many different iterations of the STMM model, there is no significant evidence to support any delivery of care framework [11]. Although most STMM clinics eschew research due to the view that it is a "luxury," most literature surrounding this care model supports the notion that analyzing outcomes is an essential part of providing high quality care [11].

Prior to the summer of 2018, the SA NGO had never measured the outcomes of its diabetic patient population. It is important for this organization to discern the outcomes in this diabetic cohort in order to optimize treatment for this population. Additionally, there is a small number of patients with severe, uncontrolled diabetes despite oral medication therapy. Their HbA1c measurements remain dangerously elevated above acceptable limits. However, prior to the summer of 2018 the NGO clinic never had the logistical capacity to offer insulin to patients.

This project aimed to measure outcomes of the diabetic patient population treated by the SA clinic in rural DR. The specific question this project attempted to answer is: What are the outcomes for diabetic patients treated by a local primary care clinic (Somos Amigos Medical Missions) in rural DR?

The project contains a clinical and research component. In the clinical component, Mark Yost, a fourth year medical student at Harvard Medical School (HMS), volunteered as a community health worker (CHW) in the SA organization to implement an insulin delivery program to a small group diabetic patients who suffered from uncontrolled diabetes despite appropriate oral medication therapy. In the research component, Mark conducted a retrospective records review to measure outcomes of all diabetic patients who have been treated at the SA medical clinic.

The project hypothesized that those patients with severe enough disease to require insulin therapy will see a benefit (e.g., a decrease in HbA1c less than 1.0% or HbA1c $\leq$8.0%) from three-to-six months of insulin therapy. The project also hypothesized that the majority of patients treated by the clinic will have HbA1c measurements less than 8.0% and will consistently show blood glucose measurements less than 182.9 mg/dL.

This project is novel because, prior to summer of 2018, the SA clinic had 1.) never offered insulin to patients as part of treatment for diabetes, and 2.) had never conducted a records review of their patient population to measure outcomes and assess performance. The clinical component of the project, if successfully implemented, can provide a template for other STMM health clinics to begin insulin therapy in diabetic patients. The research component will contribute to the field of STMM outcomes research by assessing the feasibility of treating diabetes over a period of time in a rural, LMIC community. This project also will make recommendations to alter clinical practices and improve glycemic control based on the findings of the research component.

Section 2: Student Role

Mark Yost (also referred to as "medical student") began planning his scholarly project one year before it commenced. During the summer of 2017, Mark met with Frank Brightwell, the executive director of the SA NGO, to discuss the possibility of a diabetes project in the DR. They devised a two-pronged project: implementing an insulin delivery system to uncontrolled diabetic patients (i.e., the clinical component) and a retrospective records review of all diabetic patients at the SA NGO clinic (i.e., the research component). Mark then found a HMS mentor, Dan Palazuelos, MD, MPH, to guide him through this project.

Clinical Component

Mark organized all aspects of the clinical component of the project. He identified four main areas of insulin delivery: patient identification, patient education, medication materials, and follow-up (see Methods). He worked with Dr. Palazuelos to draft a care delivery value chain to outline the systematic process of insulin delivery (Figure 1) [12, 13].

In February of 2018, Mark traveled to the DR with Frank Brightwell to meet the local CHW, Odalis Peralta, working for the SA NGO. All three men visited the homes of several diabetic patients who had their records flagged by the clinic doctors on prior STMM visits. The purpose of these visits was to discern if the patients were interested in insulin treatment. Mark and Odalis advised the patients that there would be an insulin education session in the summer of 2018. After returning to Boston, Mark met with a SA affiliated physician named James McCann,

MD, who agreed to be the supervising medical director of the project. Mark committed to send daily follow-up emails to Dr. McCann to ensure adequate medical supervision of the project. The project was scheduled to begin in the summer of 2018.

Mark traveled to the DR in late June 2018 and stayed with a host family in the community of El Naranjito, DR. After conducting the insulin education session with the local CHW, Mark conducted daily follow-up communications with each insulin patient (see Methods). About ten days prior to Mark's departure, patients began reporting daily blood glucose measurements to the local CHW. Once patients arrived at a stable insulin dose with more than 3 days of stable blood glucose readings (desired range 80-130 mg/dL), they were advised to only check their blood sugar with a glucometer if they felt the symptoms of hypoglycemia.

Mark left the DR in August 2018. Insulin patients were scheduled for three-month follow-up appointments in October 2018 and instructed to contact the local CHW for any additional concerns or adverse effects regarding their insulin use. He developed a SA program "Insulin Handbook," available in both English and Spanish (Appendix 1) for future SA providers to consult when beginning insulin therapy on a new group of patients.

Research Component

Prior to the summer of 2018, Mark obtained Institutional Review Board (IRB) approval from HMS to conduct the retrospective records review. During the summer of 2018, Mark reviewed every patient chart that was present in the SA clinic. He selected the patients with diabetes and collected relevant data pertaining to their care in order to measure outcomes (see Methods). After returning to Boston in the fall of 2018, he analyzed the data in collaboration with a statistician, Carole Mitnick, Sc.D.

Section 3: Methods

Clinical Component

Patients eligible for insulin therapy were diabetic adults treated at the NGO clinic who demonstrated consistent HbA1c measurements greater than 8.0% despite taking maximum dose metformin and sulfonylurea. Eligible patients completed an insulin education course to demonstrate that they could proficiently monitor their blood sugars and self-inject the correct

dose of their insulin medication. Upon completion of the course, patients were given neutral protamine Hagedorn (NPH) insulin and all materials (i.e., syringes, lancets, glucometers, etc.) pertinent to insulin therapy. Patients injected NPH insulin twice per day. Fasting daily blood glucose was measured by patients every morning.

Daily follow-up with insulin patients was conducted by the medical student and a local CHW via cell phone over the course of two months during the summer of 2018. After receiving the patients' fasting blood glucose values, the medical student and CHW would consult with the supervising physician before relaying insulin dosing recommendations back to the patients. Insulin doses were titrated according to a predetermined algorithm [14, 15] (Figure 2) every 3-4 days until patients obtained a fasting blood glucose level in the desired range of 80-130 mg/dL.

Baseline HbA1c measurements were taken at the time of initiation of insulin therapy. The primary endpoints were three-month and six-month follow-up HbA1c measurements.

Research Component

Data collection for the retrospective records review occurred during the summer of 2018. The records were previously existing patient chart data present as hard copies in the SA NGO medical clinic. The time period of existing medical records that data was collected from was winter 2004 through summer 2018. Institutional Review Board approval was obtained from Harvard Faculty of Medicine Office of Human Research Administration (Protocol #: IRB18-0372, Not Human Subjects Research) prior to the summer of 2018.

Inclusion criteria were non-pregnant patients over the age of 18 with diabetes who had visited the clinic at least two times within the past ten years. Exclusion criteria were patients who did not have diabetes, pregnant patients, patients under the age of 18, and patients who had visited the clinic less than two times in the past ten years.

The baseline characteristics collected for the diabetic patients were age, sex, height, weight, date of DM diagnosis, creatinine measurements at the time of DM diagnosis, and comorbidities present at the time of DM diagnosis. The date of DM diagnosis was defined as the date at which the NGO clinic diagnosed or began treating each patient for DM, regardless of past medical history from outside medical providers. Collected comorbidities at the time of DM diagnosis included the presence of hypertension (HTN), hyperlipidemia (HLD), obesity, microvascular complications (defined as presence of peripheral numbness/tingling and/or

creatinine greater than 1.2 mg/dL), and microvascular complications (defined as presence of coronary artery disease, limb claudication and/or limb amputation).

Outcome characteristics for each patient consisted of HbA1c measurements, iStat blood analyzer venous glucose measurements (referred to as iStat venous glucose or simply iStat), and glucometer finger stick blood glucose (FSBG) values. The presence of death was also recorded for each diabetic patient by discussing the vital status of each patient with the local CHW. For the patients who were known by the CHW to be deceased, the CHW estimated the date of death to the closest month and/or year according to the best of his knowledge.

Data was compiled into a database using the Epi Info 7 program from the Center for Disease Control (CDC). Data analysis was performed using the Epi Info 7 program and JMP statistical program.

The primary endpoint examined was HbA1c measurements over time. The first HbA1c measurement performed either at the time of diabetes diagnosis or after diagnosis was considered to be the baseline HbA1c. As many as five subsequent HbA1c measurements after the baseline value were recorded, for a maximum of six HbA1c measurements. During statistical analysis, a HbA1c measurement was considered to be "at target" if the HbA1c was less than 8.0% or if there was a 1.0% or more decrease in HbA1c compared to baseline. The number of "at target" HbA1c measurements was divided by the total amount of HbA1c measurements to obtain a proportion of measurements considered to be "at target" for each patient.

Secondary endpoints were iStat and FSBG measurements over time. iStat and FSBG data were collected independent of one another and analyzed separately. The data analysis process for the iStat and FSBG values was nonetheless the same. The first iStat or FSBG recorded at the time of diabetes diagnosis or after diagnosis was consider to be the baseline iStat or FSBG measurement. During statistical analysis, a iStat or FSBG measurement was considered to be "at target" if the iStat or FSBG was less than 182.9 mg/dL (corresponds to a HbA1c of 8.0%) [16] or if there was a 28.7 mg/dL or more decrease (corresponds to a change in HbA1c of 1.0% or more) [16] in iStat or FSBG compared to baseline. The number of "at target" iStat or FSBG measurements was divided by the total amount of iStat or FSBG measurements to obtain a proportion of measurements considered to be "at target" for each patient.

Section 4: Results

Clinical Component

In total, six patients, each with an accompanying family member, completed the insulin education session. One patient did not meet HbA1c criteria to begin insulin while another patient would be travelling during the months of July and August. As a result, four patients began insulin therapy on June 25, 2018. Individual demographics for each patient can be found in Table 1. 75% of the patients were male. The median age was 53 (IQR: 49, 55) years old. The median BMI was 26.2 (IQR: 24.8, 27.1) kg/m^2.

After beginning insulin, the patients reported their daily fasting blood glucose measurements to the medical student or CHW 93% of the time. There were no reported episodes of hypoglycemia.

The HbA1c trends for all insulin patients can be found in Table 2. The median baseline HbA1c at time of initiation of insulin therapy was 10.8 (IQR 9.6, 11.5) %.

After three months, patient #1 and patient #2 experienced a decrease in HbA1c (-3.1% and -1.5%, respectively). Patient #3 and patient #4 measured an increase in HbA1c (+2.9% and +0.1%, respectively). The median net change in HbA1c after three months of insulin was -0.7 (IQR: -1.9, 0.8) %.

At six-month follow-up, patient #1 exhibited a -3.3% decrease in HbA1c compared to baseline. However, patient #1 reported at his six-month follow-up appointment that he stopped using his insulin after the fifth month of treatment. He stated that he had obtained a new health insurance benefits and began seeing a local endocrinologist, who stopped his insulin and began him on a new therapy.

Patient #2 demonstrated a persistent elevation in HbA1c compared to baseline (+2.6%, respectively) at her six-month follow-up. Patient #3, who showed an initial -1.5% decrease in HbA1c at three months, experienced a +0.6% elevation compared to baseline after six months. Patient #4 showed a -2.8% decrease in HbA1c compared to baseline at six-month follow-up. The median net change in HbA1c at six-month follow-up was -1.1 (IQR: -2.9, 1.1) %.

