Glucagon Prescription Rates for Individuals With Type 1 Diabetes Mellitus Following Implementation of an Electronic Health Records Intervention

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ABSTRACT

Objective: Severe hypoglycemia can alter consciousness and inhibit oral intake, requiring nonoral rescue glucagon administration to raise blood glucose to safe levels. Thus, current guidelines recommend glucagon kit prescriptions for all patients at risk for hypoglycemia, especially patients with type 1 diabetes mellitus (T1DM). At the diabetes outpatient clinic at a tertiary medical center, glucagon prescription rates for T1DM patients remained suboptimal.

Methods: A quality improvement team analyzed patient flow through the endocrinology clinic and identified the lack of a systematic approach to assessing patients for home glucagon prescriptions as a major barrier. The team implemented 2 successive interventions. First, intake staff indicated whether patients lacked an active glucagon prescription on patients' face sheets. Second, clinical pharmacists reviewed patient prescriptions prior to scheduled visits and pended glucagon orders for patients without active prescriptions. Of note, when a pharmacy pends an order, the pharmacist enters an order into the electronic health record (EHR) but does not sign it. The order is saved for a provider to later access and sign. A statistical process control p-chart tracked monthly prescription rates.

Results: After 7 months, glucagon prescription rates increased from a baseline of 59% to 72% as the new steady state.

Conclusion: This project demonstrates that a series of interventions can improve glucagon prescription rates for patients at risk for hypoglycemia. The project's success stemmed from combining an EHR-generated report and interdisciplinary staff members' involvement. Other endocrinology clinics may incorporate this approach to implement similar processes and improve glucagon prescription rates.

Keywords: diabetes, hypoglycemia, glucagon, quality improvement, prescription rates, medical student.

Hypoglycemia limits the management of blood glucose in patients with type 1 diabetes mellitus (T1DM). Severe hypoglycemia, characterized by altered mental status (AMS) or physical status requiring assistance for recovery, can lead to seizure, coma, or death.[1] Hypoglycemia in diabetes often occurs iatrogenically, primarily from insulin therapy: 30% to 40% of patients with T1DM and 10% to 30% of patients with insulin-treated type 2 diabetes mellitus experience severe hypoglycemia in a given year.[2] One study estimated that nearly 100,000 emergency department visits for hypoglycemia occur in the United States per year, with almost one-third resulting in hospitalization.[3]

Most patients self-treat mild hypoglycemia with oral intake of carbohydrates. However, since hypoglycemia-induced nausea and AMS can make oral intake more difficult or prevent it entirely, patients require a treatment that family, friends, or coworkers can administer. Rescue glucagon, prescribed as intramuscular injections or intranasal sprays, raises blood glucose to safe levels in 10 to 15 minutes.[4] Therefore, the American Diabetes Association (ADA) recommends glucagon for all patients at risk for hypoglycemia, especially patients with T1DM.[5]

Despite the ADA's recommendation, current evidence suggests suboptimal glucagon prescription rates, particularly in patients with T1DM. One study

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reported that, although 85% of US adults with T1DM had formerly been prescribed glucagon, only 68% of these patients (57.8% overall) had a current prescription.[4] Few quality improvement efforts have tackled increasing prescription rates. Prior successful studies have attempted to do so via pharmacist-led educational interventions for providers[6] and via electronic health record (EHR) notifications for patient risk.[7] The project described here aimed to expand upon prior studies with a quality improvement project to increase glucagon prescription rates among patients at risk for severe hypoglycemia.

Methods

Setting

This study was conducted at a tertiary medical center's outpatient diabetes clinic; the clinic treats more than 9500 patients with DM annually, more than 2700 of whom have T1DM. In the clinic's multidisciplinary care model, patients typically follow up every 3 to 6 months, alternating between appointments with fellowship-trained endocrinologists and advanced practice providers (APPs). In addition to having certified diabetes educators, the clinic employs 2 dedicated clinical pharmacists whose duties include assisting providers in prescription management, helping patients identify the most affordable way to obtain their medications, and educating patients regarding their medications.

Patient flow through the clinic involves close coordination with multiple health professionals. Medical assistants (MAs) and licensed practical nurses (LPNs) perform patient intake, document vital signs, and ask screening questions, including dates of patients' last hemoglobin A1c tests and diabetic eye examination. After intake, the provider (endocrinologist or APP) sees the patient. Once the appointment concludes, patients proceed to the in-house phlebotomy laboratory as indicated and check out with administrative staff to schedule future appointments.

