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ORIGINAL RESEARCH

Assessment of the Clinical Outcome of a Symptom-Based Outpatient Hyperglycemia Protocol

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ABSTRACT

Introduction: Acute hyperglycemia (blood glucose [BG] ≥400 mg/dL) is common in primary care. An outpatient protocol was developed to streamline the treatment of acute hyperglycemia. The objective was to determine if an outpatient hyperglycemia protocol could achieve a BG level of <300 mg/dL within 4 hours. ***Methods:*** Adult diabetic patients with acute symptomatic hyperglycemia (>400 mg/dL) without acute illness were recruited. Enrolled patients were managed with a protocol that included administration of 0.15 units/kg rapid-acting insulin given subcutaneously, hydration, hourly fingerstick blood sugars (FSBS), laboratory assessment, tailored diabetes education, and follow-up within 72 hours. Independent variables for data analysis included age, baseline FSBS, sodium, potassium, chloride, blood urea nitrogen, serum creatinine, CO_2, venous glucose, and etiology (medications, diet, personal stress). ***Results:*** For the 27 patients enrolled, the average initial FSBS level (n=23) was 484 mg/dL, the average final FSBS level (n=27) was 274 mg/dL, and average time to achieve BG levels of <300 mg/dL was 2.35 hours. The protocol was successful in 20 patients (74%). The causes for seven protocol failures were nonclinical in nature. The patients' weight and total time to goal were significantly associated with odds of protocol success. Personal stress significantly correlated with protocol failure. The protocol success group had a higher sodium level than the failure group (P=0.01). Weight and baseline BG showed decreased odds of protocol success (P=0.05 and P=0.04, respectively). ***Conclusions:*** Results of this pilot study suggest acute hyperglycemia without other acute illness can be managed on an outpatient basis. Outpatient interventions to address acute hyperglycemia need further investigation. Managing acute hyperglycemia in the outpatient setting could potentially decrease hospital admissions for hyperglycemic hyperosmolar syndrome and mild diabetic ketoacidosis.

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INTRODUCTION

Diabetic ketoacidosis (DKA) and hyperglycemic hyperosmolar syndrome (HHS) contribute significantly to the estimated US$174 billion annual cost of diabetes mellitus.[1] Of the $116 billion in medical expenditures attributed to diabetes, approximately 50% ($58 billion) are inpatient costs.[1] DKA and HHS are managed initially by hospital emergency departments (EDs), followed by inpatient medical care. A typical ED visit involves at least a 4-hour wait time, is inconvenient, and the average costs for a visit without admission are estimated at ≥$1000. Wait time in the ED has increased in the last decade due to an increasing number of patients using the ED at the same time that more EDs are closing their doors.[2]

Nationally recognized management protocols only exist for hospital settings. These protocols exist as initial treatment after the DKA or HHS diagnosis has been established.[3] There is evidence to suggest type 1 diabetes patients with mild DKA can be managed with rapid-acting insulin analogs in an outpatient setting.[4-7] It is currently unknown if symptomatic, mild hyperglycemia in type 2 diabetes patients can be managed adequately in an outpatient setting. Most diabetes education centers have policies and procedures to contact physicians when a patient presents with high blood glucose (BG) levels. However, no established outpatient hyperglycemia protocol exists. The literature does describe common causes of acute metabolic decompensation: acute illness (ie, infection, myocardial infection), noncompliance with treatment, and new-onset diabetes. Significant contributing factors within the noncompliance group are omission of insulin therapy and substance abuse (especially alcohol and cocaine). Even using the costs in 1998, national estimates for hospitalization for diabetic emergencies are high at $10,876, with an average length of stay of 6.6 days.[8]

Physicians and physician assistants (PAs) in our primary-care clinic voiced concerns that diabetic patients with BG levels of >400 mg/dL needed a more focused and consistent clinical assessment and management. Concerns were raised regarding whether all patients should be triaged as outpatients with insulin in the office, or whether all patients with BG levels of >400 mg/dL should be automatically referred to the ED. Concerns were also raised regarding whether all patients with positive urine ketones should be sent to the ED. To address these concerns, a multidisciplinary team of a medical doctor (MD), PA, and pharmacist developed a standardized assessment and outpatient protocol for symptomatic hyperglycemia. Based on preliminary data using the protocol informally, we hypothesized that this management approach was feasible. The purpose of this pilot study was to determine if the use of an outpatient hyperglycemia protocol could achieve a BG level of <300 mg/dL within 4 hours. This paper describes the clinical outcome of 27 patients with known diabetes treated with an outpatient hyperglycemia protocol.