Research Component

A total of 2,445 patient charts were screened at the SA NGO clinic. 170 patients (7.0%) were found to have DM in the clinic population. 53.5% of the patients were female. The median age of patients at the time of DM diagnosis was 56 (IQR: 49, 67) years. The median BMI of diabetic patients at time of DM diagnosis was 27.8 (IQR: 25.0, 30.9) kg/m^2. Diabetic patients had their disease followed at the NGO clinic for a median duration of 4.8 (IQR: 1.5, 7.4) years. 12 patients with DM were determined to be deceased. Deceased patients died at an estimated median age of 77 (IQR: 70, 86) years after having diabetes for a median duration of 9.4 (IQR: 5.5, 11.6) years (Table 3).

84.7% of patients had at least one comorbidity present at the time of DM diagnosis, while 50.6% of patients had two or more comorbidities present. The most common comorbidity was hypertension – present in 71.2% of patients at time of DM diagnosis. Hyperlipidemia and obesity – at 38.2% and 28.8% of the diabetic population, respectively – were the second and third most common comorbidities (Table 4).

The primary endpoint evaluated HbA1c measurements in NGO clinic patients with DM. Baseline HbA1c, defined as the first HbA1c measurement that appeared in the patient record either on the date of DM diagnosis or after DM diagnosis, was recorded in 78.2% of the diabetic cohort. The median baseline HbA1c measurement was 8.2 (IQR: 6.8, 10.7) % at a median duration of disease of 0 (IQR: 0, 13) months (i.e., zero months is at time of DM diagnosis). Only 36.5% of patients with DM had three HbA1c measurements at a median duration of 24 (IQR: 5, 54) months after DM diagnosis while 17.6% of diabetic patients had six HbA1c measurements at a median duration of 51 (IQR: 36, 92) months after diagnosis (Table 5).

A median of 2 (IQR: 1, 5) total HbA1c measurements were present per patient. A median of 1 (IQR: 0, 3) HbA1c measurement per patient was considered to be "at target" (Figure 3). 55.9% of patients with DM had at least one HbA1c measurement at target. A median proportion of 66.7% (IQR: 0%, 100%) of HbA1c measurements per patient were considered to be at target (Figure 6).

One secondary endpoint studied iStat venous blood glucose over time. 92% of patients with DM had baseline iStat measurements and were eligible to undergo this analysis. The median baseline iStat measurement was 172 (IQR: 128, 270) mg/dL. Similar to the primary endpoint HbA1c analysis, the median number of iStat measurements at target was 1 (IQR: 1, 3)

measurement per patient while the median number of total iStat measurements was 2 (IQR: 1, 5) measurements per patient (Figure 4). 72.3% of patients with DM had at least one iStat venous blood glucose measurement at target. A median proportion of 66.7% (IQR: 25%, 100%) of iStat measurements per patient were considered to be at target (Figure 6).

Another secondary endpoint examined FSBG measurements over time. 74% of patients with DM had a baseline FSBG present. The median baseline FSBG measurement was 197 (IQR: 135, 285) mg/dL. Again similar to prior endpoint analyses, each patient experienced a median of 2 (IQR: 1, 6) total FSBG measurements of which a median of 1 (IQR: 0, 3) FSBG measurements was considered to be at target (Figure 5). 52.4% of patients with DM had at least one FSBG measurement at target. A median proportion of 66.7% (IQR 0%, 100%) of FSBG measurements per patient were at target (Figure 6).

Section 5: Discussion, Limitations, Conclusions, and Suggestions for Future Work

Clinical Component

The SA NGO was able to safely and successfully introduce insulin therapy in a rural setting. The medical student and CHW demonstrated the competency to teach patients how to properly use the injectable medication. The patients were able to administer the medication at the correct dosages at home while being monitored remotely. Additionally, patients were able to report fasting blood glucose values with regularity. Prior to the summer of 2018, the clinic did not possess the capacity to dispense insulin therapy. Therefore, the NGO was able to expand its scope of practice for its diabetic population.

It is widely established that a 1% decrease in HbA1c correlates to a significantly decreased risk of diabetic microvascular complications such as retinopathy, nephropathy, and neuropathy [17-19]. However, there is no evidence to support that a decrease in HbA1c will reduce the risk of macrovascular disease in diabetic patients [19, 20]. In fact, there is evidence to suggest that diabetic patients with HbA1c measurements below 7.0% experience an increased risk of mortality [21]. According to this evidence, the project sought to steadily increase insulin doses over a period of several weeks in order to avoid hypoglycemic events. The conservative dosing algorithm resulted in no episodes of hypoglycemia among the four patients who began insulin therapy.

Patient #1 demonstrated a sustained HbA1c decrease greater than 3.0% at three-month and six-month follow-up. However, the HbA1c results are confounded due to fragmentation of care services and a change in medication. The patient discontinued insulin use after the fifth month of treatment and began taking a new medication after receiving new health insurance. Thus, it is difficult to discern the impact that insulin therapy had on his six-month HbA1c follow-up.

Though Patient #4 did not display an initial HbA1c response to insulin therapy, his six-month follow-up HbA1c demonstrated a significant reduction in HbA1c to within the target range of 7.0-8.0%. Proper insulin dosing adjustments made at his three-month follow-up appointment likely resulted in improved blood glucose control.

While patient #2 experienced a decrease in HbA1c after three months, his HbA1c elevated at six-month follow-up. Likewise, patient #3 exhibited a sustained elevation in HbA1c at both three-month and six-month follow-up despite insulin therapy. Possible explanations for the increase HbA1c measurements include nonadherence to medication, physiologic insulin resistance due to the longstanding nature of the patients' DM, and discontinuation of sulfonylurea (SFUs) medication prior to insulin therapy [22-24].

There are several barriers that may contribute to insulin nonadherence such as number of injections, forgetfulness, and belief in negative effects of insulin on overall health [25]. Insulin patients were instructed to inject NPH insulin twice per day. This injection regimen may have resulted in lower adherence for some patients. Moreover, SFU medications increase the amount of insulin reduced from the pancreas [24]. Insulin patients in this study were not prescribed SFUs in order to avoid hypoglycemic events due to insulin excess. Since the insulin patients had multiple year histories of inadequately treated diabetes, they required large amounts of insulin in order to obtain a proper blood glucose response. The conservative insulin dosing algorithm, though safe, did not allow the patients to initially inject large amounts of insulin. As a result, the combination of discontinuation of SFUs and initial low doses of insulin during dose titration may have resulted in prolonged hyperglycemic states that ultimately reflected elevated HbA1c values in the short-term.

There are several limitations to the clinical component of this study. The limitations include small number of patients receiving insulin who were not randomly selected. The four patients were screened during clinic visits before the summer of 2018, expressed a desire to use

insulin, and demonstrated that they had family members willing to participate in their care. Therefore, it is difficult to discern if the implemented insulin system can be replicated when applied to a larger number of patients on a broader scale. Additionally, patients self-reported daily fasting glucose values via telephone to the medical student and/or CHW. The patients also self-reported their adherence to insulin injections. The number of daily insulin injections by each patient was not measured by the study due to concerns of CHWs being negatively perceived by patients as enforcers of medication adherence.

Research Component

This study retrospectively examined blood glucose control outcomes of diabetic patients in a rural community who have been treated by a NGO STMM model. We hypothesized that the majority of patients with DM would have consistent HbA1c measurements less than 8.0% and iStat or FSBG measurements less than 182.9 mg/dL. This project aimed to determine the feasibility of diabetic care in a STMM model and make practice recommendations based on our findings. Based on the results of this study, it appears that there is not enough laboratory data to demonstrate that most patients with DM in the clinic population have consistent blood glucose control.

The results of this retrospective review show that a patient with DM at the NGO clinic experienced limited HbA1c follow-up measurements. Though a typical patient with DM had their illness followed by the clinic for a median duration of about five years, that patient experienced only a median of two HbA1c measurements. And of those two measurements, usually only one HbA1c measurement per patient remained within the treatment target range. We also determined that a median proportion of 66.7% of HbA1c measurements per patient were considered to be at target. This finding suggests that patients who demonstrated the most HbA1c measurements at target are more likely to have a larger amount of HbA1c measurements taken. In other words, diabetic patients with better overall glycemic control are more likely to have a larger amount of HbA1c measurements taken. This result makes logical sense, as patients with more follow-up data may encounter less barriers to care or may be more motivated to visit the clinic for routine health maintenance appointments.

The results in Table 5 appear to correlate with this conclusion, as the median values of HbA1c measurements decrease from baseline HbA1c (i.e., HbA1c #1) over time. This difference

is greatest in the sixth HbA1c measurement (i.e., HbA1c #6), which has a median value of 7.5 (IQR: 6.7, 10.3) % compared to the baseline HbA1c median value of 8.2 (IQR: 6.8, 10.7) %. However, it is important to note that only 17.6% of patients had six HbA1c measurements taken over a median duration of about 4 years, compared to 78.2% of patients with a baseline HbA1c measurement at the time of diagnosis. While the population with six HbA1c measurements is small, it appears that these patients may exhibit improved glycemic control.

The prevalence of DM in the NGO clinic population is similar to IDF estimates of DM prevalence in the DR [3]. Compared to the established literature, the NGO patient population with DM exhibited similar rates of hypertension [26] and decreased rates of obesity [27] as disease comorbidities. This suggests that the patients with DM in this clinic population do not present with a greater disease burden at baseline compared to the general diabetic population.

The infrequency of HbA1c measurements among patients with DM may be due to lack of consistent patient follow-up, scarcity of laboratory resources, and differences among clinic provider preferences. First, the NGO operates a STMM model and opens the clinic four times per year, treating about 350-400 patients per trip [28]. With more than 150 known patients with DM in the population, it is unlikely that every patient with DM can be seen on each trip, resulting in inconsistent follow-up over time. Additionally, while the clinic obtained the capacity to measure HbA1c in October 2011, it had been treating many patients with DM prior to having this technological capability. Hence, a portion of patients diagnosed with DM prior to October 2011 demonstrated no HbA1c follow-up due to lack of technological resources. Furthermore, different providers at the NGO clinic ordered HbA1c tests according to individual practice preferences. The lack of a formal, consistent HbA1c measurement policy, coupled with occasional scarcity of clinic laboratory resources, created an environment in which providers would often defer to order HbA1c tests unless there was a clear indication. As a result, other laboratory values such as iStat venous glucose and FSBG were often used as proxies for monitoring diabetic treatment. Although the secondary endpoint results of iStat and FSBG measurements are consistent with the primary endpoint findings, these numbers are less clinically valuable due to reasons mentioned later in this section. Compared to HbA1c, a larger portion of patients with DM had iStat values most likely because the iStat technology had existed at the clinic for a longer amount of time.

There are many limitations to this study. Specifically, the study is retrospective and examines data that has been collected over a period greater than ten years. Inconsistent patient follow-up, limited laboratory resource availability, and differing provider preferences over this time resulted in sporadic HbA1c, iStat, and FSBG clinical data collection. Accordingly, all NGO patients with DM received laboratory monitoring at different time intervals, making it difficult to analyze outcomes. By comparing the change in all laboratory blood measurements to a baseline, we were able to assess change in laboratory values regardless of time interval. We chose thresholds of "target" values for laboratory data – for example, a 1.0% decrease in HbA1c or a HbA1c less than 8.0% – based on prior literature. While a 1.0% decrease in HbA1c correlates to significantly decreased risk of diabetic microvascular complications [17-19], we chose a target of a HbA1c less than than 8.0% based on a clinic-wide conservative glycemic control practice to avoid hypoglycemia from aggressive DM treatment [29]. Based on the data present, it is not possible to measure the direct impact this particular NGO had on its patients' diabetic outcomes. A prospective study is likely needed in order to definitively determine the NGO's impact on patients with DM [30].