Project Design

From August 2021 through June 2022, teams of medical students at the tertiary center completed this project as part of a 4-week integrated science course on diabetes. Longitudinal supervision by an endocrinology faculty member ensured project continuity. The project employed the Standards for QUality Improvement Reporting Excellence (SQUIRE 2.0) method for reporting.[8]

Stakeholder analysis took place in August 2021. Surveyed clinic providers identified patients with T1DM as the most appropriate population and the outpatient setting as the most appropriate site for intervention. A fishbone diagram illustrated stakeholders to interview, impacts of the clinical flow, information technology to leverage, and potential holes contributing to glucagon prescription conversations falling through.

Interviews with T1DM patients, clinical pharmacists, APPs, MAs/LPNs, and endocrinologists identified barriers to glucagon prescription. The interviews and a process map analysis revealed several themes. While patients and providers understood the importance of glucagon prescription, barriers included glucagon cost, prescription fill burden, and, most pervasively, providers forgetting to ask patients whether they have a glucagon prescription and failing to consider glucagon prescriptions.

For this study, each team of medical students worked on the project for 1 month. The revolving teams of medical students met approximately once per week for the duration of the project to review data and implementation phases. At the end of each month, the current team recorded the steps they had taken and information they had analyzed in a shared document, prepared short videos summarizing the work completed, and proposed next steps for the incoming team to support knowledge generation and continuity. Students from outgoing teams were available to contact if incoming teams had any questions.

Interventions

In the first implementation phase, which was carried out over 4 months (December 2021 to March 2022), the patient care manager trained MAs/LPNs to write a glucagon reminder on patients' face sheets. At check-in, MAs/LPNs screened for a current glucagon prescription. If the patient lacked an up-to-date prescription, the MAs/LPNs hand-wrote a reminder on the patient's face sheet, which was given to the provider immediately prior to seeing the patient. The clinical staff received an email explaining the intervention beforehand; the daily intake staff email included project reminders.

In the second implementation phase, which started in April 2022, had been carried out for 3 months at the time of this report, and is ongoing, clinical pharmacists have been pending glucagon prescriptions ahead of patients' appointments. Each week, the pharmacists generate an EHR report that includes all patients with T1DM who have attended at least 1 appointment at the clinic within the past year (regardless of whether each patient possessed an active and up-to-date glucagon prescription) and the date of each patient's next appointment. For patients who have an appointment in the upcoming week and lack an active glucagon prescription, the pharmacists run a benefits investigation to determine the insurance-preferred glucagon formulation and then pend the appropriate order in the EHR. During the patient's next appointment, the EHR prompts the provider to review and sign the pharmacist's pended order (**Figure 1**).

Measures

This project used a process measure in its analysis: the percentage of patients with T1DM with an active glucagon prescription at the time of their visit to the clinic. The patient population included all patients with a visit diagnosis of T1DM seen by an APP at the clinic during the time scope of the project. The project's scope was limited to patients seen by APPs to help standardize appointment comparisons, with the intent to expand to the endocrinologist staff if the interventions proved successful with APPs. Patients seen by APPs were also under the care of endocrinologists and seen by them during this time period. The project excluded no patients.

Each individual patient appointment represented a data point: a time at which an APP could prescribe glucagon for a patient with T1DM. Thus, a single patient who had multiple appointments during the study period would generate multiple data points in this study.

Specific Aims and Analysis

For all T1DM patients at the clinic seen by an APP during the study period, the project aimed to increase the percentage with an active and up-to-date glucagon prescription from 58.8% to 70% over a 6-month period, a relatively modest goal appropriate for the time constraints

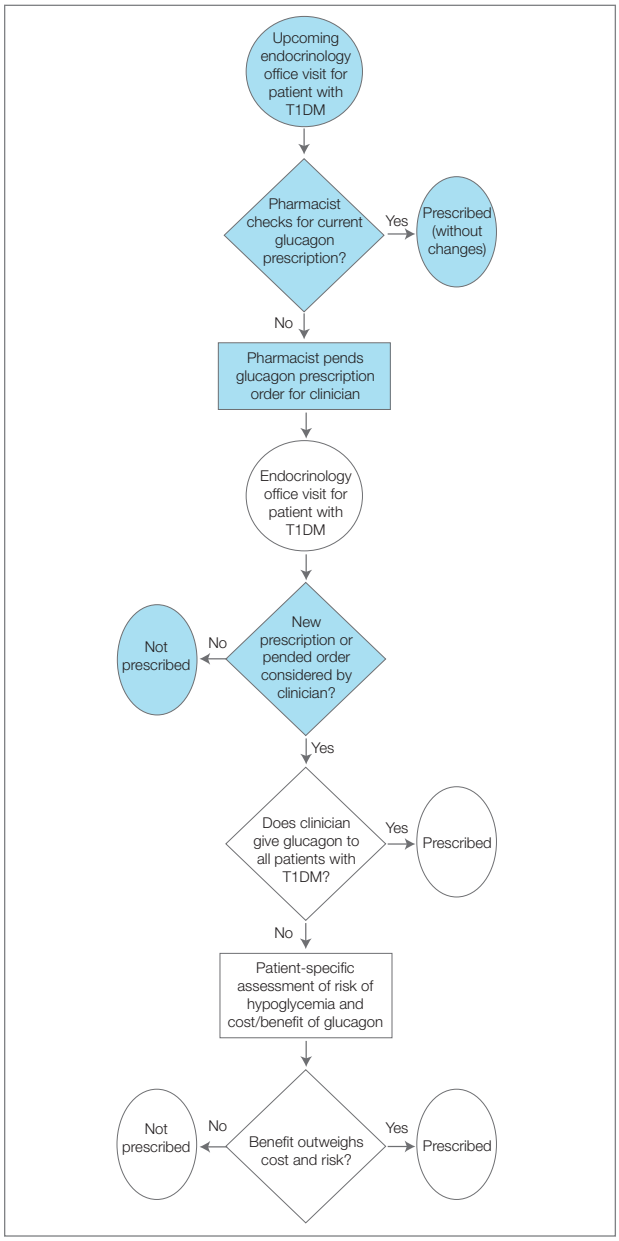

Figure 1. Process map illustrating when patients with type 1 diabetes mellitus (T1DM) receive glucagon prescriptions in the clinic after implementation of intervention 2. The colored portions of the map indicate process changes made during the interventions. Prior quality improvement projects at this clinic[8] suggested that systematic changes to patient flow and orders prepared in advance in the electronic health record (EHR) would likely increase glucagon prescribing. Stakeholder feedback from medical assistants (MAs) and licensed practical nurses (LPNs) indicated intake as an appropriate time to screen patients for active glucagon prescriptions. Since MAs/LPNs at this clinic cannot pend orders for prescriptions, this project mobilized clinical pharmacists to screen patients on the day of their appointment using EHR filtering and to pend glucagon orders if necessary. (See supplementary **eFigure** online for the process map prior to implementation of the project interventions.)

and that would be similar to the changes seen in previous work in the same clinic.[9]

This project analyzed de-identified data using a statistical process control chart (specifically, a p-chart) and standard rules for assessing special-cause signals and thus statistical significance.

Results

Baseline data were collected from October 2020 to September 2021. During this time, APPs saw 1959 T1DM patients, of whom 1152 (58.8%) had an active glucagon prescription at the time of visit and 41.2% lacked a glucagon prescription (**Figure 2**). During the 4 months of implementation phase 1, analysis of the statistical process control chart identified no special cause signal. Therefore, the project moved to a second intervention with implementation phase 2 in April 2022 (3 months of postintervention data are reported). During the entire intervention, 731 of 1080 (67.7%) patients had a glucagon prescription. The average for the last 2 months, with phase 2 fully implemented, was 72.3%, surpassing the 70% threshold identified as the study target (**Figure 3**).

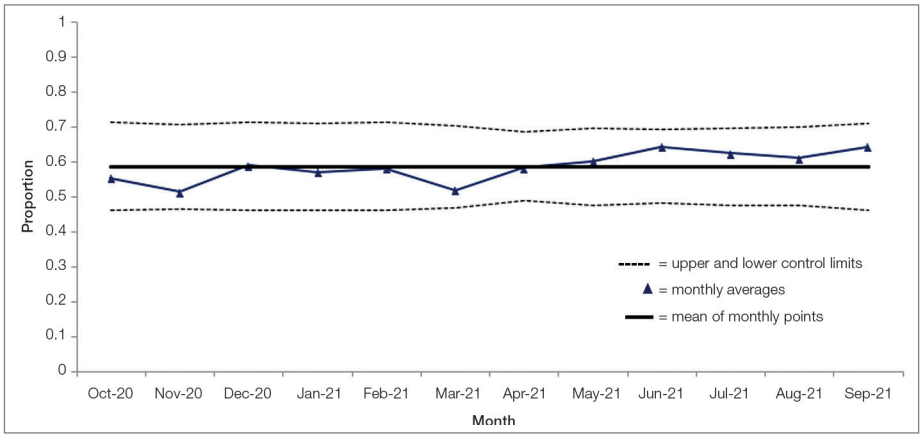

Figure 2. Baseline data for the project prior to implementation of the interventions (October 2020–September 2021) showing the proportion of patient visits with an advanced practice provider for type 1 diabetes mellitus with an active glucagon prescription at the time of visit.