Likewise, there are limitations with using iStat venous glucose and FSBG measurements as secondary endpoints. iStat and FSBG values are not appropriate proxies for HbA1c since they represent an isolated, one-time blood glucose value. These values are more susceptible to short-term fluctuations in blood glucose that may not represent the severity the patient's DM disease. In contrast, HbA1c remains the gold standard for diabetic monitoring because it represents the *average* blood glucose over a period of about three months, which imparts more valuable information about the longitudinal disease control of a patient with DM [16, 31, 32].

Finally, there remain limitations regarding the date of DM diagnosis and date of death. We characterized the date of DM diagnosis as the first documented date at which the clinic diagnosed or began treating a patient for DM. Some patients presented to the clinic who had already been diagnosed with DM by outside providers. However, it was often never recorded when or how outside providers diagnosed DM in these patients. Due to this inconsistent documentation, we defined the date of DM diagnosis as previously stated. This method likely underestimates the amount of time patients had been living with a DM diagnosis. However, since most patients in the study were first diagnosed with DM by the NGO clinic, we do not believe that this limitation drastically affects our findings. Lastly, the determination of death was limited

due to the lack of formal records documenting the deaths of NGO clinic patients. We conferred with the local CHW to determine the vital status of each DM patient in the clinic population. The CHW personally knew that twelve DM patients were deceased at the time of data collection. For the patients who were known to be deceased, the CHW estimated the date of death to the closest month and/or year according to the best of his knowledge. This process can falsely estimate the ages and duration of diabetic illness in deceased patients. However, due to lack of alternative methods, we believed this course of action was the best approach to obtain death outcomes.

Conclusions

A STMM NGO was able to safely expand its scope of clinical practice and introduce insulin therapy to a rural setting. A medical student and CHW were able to teach patients how to administer insulin and conduct routine follow-up to adequately titrate insulin doses.

Patients with DM in the NGO clinic population lack consistent HbA1c follow-up measurements. A significant portion of the HbA1c measurements are not considered to be at target, reflecting poor blood glucose control in the NGO clinic population. Patients with more frequent HbA1c measurements may exhibit better glycemic control. We cannot directly measure the impact of diabetic treatment at the NGO based on the dearth of available laboratory data and retrospective nature of the study.

We recommend that the NGO clinic increase access to HbA1c testing in all patients with DM. The clinic should adopt a policy that all patients with DM receive a HbA1c test at each visit (provided that there are enough resources to ensure adequate amounts of HbA1c tests). This policy would mitigate differences in provider practices and ensure consistent laboratory measurement follow-up for each patient with DM. Additionally, we recommend that the NGO clinic expand the newly developed insulin program to provide insulin therapy to more patients with uncontrolled DM.

Section 6: Acknowledgements

There are many people who contributed to this project. First and foremost, I would like to express my gratitude to the community of El Naranjito and the patients of Somos Amigos Medical Missions who allowed me to work on this project. I would like to thank the local

Dominican board members of the clinic – *El Comité de la Clínica* – who supported both the clinical and research projects. I express my deepest gratitude to the family of Lourdes Fernandez and Ramón de Jesus "Chucho" Reyes who hosted me throughout the summer of 2018. To Lourdes and Chucho, my Dominican host parents, I would like to say, "*Gracias por todo el cariño y toda la comida rica, los amo mucho.*" I would also like to thank our CHW Odalis Peralta for his great work on the insulin project.

Moreover, I want like to thank Frank Brightwell, the executive director of Somos Amigos Medical Missions, for helping create the project idea and supporting me throughout all phases. The project would not have been possible without Frank's hard work and dedication. The insulin component of the project would also not have been possible without the efforts of our supervising physician, Dr. Jim McCann. Jim, thank you for taking the time to patiently read and respond to my daily patient updates. I promise to stop flooding your inbox now.

I am also truly grateful for all of the guidance that Dr. Dan Palazuelos has offered me as a mentor for the past two years. Every time I speak with Dr. Palazuelos, I feel like I have learned ten new facts about global health and realize the immense knowledge a global physician must attain. Thank you Dan for all of your mentorship.

After arriving back from the Dominican Republic in the fall of 2018, Dr. Carole Mitnick helped analyze the data and interpret conclusions for the retrospective study. Carole, thank you very much for your patience, expertise, and teaching.

Over the course of the past two years, I was able to speak with several HMS affiliated diabetes experts who helped me with certain questions regarding the project. I would like to thank Dr. Joseph Majzoub, Dr. Marie McDonnell, and Dr. Sylvia Kehlenbrink for their advice.

Finally, I would like to thank my HMS Holmes Society Research Advisor, Dr. Kerim Munir, for connecting me with all of the tremendous HMS faculty. Dr. Munir was one of the first HMS faculty members to approve of the project and advise me of future steps. Dr. Munir was the person who suggested that I contact Dr. Palazuelos and ask him to be my mentor. Thank you for all of your encouragement and advice, Dr. Munir.

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Tables and Figures

Table 1.

Baseline Characteristics of Insulin Patients.

Patient No.	Age (years)	Sex	Mass (kg)	BMI (kg/m^2)
#1	61	Male	69	23.0
#2	37	Male	77	27.3
#3	53	Female	60	25.4
#4	53	Male	85	27.0

Key: No. = number, kg = kilogram, m^2 = meters squared

Table 2.

Insulin Patient HbA1c Trends.

Patients experienced HbA1c measurements before starting insulin therapy. Subsequent follow-up HbA1c measurements occurred at three months and six months after starting therapy. It is important to note that Patient #1 discontinued his use of insulin about one month before his six-month follow-up appointment.

Patient No.	Pre-Insulin Tx Baseline A1c (%)	A1c at 3 mos. (%)	Net A1c change from baseline at 3 mos. (%)	A1c at 6 mos. (%)	Net A1c change from baseline at 6 mos. (%)
#1	11.2	8.1	- 3.1	7.9*	- 3.3*
#2	12.4	10.9	- 1.5	13.0	+ 0.6
#3	7.6	10.5	+ 2.9	10.2	+ 2.6
#4	10.3	10.4	+ 0.1	7.5	- 2.8

Key: No. = number, A1c = HbA1c, % = percentage, mos. = months, Tx = treatment
*: Patient #1 stopped his insulin one month before his 6-month follow-up HbA1c.

Table 3.

Baseline Characteristics, Duration of Diabetes, and Death.

Researchers documented sex, BMI, age at time of DM diagnosis, and vital status of all diabetic patients treated at the clinic. Each patient's vital status was discussed with the clinic CHW. If the patient was known by the CHW to be deceased, the CHW estimated the date of death to the closest month and/or year to the best of his ability.

	Number of Patients	Percentage (%)	Median	IQR (Q1, Q3)
Female	91	53.5	-	-
Male	79	46.5	-	-
BMI at DM dx	161	94.7	27.8 kg/m^2	5.9 kg/m^2 (25.0 kg/m^2, 30.9 kg/m^2)
Age at DM dx	170	100	56 yr.	18 yr. (49 yr., 67 yr.)
Duration of DM	170	100	4.8 yr.	5.9 yr. (1.5 yr., 7.4 yr.)
Deceased	12	7.0	-	-
Age at time of Death			77 yr.	16 yr. (70 yr., 86 yr.)
Duration of DM until Death			9.4 yr.	6.1 yr. (5.5 yr., 11.6 yr.)

Key: IQR = interquartile range, Q1 = first quartile, Q3 = third quartile, DM = diabetes, dx = diagnosis, yr. = years, BMI = body mass index, kg/m^2 = kilogram per meters-squared,

Table 4.

Comorbidities Present at Time of Diabetes Diagnosis.

The presence of HTN was defined as two or more blood pressure readings greater than 140/90 or patient was already on HTN medications at time of diabetes diagnosis. HLD was defined as lab measurements of low-density lipoproteins (LDL) greater than 130 mg/dL or patient was already on a statin medication at the time of diabetes diagnosis. Obesity was defined as a body mass index (BMI) greater than 30 kg/m^2 at the time of diabetes diagnosis. The presence of microvascular complications at time of diabetes diagnosis were defined as a creatinine greater than 1.2 mg/dL or documented complaints of peripheral extremity numbness/tingling. Macrovascular complications were defined as the presence of coronary artery disease (history of myocardial infarction or exertional angina), limb claudication, or limb amputation at the time of diabetes diagnosis.

	Number of Patients	Percentage (%)
Number of Comorbidities		
0	26	15.3
1	58	34.1
2 or more	86	50.6
Type of Comorbidity		
Hypertension	121	71.2
Hyperlipidemia	65	38.2
Obesity	49	28.8
Microvascular Complications	16	9.4
Macrovascular Complications	8	4.7

Table 5.

HbA1c Measurements and Duration of Diabetes.

Starting from the time of DM diagnosis, HbA1c measurements for all 170 confirmed DM patients were recorded. Baseline HbA1c measurements were defined as the HbA1c measured either at the the time of DM diagnosis or the first HbA1c recorded after documented DM diagnosis by NGO clinic physicians. A maximum of five additional HbA1c results after baseline were recorded. Dates of each HbA1c were also documented in the research component.

	Sample Size (n, %)	Median	IQR (Q1, Q3)
HbA1c #1	133, 78.2%	8.2%	3.9% (6.8%, 10.7%)
HbA1c #1 Duration of DM		0 months	13 months (0 months, 13 months)
HbA1c #2	84, 49.4%	8.1%	3.5% (6.7%, 10.2%)
HbA1c #2 Duration of DM		14 months	49 months (5 months, 54 months)
HbA1c #3	62, 36.5%	7.7%	2.3% (6.9%, 9.2%)
HbA1c #3 Duration of DM		24 months	50 months (14 months, 64 months)
HbA1c #4	47, 27.6%	7.7%	2.8% (6.7%, 9.5%)
HbA1c #4 Duration of DM		32 months	57 months (20 months, 77 months)
HbA1c #5	38, 22.4%	8.1%	4.0% (6.8%, 10.8%)
HbA1c #5 Duration of DM		42 months	56 months (27 months, 83 months)
HbA1c #6	30, 17.6%	7.5%	3.6% (6.7%, 10.3%)
HbA1c #6 Duration of DM		51 months	56 months (36 months, 92 months)

Key: n = number of patients, IQR = interquartile range, Q1 = first quartile, Q3 = third quartile, HbA1c = hemoglobin A1c, DM = diabetes mellitus

Figure 1.

Care Delivery Value Chain.

This care delivery value chain outlines the systematic process of insulin delivery in the Dominican Republic. The graphic highlights the comprehensive process of diabetes management in the community and includes prices of certain phases of care. According to the figure, the long term outcomes are to sustainably provide insulin and achieve the best possible HbA1c without hypoglycemic complications at the lowest possible cost.

Care Delivery Value Chain

Somos Amigos Insulin Project 2018

Prevention →	Detection →	Start →	Titrate →	Complications →	Outcomes
- Education - Exercise - Diet: [ ] USDA MyPlate [ ] General dietary recommendations = decreased carbs/sugar	- HbA1c: **USD $9.50 per test** - Glucometer blood test strips: **USD $1 per test** - Urine test strips: can detect glucose in urine if blood sugar is over 200 mg/dL	- Oral medications max dose: [ ] Metformin: 2000 mg daily [ ] Sulfonylurea (SFU): Glipizide 20 mg daily OR Glyburide 20 mg daily - Insulin: [ ] NPH two times per day OR [ ] Lantus one time per day	- Monthly supply of insulin - Price: **USD $5-5.40 per 1000U** - Administration [ ] Syringe/vials OR [ ] Insulin pens - Algorithm of dose titration - Storage: supply can exist in a dark, dry place in a warm house for 1 month without refrigerator (refrigeration is NOT a barrier) [ ] Refrigerator [ ] Insulated bottle [ ] Clean box - Adherence support: CHWs, see below	- Of uncontrolled diabetes: [ ] Acute coronary syndrome [ ] Retinopathy [ ] Vasculopathy [ ] Nephropathy [ ] Death - Of insulin: [ ] **Hypoglycemia** [ ] Overdose = death	- **Insulin always** - **Decrease HbA1c** - **No deaths** due to diabetes side effects or insulin side effects **Value = Max possible outcome for cheapest possible cost**

Adherence support ideas:

- Community Health Workers (CHW): aka "barrier reduction agents,"
  - What they ARE: expert patients, provide instrumental support
  - What they ARE NOT: medication police, biology teachers
- Food packages: buying the low carb food for our patients and teaching them how to cook
- Provide transportation support to the clinic

Figure 2.