Interviews with clinical pharmacists during implementation phase 2 revealed that generating the EHR report and reviewing patients with glucagon prescription indications resulted in variable daily workload increases ranging from approximately 15 to 45 minutes, depending on the number of patients requiring intervention that day. During the first month of implementation phase 2, the EHR report required repeated modification to fulfill the intervention needs. Staffing changes over the intervention period potentially impacted the pattern of glucagon prescribing. This project excluded the 2 months immediately prior to implementation phase 1, from October 2021 to November 2021, because the staff had begun having discussions about this initiative, which may have influenced glucagon prescription rates.

Discussion

This project evaluated 2 interventions over the course of 7 months to determine their efficacy in increasing the frequency of glucagon prescribing for individuals with T1DM in an endocrinology clinic. These interventions were associated with increased prescribing from a baseline of 58.8% to 72.3% over the last 2 months of the project. In the first intervention, performed over 4 months, MAs/LPNs wrote reminders on the appropriate patients' face sheets, which were given to providers prior to appointments. This project adapted the approach from a successful previous quality improvement study on increasing microalbuminuria screening rates.[9] However, glucagon prescription rates did not increase significantly, likely because, unlike with microalbuminuria screenings, MAs/LPNs could not pend glucagon prescriptions.

In the second intervention, performed over 3 months, clinical pharmacists pended glucagon prescriptions for identified eligible patients. Glucagon prescribing rates increased considerably, with rates of 72.3% and 72.4% over May and June 2021, respectively, indicating that the intervention successfully established a new higher steady state of proportion of patient visits with active glucagon prescriptions compared with the baseline rate of 58.8%. Given that the baseline data for this clinic were higher than the baseline glucagon prescription rates reported in other studies (49.3%),[10] this intervention could have a

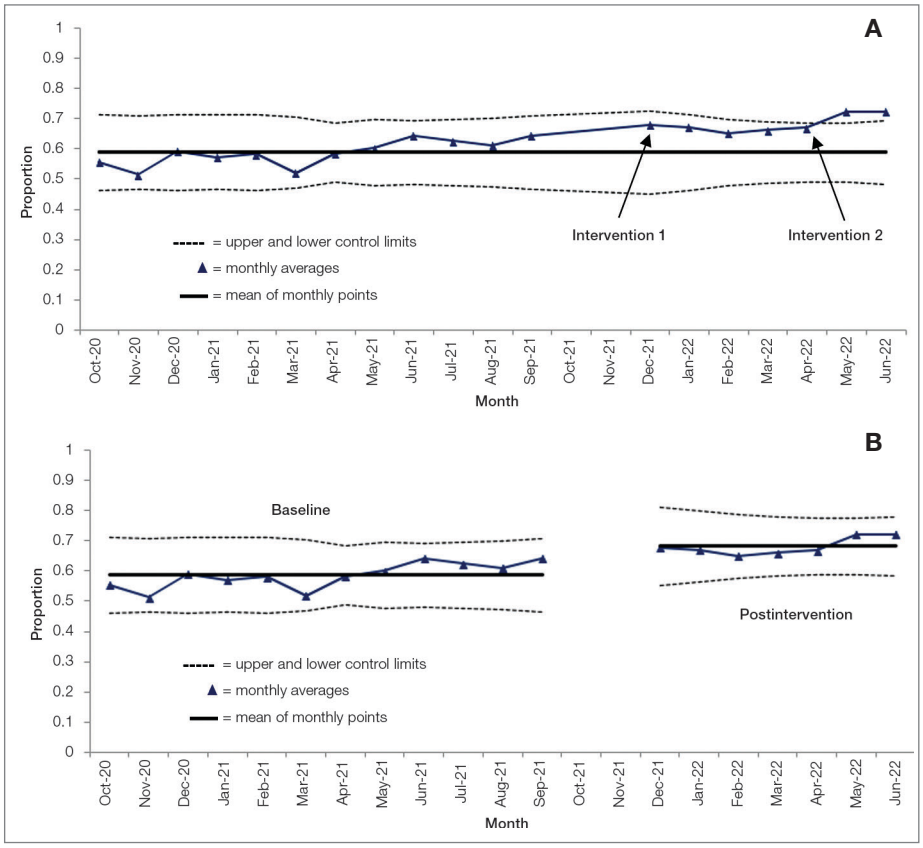

Figure 3. Statistical process control charts of the proportion of patient visits with an advanced practice provider for type 1 diabetes mellitus with an active glucagon prescription at the time of visit. (**A**) Fixed mean based on baseline performance, and (**B**) 2 separate means based on baseline (October 2020–August 2021) vs postintervention (December 2021–May 2022) data, with a split demarcating the period without study interventions.

major impact in clinics with a baseline more comparable to conditions in that study.

This project demonstrated how a combination of an EHR-generated report and interdisciplinary involvement provides an actionable process to increase glucagon prescription rates for patients with T1DM. Compared to prior studies that implemented passive interventions, such as a note template that relies on provider adherence,[7] this project emphasizes the benefit of implementing an active systems-level intervention with a pre-pended order.

Regarding prior studies, 1 large, 2-arm study of clinical pharmacists proactively pending orders for appropriate patients showed a 56% glucagon prescription rate in the intervention group, compared with 0.9% in the control group with no pharmacist intervention.[11] Our project had a much higher baseline rate: 58.8% prior to intervention vs 0.9% in the nonintervention group for the previous study—likely due to its chosen location's status as an endocrinology clinic rather than a general health care setting.

A different study that focused on patient education rather than glucagon prescription rates used similar EHR-generated reports to identify appropriate patients and assessed glucagon prescription needs during check-in. Following the educational interventions in that study, patients reporting self-comfort and education with glucagon administration significantly increased from 66.2% to 83.2%, and household member comfort and education with glucagon administration increased from 50.8% to 79.7%. This suggests the possibility of expanding the use of the EHR-generated report to assist not only with increasing glucagon prescription rates, but also with patient education on glucagon use rates and possibly fill rates.[7] While novel glucagon products may change uptake rates, no new glucagon products arose or were prescribed at this clinic during the course of data collection.

Of note, our project increased the workload on clinical pharmacists. The pharmacists agreed to participate, despite the increased work, after a collaborative discussion about how to best address the need to increase glucagon prescriptions or patient safety; the pharmacy department had initially agreed to collaborate specifically to identify and attend to unmet needs such as this one. Although this project greatly benefited from the expertise and enthusiasm of the clinical pharmacists involved, this tradeoff requires further study to determine sustainability.

Limitations

This project had several limitations. Because of the structure in which this intervention occurred (a year-long course with rotating groups of medical students), there was a necessary component of time constraint, and this project had just 2 implementation phases, for a total of 7 months of postintervention data. The clinic has permanently implemented these changes into its workflow, but subsequent assessments are needed to monitor the effects and assess sustainability.

The specific clinical site chosen for this study benefited from dedicated onsite clinical pharmacists, who are not available at all comparable clinical sites. Due to feasibility, this project only assessed whether the providers prescribed the glucagon, not whether the patients filled the prescriptions and used the glucagon when necessary. Although prescribing rates increased in our study, it cannot be assumed that fill rates increased identically.

Finally, interventions relying on EHR-generated reports carry inherent limitations, such as the risk of misidentification or omission of patients who had indications for a glucagon prescription. The project attempted to mitigate this limitation through random sampling of the EHR report to ensure accuracy. Additionally, EHR-generated reports encourage sustainability and expansion to all clinic patients, with far less required overhead work compared to manually derived data.

Future investigations may focus on expanding this intervention to all patients at risk for hypoglycemia, as well as to study further interventions into prescription fill rates and glucagon use rates.

Conclusion

This project indicates that a proactive, interdisciplinary quality improvement project can increase glucagon prescription rates for patients with T1DM in the outpatient setting. The most effective intervention mobilized clinical pharmacists to identify patients with indications for a glucagon prescription using an integrated EHR-generated report and subsequently pend a glucagon order for the endocrinology provider to sign during the visit. The strengths of the approach included using a multidisciplinary team, minimizing costs to patients by leveraging the pharmacists' expertise to ensure insurance coverage of specific formulations, and utilizing automatic EHR reporting to streamline patient identification. Ideally, improvements in glucagon prescription rates should ultimately decrease hospitalizations and improve treatment of severe hypoglycemia for at-risk patients.

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