Insulin Dosing Algorithm.

Prior to the summer of 2018, the medical student and his NGO physician supervisor devised an algorithm to titrate the doses of insulin for each patient. The four insulin patients submitted daily fasting blood glucose measurements 93% of the time. Based on the patient reported data, insulin doses were steadily increased over the course of the summer based on the established algorithm. There were no episodes of hypoglycemia during titration of insulin doses.

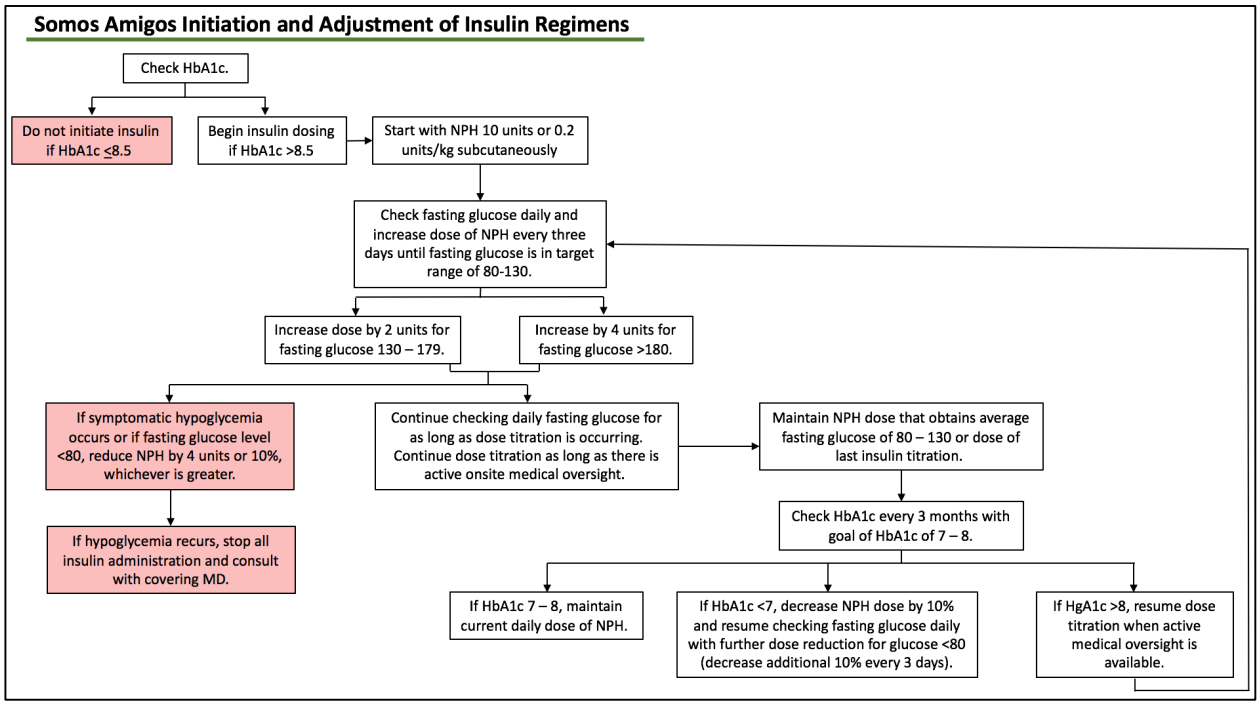


Figure 3.

Primary Endpoint: Hemoglobin A1c (HbA1c) Outcomes.

The first HbA1c measurement performed either at the time of diabetes diagnosis or after diagnosis was considered to be the baseline HbA1c. As many as five subsequent HbA1c measurements after the baseline value were additionally recorded. During statistical analysis, a HbA1c measurement was considered to be "at target" if the HbA1c was less than 8.0% or if there was a 1.0% or more decrease in HbA1c compared to baseline. A median of 2 (IQR: 1, 5) total HbA1c measurements were present per patient. A median of 1 (IQR: 0, 3) HbA1c measurement per patient was considered to be "at target" (Figure 1). 55.9% of patients with DM had at least one HbA1c measurement at target.

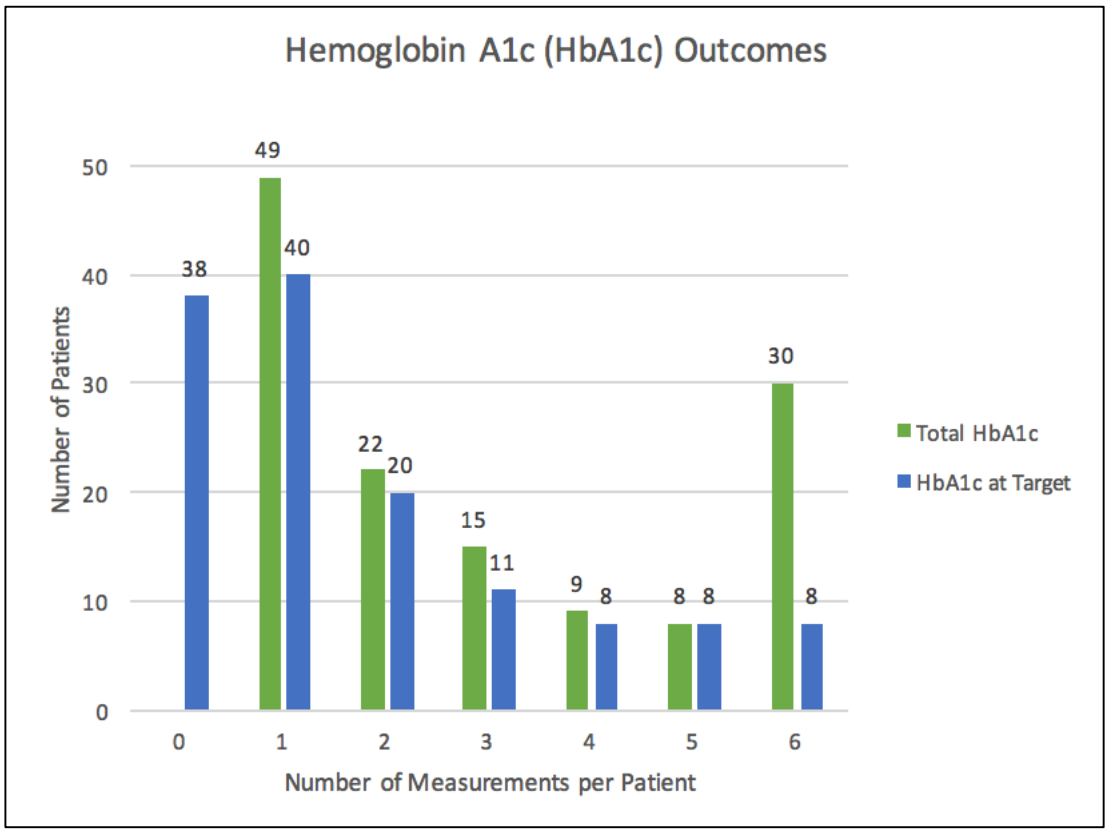


Figure 4.

Secondary Endpoint: iStat Venous Blood Glucose (iStat) Outcomes.

The first iStat recorded at the time of diabetes diagnosis or after diagnosis was consider to be the baseline iStat measurement. During statistical analysis, an iStat measurement was considered to be “at target” if it was less than 182.9 mg/dL or if there was a 28.7 mg/dL or more decrease in iStat compared to baseline. The median number of iStat measurements at target was 1 (IQR: 1, 3) measurement per patient while the median number of total iStat measurements was 2 (IQR: 1, 5) measurements per patient. 72.3% of patients with DM had at least one iStat venous blood glucose measurement at target.

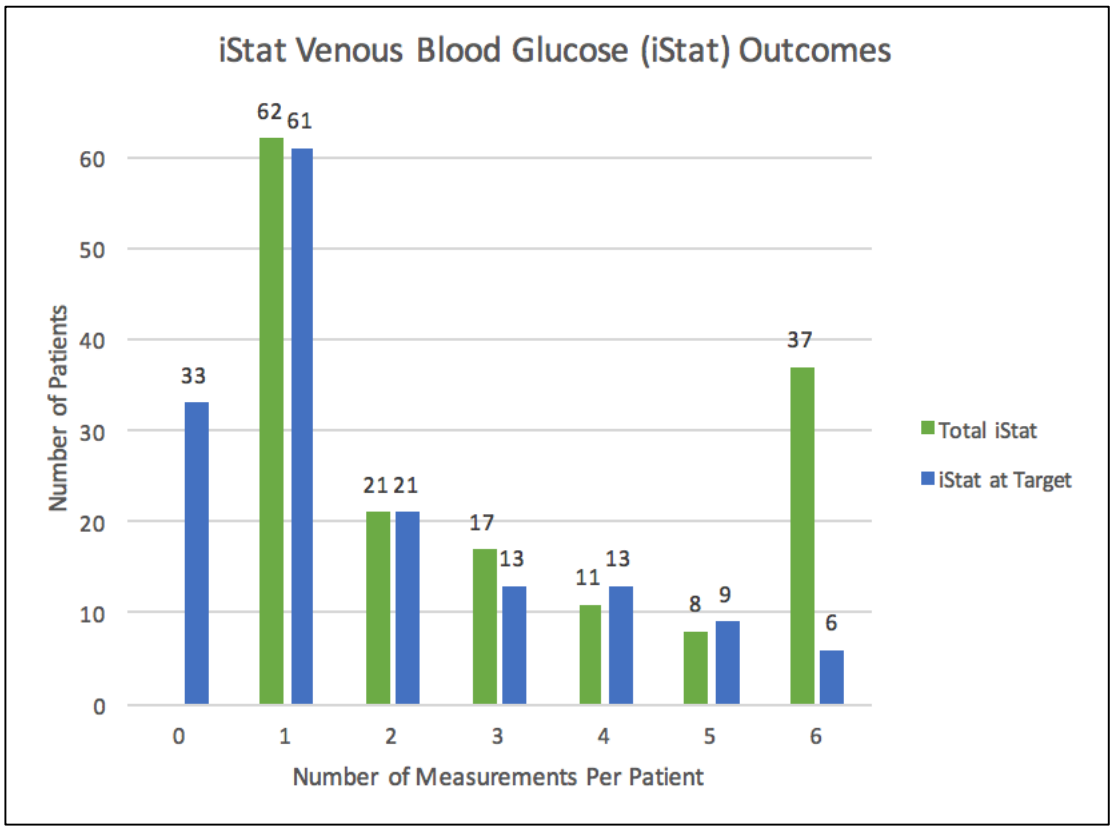


Figure 5.

Secondary endpoint: Finger Stick Blood Glucose (FSBG) Outcomes.

The first FSBG recorded at the time of diabetes diagnosis or after diagnosis was consider to be the baseline FSBG measurement. During statistical analysis, an FSBG measurement was considered to be "at target" if it was less than 182.9 mg/dL or if there was a 28.7 mg/dL or more decrease in FSBG compared to baseline. Each patient experienced a median of 2 (IQR: 1, 6) total FSBG measurements of which a median of 1 (IQR: 0, 3) FSBG measurements was considered to be at target. 52.4% of patients with DM had at least one FSBG measurement at target.

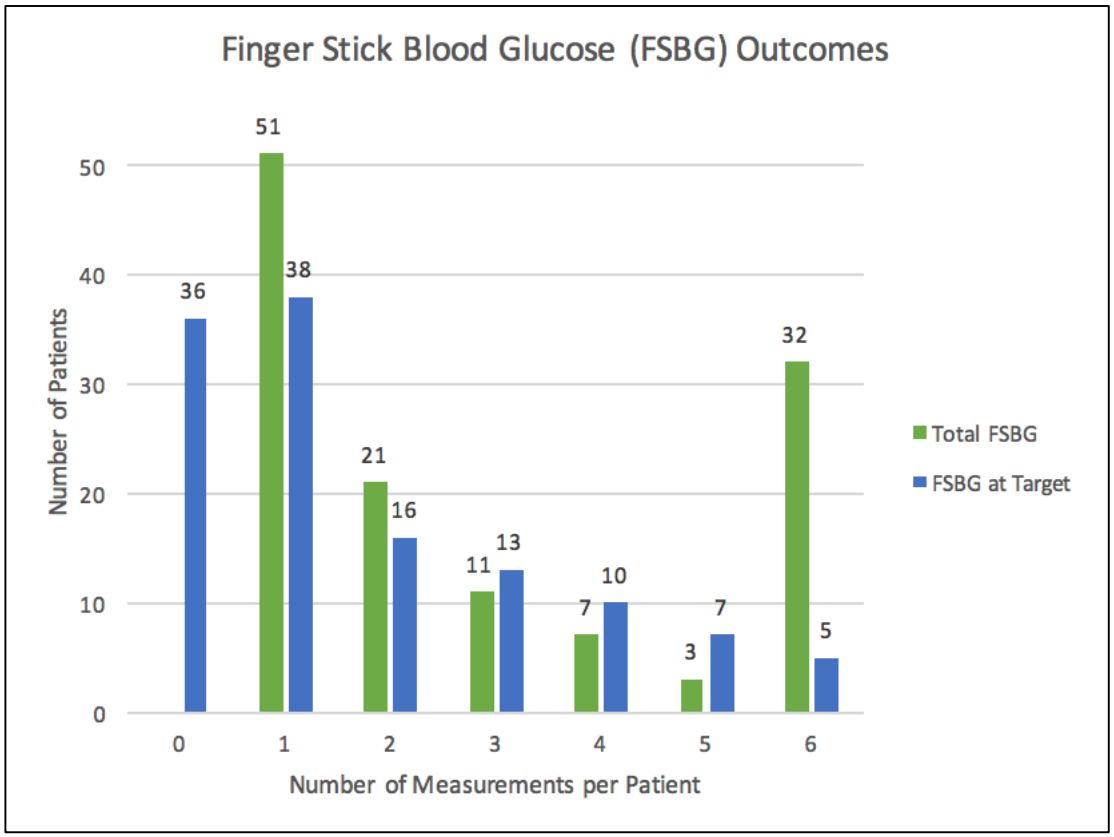
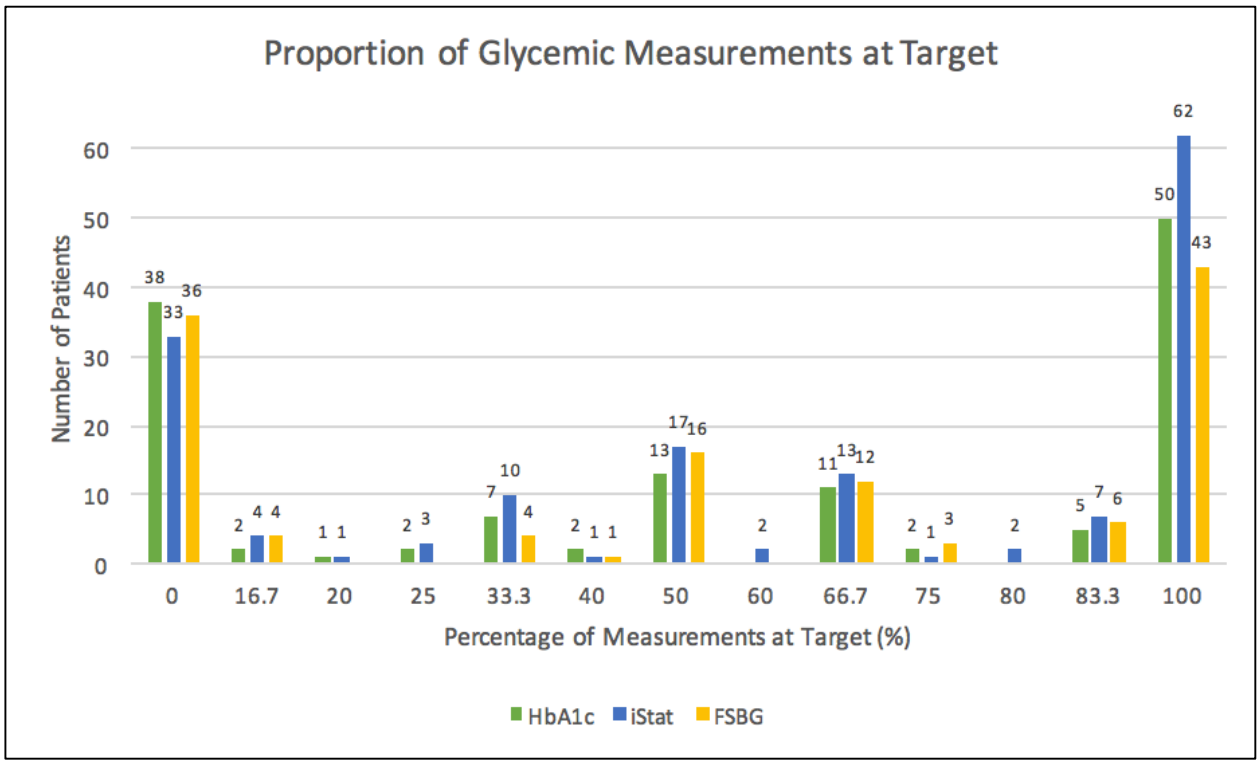


Figure 6.

Proportion of Glycemic Measurements at Target.

The number of "at target" HbA1c, iStat, and FSBG measurements was divided by the total amount of respective HbA1c, iStat, and FSBG measurements to obtain a proportion of measurements considered to be "at target" for each patient. A median proportion of 66.7% (IQR: 0%, 100%) of HbA1c measurements per patient were considered to be at target. Similarly, a median proportion of 66.7% (IQR: 25%, 100%) of iStat measurements per patient were considered to be at target. Finally, a median proportion of 66.7% (IQR 0%, 100%) of FSBG measurements per patient were at target.



Appendix 1: Insulin Program Handbook

Somos Amigos Medical Missions

Insulin Program Handbook

Mark Yost
Jim McCann
Frank Brightwell

1 August 2018

Insulin Handbook Table of Contents

Section 1:
Pre-Insulin Management

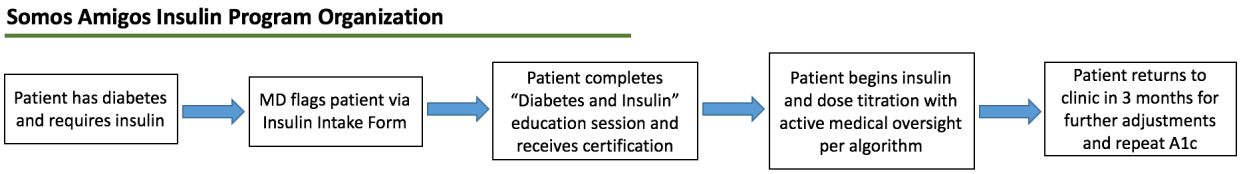
Introduction:

At Somos Amigos, insulin is a new treatment that we are able to offer our diabetic patients who suffer from uncontrolled diabetes. Based on the unique logistical challenges of this medication in this community, the organization has decided to created its own guidelines for management of diabetics who require insulin therapy. These guidelines aim to go into effect in October 2018. Please note that patients who have been seen before this date may not reflect all of these components in their record, as there were no formal guidelines in the clinic prior to October 2018.

Organization of Insulin Program:

Once a patient is diagnosed with diabetes, there must be many steps that the patient must undergo before beginning insulin therapy. Most of these steps will be determined by the patient's clinical course and how the patient responds to oral medication. However, once it is determined that the patient needs to be prescribed insulin, the patient must complete a training program before the patient can begin the therapy.

See flowsheet below:



Care Delivery Value Chain [1,2]:

Care Delivery Value Chain

Somos Amigos Insulin Project 2018

Prevention →	Detection →	Start →	Titrate →	Complications →	Outcomes
- Education - Exercise - Diet: [ ] MyPlate [ ] General dietary recommendations = decreased carbs/sugar	- HbA1c: **USD $9.50 per test** - Glucometer - Blood test strips: **USD $1 per test** - Urine test strips: can detect glucose in urine if blood sugar is over 200 points	- Oral Medications max dose [A-C]: [ ] Metformin: 2000 mg daily [ ] Sulfonylurea: Glipizide 20 mg daily OR Glyburide 20 mg daily - Insulin: [ ] NPH two times per day OR [ ] Lantus one time per day	- Monthly supply of insulin - Price: **USD $5-5.40 per 1000U** - Administration [ ] Syringe/vials OR [ ] Insulin pens - Algorithm of dose titration - Storage: supply can exist in a dark, dry place in a warm house for 1 month without refrigerator (refrigeration is NOT a barrier) [ ] Refrigerator [ ] Insulated bottle [ ] Clean box - Adherence support: CHWs, see below	- Of uncontrolled diabetes: [ ] Acute coronary syndrome [ ] Retinopathy [ ] Vasculopathy [ ] Nephropathy [ ] Death - Of insulin: [ ] **Hypoglycemia** [ ] Overdose = death	- **Insulin always** - **Decrease A1c** - **No deaths** due to diabetes side effects or insulin side effects **Value = Max possible outcome for cheapest possible cost**

Adherence support ideas:

- Community Health Workers (CHW): aka "barrier reduction agents,"
  - What they ARE: expert patients, provide instrumental support
  - What they ARE NOT: medication police, biology teachers

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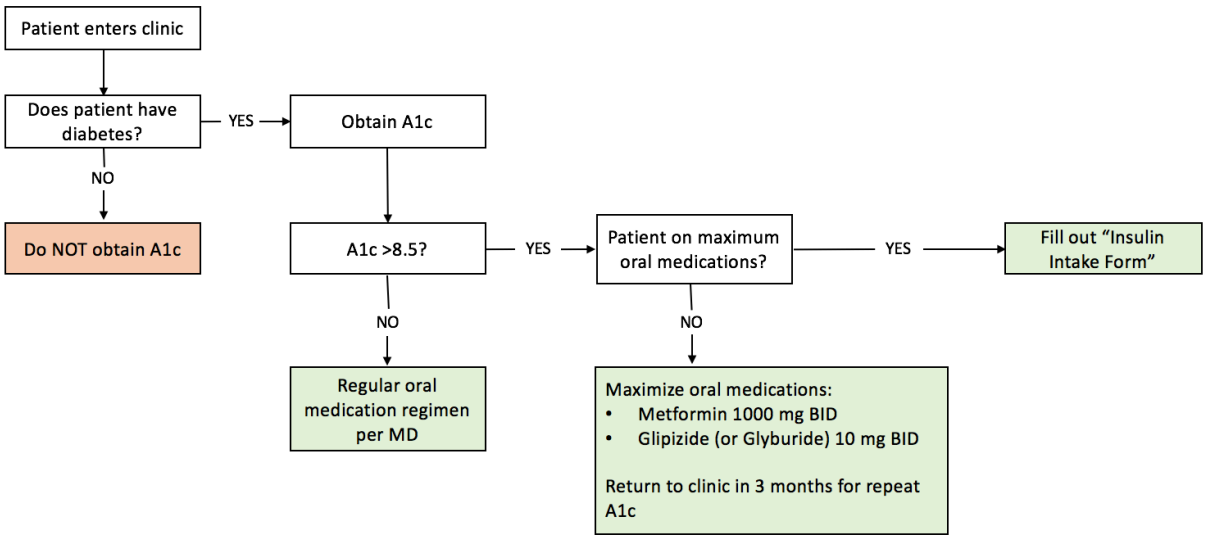
Somos Amigos Clinic Assessment of **All** Diabetic Patients:

I. Intake:
    a. If patient has diabetes: Obtain A1c on all patients in intake area prior to entering doctor's office
II. Doctor (MD):
    a. Ensure that creatinine and lipid panels are checked annually
    b. Order random blood sugar test (i.e., finger stick glucose) ONLY when there is concern for hypoglycemia or hyperglycemia
    c. Target A1c goal for all diabetic patients is less than 7.5. Refer to below guidelines and algorithm for A1c above goal.
        i. A1c ≤8.5
            1. Regular oral medication management of anti-hyperglycemics per MD.
        ii. A1c >8.5
            1. Check medications: Is patient on maximum oral regimen?
                a. If patient is NOT on maximum oral regimen, please increase oral regimen to the following medications/dosages and advise patient to return to clinic in three months:
                    i. Maximum oral medication doses for diabetes:
                        1. Metformin 1000 mg two times per day
                        2. Glipizide (or Glyburide) 10 mg two times per day
                b. If patient is ALREADY on maximum oral regimen, please fill out the "Insulin Intake Form" (page 8)

See algorithm on next page:

Somos Amigos Assessment of ALL Diabetic Patients



Insulin Intake Form:

Fill out Insulin Intake form once it has been determined that patient is a candidate for insulin therapy. Return forms to Frank Brightwell.

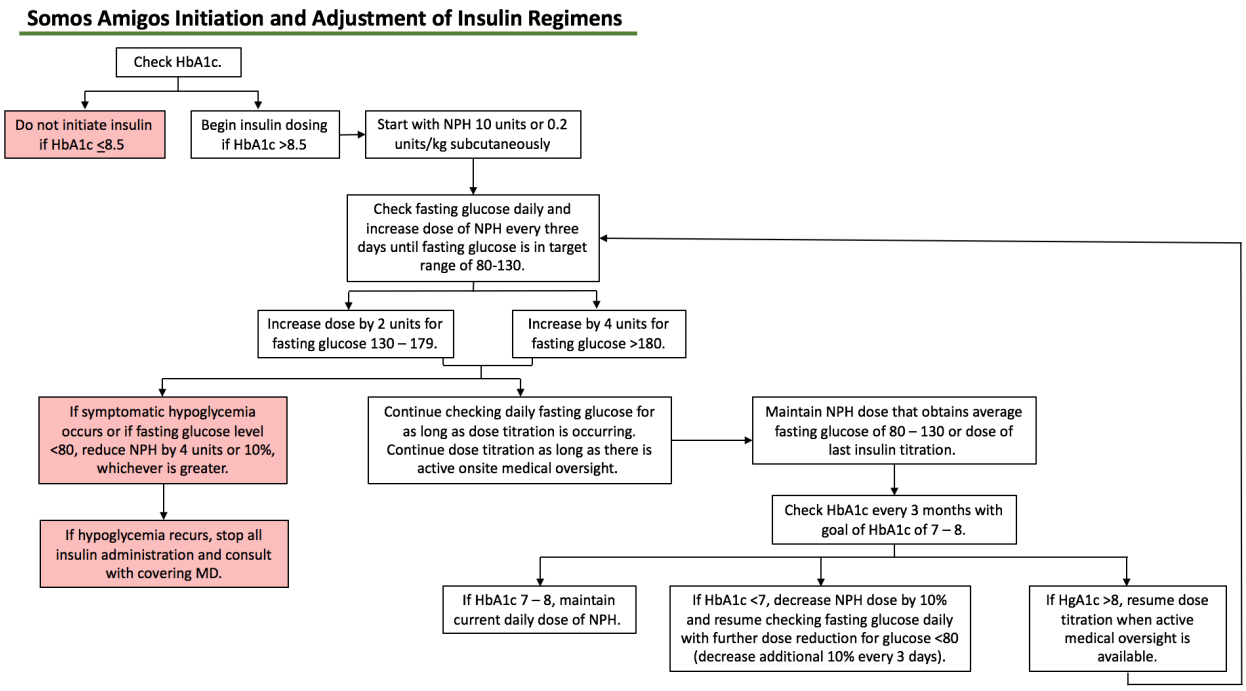
You are a diabetic patient who receives care at this clinic. Somos Amigos is looking for ways to provide more services for our diabetic patients. May we please ask a few questions about you to see if we can offer you future treatments?

Usted es un paciente diabético que recibe su atención médica en esta clínica. Somos Amigos está buscando opiciones para proveer más servicios para nuestros pacientes diabéticos. Por favor, ¿podemos pedirle algunas preguntas sobre ti para averiguar si podemos ofrecerle tratamientos en el futuro?

Insulin Intake Form			
Chart ID#:		Patient age/sex/weight:	
Last three HbA1c and dates:			
A1c			
Date			
Diabetes medications and total doses per day: [ ] Metformin – Dose: _____ [ ] Glyburide – Dose: _____ [ ] Glipizide – Dose: _____ [ ] Other:			
Patient taking oral medications as prescribed?: [ ] Yes [ ] No			
Would patient be interested in taking another diabetes medication such as insulin in the future?: [ ] Yes [ ] No [ ] Undecided			
Campo:		**Cell phone number:**	
Number of roommates or family members living with patient or living close by:			
Would a roommate or family like to be involved in your care?: [ ] Yes [ ] No		Roommate/family member cell phone #:	

Section 2:
Insulin Management

Insulin Dosing Algorithm [3,4]:



Patient Plans:

Once the decision has been made to start patient on insulin, initial insulin plans must be determined in partnership with supervising MD. Plans must be created and approved (i.e., signed off) by supervising MD **prior** to initiation of insulin therapy:

- Somos Amigos uses weight based dosing to start insulin on diabetic patients.
    - Start with NPH 0.2 units/kg OR 10 units for total daily insulin dose
    - Patient will undergo twice per day (BID) injections
        - Therefore, the patient will inject *half* of the total daily insulin dose in the morning after breakfast and then *half* of the total daily insulin dose in the evening after dinner.
- Oral medication adjustment while on insulin
    - **Discontinue** all glipizide (or glyburide)
    - Continue metformin 1000 mg BID

For example:

Plan:
Patient ID ####: 50-year-old male, 80 kg

- Insulin dosing: (80 kg)*(0.2 units/kg) = 16 units total daily insulin dose
    - Inject 8 units in the morning after breakfast and 8 units in the evening after dinner (8U BID)
- **Discontinue** all glipizide (or glyburide)
- Continue metformin 1000 mg BID

Components of Insulin Box:

Upon entering the insulin program, each patient will receive an insulin box and an empty red sharps container.

The insulin box will have the following items:

1. 1 insulated bottle
2. 1 hand towel
3. 1 glucometer (programmed with accurate date/time)
4. 2 bottles of 25 glucometer test strips
5. 1 box of 100 round Band-Aids
6. 30-60 0.5 mL insulin syringes with needles
7. 1 box of alcohol prep pads
8. 1 box of 100 Surgilance safety lancets
9. Patient instructional handouts
10. 5 packets of glucose jelly

See example of insulin box and empty sharps container:

Patient Education:

Prior to initiation of insulin therapy, the patient must complete a one-day long education course titled "Diabetes and Insulin." It is strongly preferred that the patient brings a companion (i.e., spouse, roommate, older child, etc.) who lives with them to complete the class as well. Both the patient and the patient's companion will be presented with "Certificates of Completion" at the conclusion of the education course.

Diabetes and Insulin Course Curriculum:

Before patients arrive:

- Call patients the day or night before the class and tell them:
    - Eat a good breakfast before coming to the class
    - Do not take medications during the morning of the class
    - Bring all medications to the clinic
    - Remind patients to come to the course with a companion

1. Introductions:
    a. Odalis → Community health worker
    b. Student or other health care provider → Community health worker for ### (amount of time)
2. Diabetes
    a. What is diabetes?
        i. YouTube video (0:37 - 8:34)
            1. URL: https://www.youtube.com/watch?v=8MHGvx553yI&feature=related
            2. Caveat: This video is about type I diabetes. Our patients have insulin dependent type II diabetes. The teaching regarding insulin/pancreatic function is relevant to them. After the video, explain to patients that they have type II diabetes, but all of the learning points in the video are the same.
        ii. Diabetes is a disease of too much sugar in the body. When there is too much sugar, it cannot enter cells and can cause damage throughout the body.
    b. What are the side effects of diabetes?
        i. Microvascular: peripheral neuropathy, kidney damage, visual problems
        ii. Macrovascular: heart disease, claudication, infection, amputation, death
3. Insulin
    a. What is insulin? What does it do?
        i. Insulin is a protein produced by the pancreas that allows cells to accept glucose. In diabetes, there is a lack in normal insulin production and the cells cannot accept glucose, causing a buildup of glucose in the body.
    b. Risks of insulin: Insulin is not a benign medication, there are risks if it is not used according to the way it is prescribed

i. Hypoglycemia: hypoglycemia is an adverse event that occurs when there is not enough glucose in the body
    1. Hypoglycemia symptoms: lightheadedness/dizziness, sweating, chest palpitations, hunger, confusion, fatigue, fainting, blurred vision, and if bad enough death.
        a. What to do if patient suffers from hypoglycemia:
            i. Have patient sit down
            ii. Check a blood sugar using glucometer
            iii. Give glucose paste
            iv. Call Odalis

c. How to transport insulin
    i. After receiving insulin from the clinic, it is important to travel home immediately to properly store the insulin
    ii. Put the insulin in the insulated bottle (lined with the hand towel), close the lid, and bring home
    iii. Proper handling/transport of medication is most important because if not handled properly, the medication will spoil.
d. Where to store insulin at home
    i. Preferred that it is stored in the refrigerator. DO NOT store in the freezer
    ii. If no refrigerator, store in a cool, dry place out of the sunlight.
        1. Store in insulated bottle provided by Somos Amigos
    iii. Proper storage of insulin is most important because if not stored properly the medication will spoil
e. What to do with your lancets, syringes and needles
    i. You have been provided a sharps container for proper disposal of all sharps
        1. Keep your sharps container in a safe place away from the reach of children
    ii. IMPORTANT: Please do not allow your children access to sharps, especially used sharps
        1. Please dispose of sharps properly after each use. Do not share lancets, needles, or syringes as this can lead to the spread of disease.
        2. DO NOT give syringes or needles to children to let them play with them. This is dangerous.
    iii. Once your sharps container is full, please lock the top, and bring it to the clinic for a free container exchange
f. How to use insulin/glucometer
    i. Twice per day dosing [3]: Take total amount of insulin units (i.e., total daily insulin dose) and divide by 2. Give first dose in morning after breakfast and second dose in evening after dinner
        1. For example: If a patient requires 20U of insulin total each day, give 10U after breakfast and 10U after dinner.

ii. Glucometer use is for one person only. The patient should not share his/her glucometer with anyone. The glucometer has a small computer that saves every blood sugar reading. If there is more than one person using the glucometer, it will be impossible to determine the true values for the patient.
iii. Practice:
1. Check blood sugar: Remind patients that they will need to perform daily blood sugar tests while undergoing insulin dose titration. Finger stick blood sugar tests need to be done after the patient has woken up in the morning **before they have had anything to eat or drink**.
a. Patients should contact Odalis or other community health worker (preferably via WhatsApp) to advise them of their daily fasting blood sugar measurements.
2. Administer saline (substituted for insulin for practice)

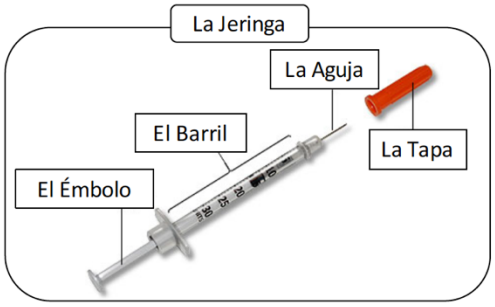
g. How many times can I use my syringe and needle for insulin?
i. You can use your syringe for a maximum of 4 injections [5-7]. At the least, you can change the syringes every third day.
1. Most patients notice that the needle becomes dull after two or three injections and use one syringe per day (hence one syringe = two injections).

4. Sign consent forms and place forms in patient charts.
5. Administer PHQ-2 depression screen [8]
a. Score <3 → continue with insulin therapy
b. Score ≥3 → do NOT begin insulin therapy, consult with supervising MD for further options
6. Measure baseline HbA1c
7. Check finger stick glucose
8. Review patients' oral medications. Advise them to continue taking their metformin 1000 mg twice per day. Find the patients' glipizide (or glyburide) bottles and **keep them at the clinic**. Tell the patient that because they have started insulin, they do not need to take these pills.
a. Note: Do not let patient leave with their glipizide or glyburide pills while taking insulin therapy. This increases the risk of hypoglycemia.
9. Have patient inject insulin
a. Observe patients
b. Have crackers/cookies and juice on hand in case patient has symptoms of hypoglycemia.
10. Give certificates of completion

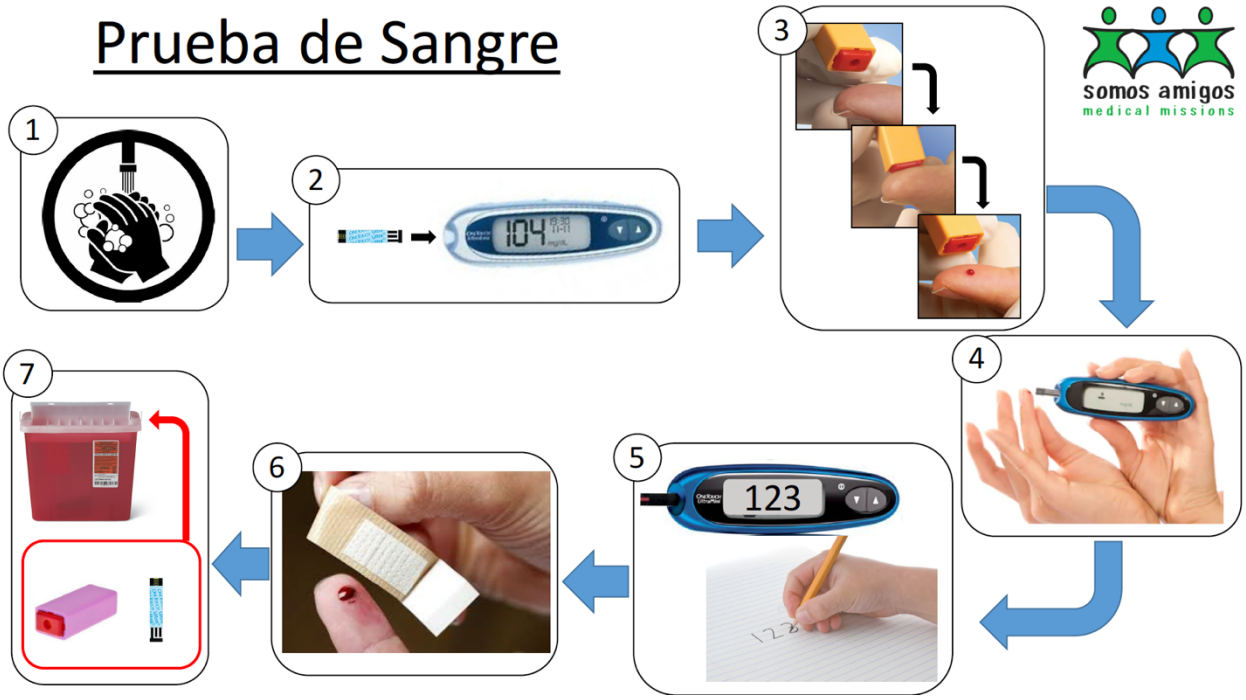
Patient Instructional Handouts:

Prior to patients receiving their insulin boxes, these instructional handouts should be printed (double sided, one image on each side for two pieces of paper total) on bright colored paper, laminated, and placed in the box. The handouts may have to be cut in order to fix it in the box. The handouts can be found as a PDF in the Somos Amigos computer folder named “Insulin Project.”

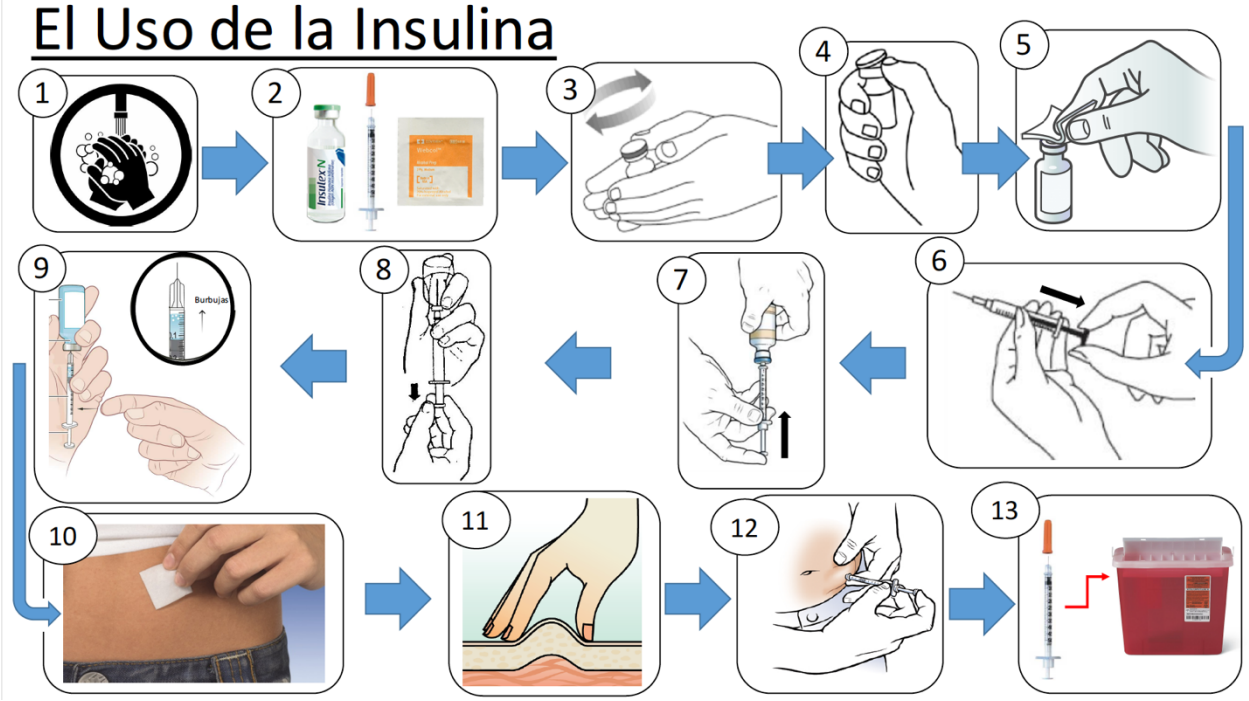
Componentes de la Insulina

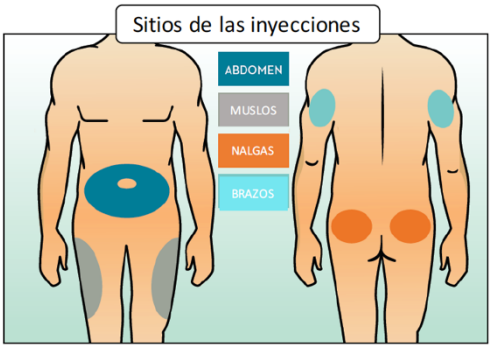


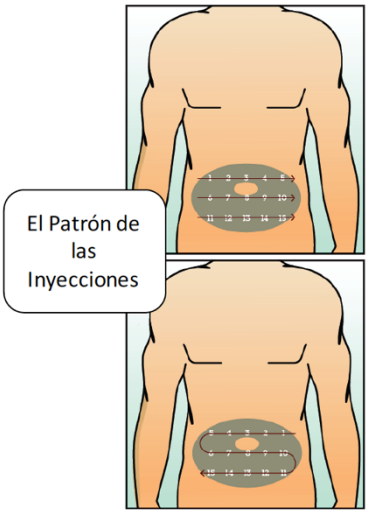
Prueba de Sangre



El Uso de la Insulina




Sitios de las inyecciones
ABDOMEN
MUSLOS
NALGAS
BRAZOS


El Patrón de las Inyecciones

PHQ-2 Depression Screen [8-10]:

If Score <3 → continue with insulin therapy

If Score ≥3 → do NOT begin insulin therapy, consult with supervising MD for further options

Cuestionario sobre la salud del paciente-2 (PHQ-2)

Durante las *últimas 2 semanas*, ¿qué tan seguido ha tenido molestias debido a los siguientes problemas?	**Ningún día**	**Varios días**	**Más de la mitad de los días**	**Casi todos los días**
1. Poco interés o placer en hacer cosas	0	1	2	3
2. Se ha sentido decaído(a), deprimido(a) o sin esperanzas	0	1	2	3

For office coding: _____*0*_____+_____+_____+_____

= Total Score _____

Insulin Consent Form:

Prior to their first injection of insulin at the conclusion of the education session, the patient must read and sign an insulin consent form. Please try to print these consents on official Somos Amigos stationery.

Somos Amigos Medical Missions

Formulario de Consentimiento

Medicamento: Insulina

Al firmar este formulario, entiendo que voy a tomar la insulina para tratar la diabetes. He completado el curso "La Diabetes y La Insulina" con los compañeros en salud de Somos Amigos Medical Missions. Al graduarme del curso, yo sé tomar la insulina según la prescripción de la clínica. También sé que puedo llamar a un compañero en salud si tengo preguntas. Comprendo los riesgos y efectos adversos de tomar la insulina. Escojo tomar la insulina y entiendo que puedo parar este medicamento cuando quiera.

Nombre del paciente:

Firma del paciente: _____

Fecha: _____

Testigo: _____

Certificate of Completion:

Before the patients arrive at the clinic for the diabetes education session, the community health worker should already have their certificates prepared, printed, and laminated. To edit the the certificates, find the PowerPoint file in the Somos Amigos computer folder named "Insulin Project." Save the slides as PDF, print, and laminate certificates.

Certificate for patient:

Certificate for patient companion:

Patient Progress Notes:

After starting a patient on insulin after education session, a patient progress note must be created, co-signed by a supervising MD, and put in the patient's chart. SOAP note format. See below for example:

Date: 6/25/18

Patient ###:
Subjective: 37 yo M with PMH DM who presents today for initiation of insulin therapy. Flagged for Insulin Project in October 2017. He attended and successfully completed the "Diabetes and Insulin" training course provided by Somos Amigos on 6/25/18. His wife attended and completed the course as his health companion.

Objective:
Height: 66" Weight: 169 lbs. BMI: 27
Non-fasting finger stick blood glucose = 265
- (Note: All patients were told to eat breakfast before arriving at the clinic for the training course)

HbA1c: 12.4
- HbA1c trend: 13.0 (06/2017) → 9.6 (10/2017) → 12.7 (01/2018) → 10.6 (04/2018) → 12.4 (06/25/2018)

DM Meds: Glipizide 10mg BID, Metformin 1000mg BID

Assessment: 37 yo M with a PMH DM who presents today for initiation of insulin therapy.

Plan:
#IDDM
- 15U daily NPH → 8U qAM after breakfast and 7U qHS after dinner
  - Patient injected 8U NPH at clinic today, tolerated medication well
  - Given 5 vials 1000U of NPH insulin today
  - F/u with Odalis for med refill in 3-4 months
- Continue Metformin 1000mg BID
- **Discontinue** glipizide
- Patient will follow up daily with Odalis to report AM fasting blood sugar measurements
- Adjust insulin dosing medication as per protocol
- F/u HbA1c in 3 months (10/2018)
- Signed insulin consent in chart.

Mark Yost, MS4
Somos Amigos Community Health Worker

With MD Supervision by Jim McCann, MD – Electronically signed 6/25/18 at 5:53PM

Fasting Blood Glucose (FBG) Chart and Data Collection:

During titration of insulin dosing, the patients will need to update the community health workers of their daily fasting blood glucose. The blood glucose measurements should be taken after waking up in the morning, before the patient has had anything to eat or drink.

Write down values in format below. Convert values to excel spreadsheet in order to graphically demonstrate trend over time.

Patient ID	Date	Day	Fasting Blood Glucose	Total Daily Insulin Dose
####	dd/mm/yy	1		
		2		
		3		
		4		
		5		
		6		
		7		
		8		
		9		
		10		
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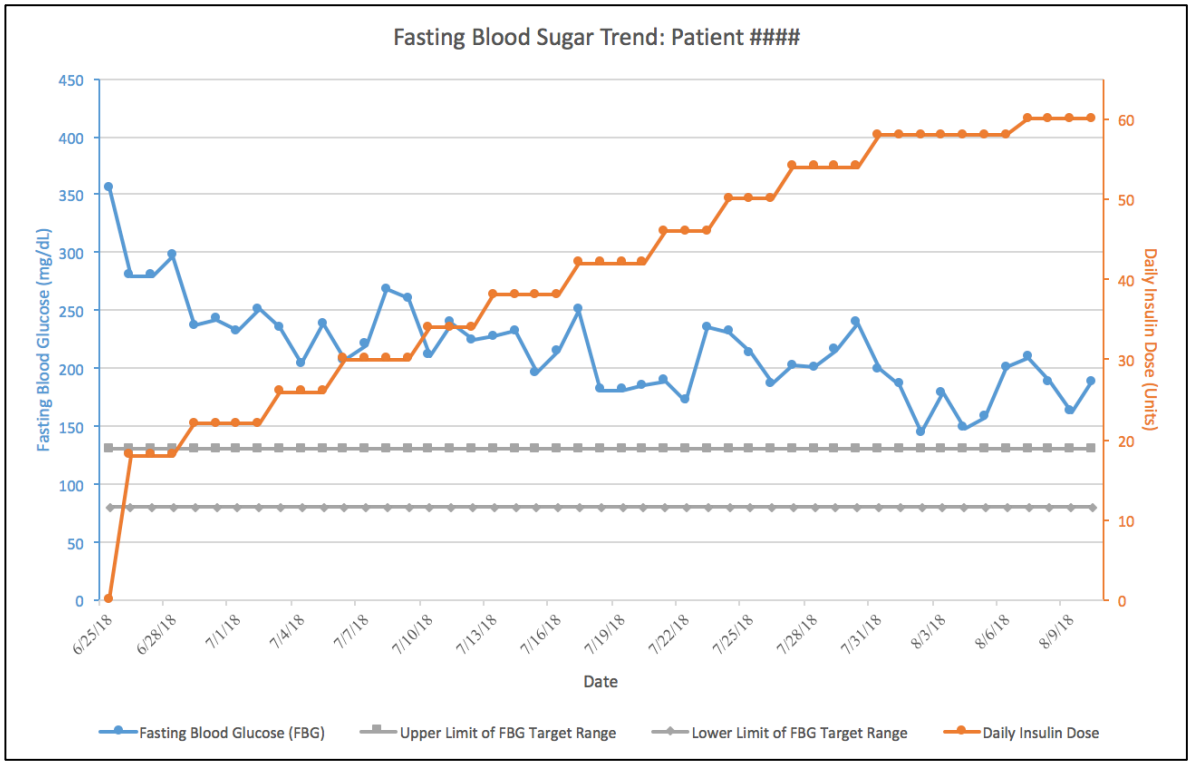


Dietary Recommendations [11-14]:

Glycemic Index (GI): indicates effect of carbohydrates on person's blood glucose level

- Standard: Value of 100 = amount of pure glucose
- Classification
    - Low GI: 55 or less
        - Will cause post prandial blood glucose levels to increase more slowly and steadily
        - Encourage more intake of low GI foods
    - Medium GI: 56-69
    - High GI: 70 and above
        - Will cause post prandial blood glucose levels to increase rapidly
        - Encourage less intake of high GI foods

Classification	Examples
Low GI (55 or less)	• White spaghetti (49 ± 2) • Carrots (39 ± 4) • Milk full fat (39 ± 3) • Skim milk (37 ± 4) • Kidney beans (24 ± 4) • Oatmeal (55 ± 2) • Banana (51 ± 3) • Mango (51 ± 5) • Orange juice (50 ± 2) • Orange (43 ± 3) • Plantain (55 ± 6) • Sweet corn (52 ± 5)
Medium GI (56-69)	• Sweet potato (63 ± 6) • Pumpkin (64 ± 7) • Soda (59 ± 3) • Potato chips (56 ± 3)
High GI (70 and above)	• White rice (73 ± 4) • White bread (75 ± 2) • Whole wheat bread (74 ± 2) • Boiled potato (78 ± 4) • Sugar (103 ± 3)

Recommendations based on interview with patient(s) of El Naranjito

"*La salud entra por la boca*"

General Recommendations:

- Instead of rice, use trigo (wheat meal)
    - Can accompany trigo the same as rice → use beans and salsa
- Avoid sweet foods. If using sugar, only use "un chin de azúcar"
- Eat less fried foods, use less oil while cooking. More boiled foods.
- Less salt
- Skim milk > whole milk
- Eat: avocado, almond, carrots, beets, meat, fish
    - To add spice/flavor/color: carrot "salsa," garlic, oregano, onion, chili pepper

- Avoid: yuka, spaghetti, potato, bread, butter, soda
    - Less fruit

Examples of meals:

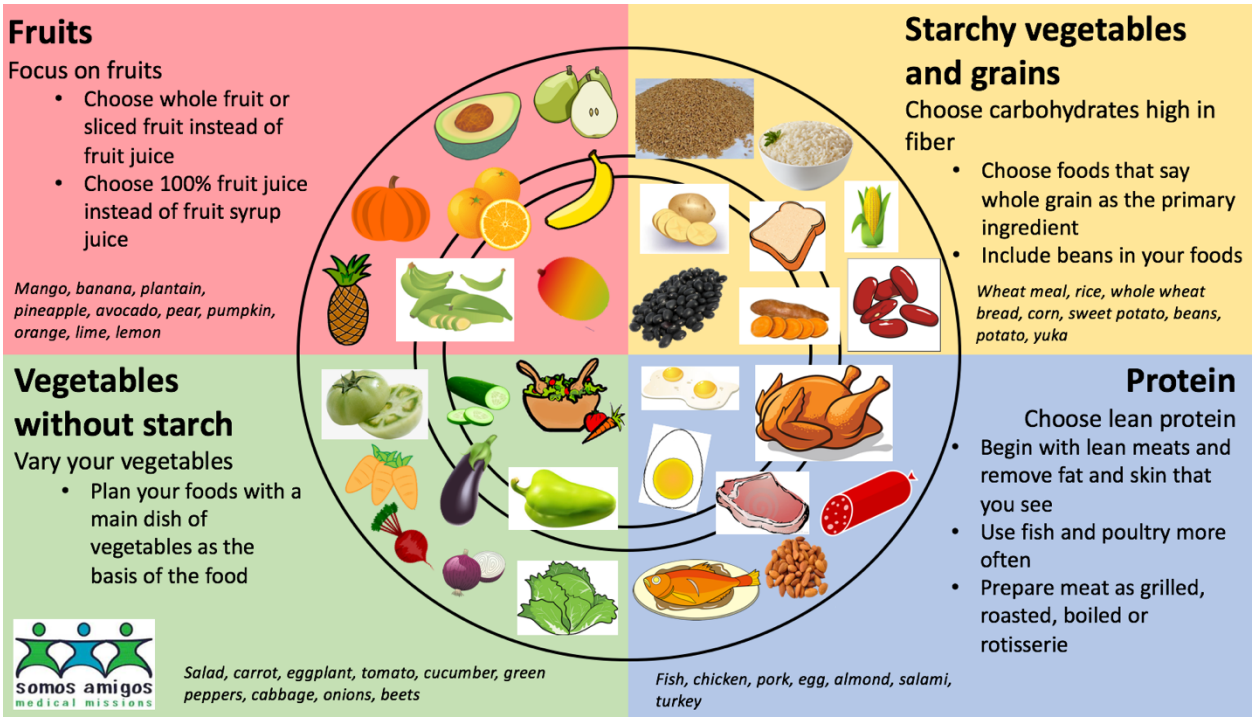
- Breakfast: banana, eggs, pumpkin
- Dinner: green salad topped with carrots, beets
    - Meat, fish

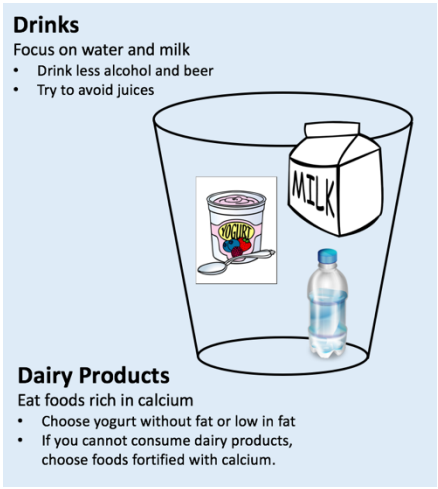
MyPlate Model [12,14]:

MyPlate is a concept developed by the American Diabetes Association that focuses on dietary teaching for diabetic patients. With dietary advising, the goal is to not avoid or eliminate entirely certain foods. Rather, the goal is to add healthier foods at greater portions on a given plate. The thinking is as the patient increases the portions of healthier foods, the less healthy foods become "crowded out." Instead of framing diet in with negative references (i.e., "Do not eat rice"), encouraging positive additions to our patients' plates (i.e., "Add more avocado to the plate where rice used to be") may result in more long lasting changes in the dietary behaviors in our patients.

See MyPlate model from American Diabetes Association (ADA) on next page:

MyPlate:





Note: MyPlate handouts given to patients are written in Spanish

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