METHODS

Study Setting

The Family Medicine Center (FMC) has approximately 2000 patients with diabetes, and includes an American Diabetes Association (ADA)-recognized diabetes self-management education (DSME) service on-site. The site trains both family medicine and pharmacy residents. The FMC conducts approximately

60,000 visits per year. The diabetes population is predominantly African-American females in their 50s with type 2 diabetes. Patients generally belong to lower socioeconomic groups, and therefore noncompliance due to lack of resources is very common. A total of 70% of the FMC population is insured by either Medicare or Medicaid (many are dual eligibles), and approximately 30% have a coexisting psychiatric diagnosis. The study was designed within a primary-care setting equipped to educate, manage, and coordinate care for patients with diabetes.

Study Design

This study was an uncontrolled case series.

Study Population

University of Oklahoma Health Sciences Center Institutional Review Board (IRB) approval was granted prior to study initiation. Participants were selected from outpatients seen at the FMC, who, upon presentation, were found to have a finger-stick blood sugar (FSBS) level of >400 mg/dL, with hyperglycemic symptoms (polyuria, polydipsia, polyphagia, drowsiness, fatigue, blurry vision). The participants were aged between 20 and 80 years, with known diabetes. Exclusion criteria included patients with large blood ketones (as measured by >1.5 mmol/L of ketones by the blood glucose and ketone monitoring system [Precision Xtra® meter, Abbott Laboratories, Abbott Park, Illinois, USA], because the severity of dehydration would prevent outpatient treatment), patients with initial venous glucose >700 mg/dL (given maximal fall in BG at 75-100 mg/dL per hour, those >700 would automatically fail the protocol due to time), and patients who were acutely ill (ie, fever, infection, acute myocardial infarction) as assessed by the medical team (see Table 1 in Appendix 1).

Methods and Procedures

Clinical decision-making related to acute hyperglycemia was summarized with the creation of an assessment document (see Appendix 1). The assessment document was intended as a medical decision-making tool to determine appropriateness for outpatient treatment. Patients who gave consent were managed by the use of a protocol for hyperglycemia using FSBS, rapid-acting insulin analog, hydration (either intravenous [IV] or oral), diabetes self-management education, and discharge instructions (see Appendix 2). The goal was to decrease BG levels by 75-100 mg/dL per hour.

The initial insulin dose was 0.15 units/kg subcutaneously (SQ) into the abdomen. This is the IV dose recommended by the ADA for HHS management.[3] Subcutaneous administration was chosen so that the protocol would be simple, and because IV access in the outpatient environment is often unavailable. Subsequent insulin doses were determined by the physician and pharmacist. Any subsequent dose was very patient specific, and based on several factors: 1) the rate of decline of the BG level after the first insulin dose; 2) amount of hydration given; 3) the type of diabetes; 4) body weight; 5) body habitus; and 6) total daily insulin dose for current insulin users. Type 2 diabetes patients may have required additional insulin doses depending on the level of insulin resistance. Type 1 diabetes patients (a small percent of our diabetic population) are very insulin sensitive, and therefore required small amounts of insulin. Protocol patients received either a telephone follow-up or an appointment with the primary-care physician or pharmacist-diabetes educator within 72 hours.

The protocol was carried out by a team of physicians, nurses or medical assistants (MA), and pharmacists. The physician's role was to provide

patient-assessment, consult with the pharmacist to initiate the protocol, determine subsequent insulin dose(s), provide clinical decision-making when ED referral was warranted, and sign the progress note as required for billing purposes. The MA/licensed practical nurse's (LPN) role was to start and administer IV fluids if necessary or ensure the patient was drinking water throughout the protocol, perform hourly FSBS, administer insulin SQ into the abdomen, coordinate the patient getting samples for statistical laboratory tests (stat labs) drawn, ongoing communication with the pharmacist for insulin dose-orders, documentation of every step in the protocol (FSBS results, amount of hydration given, stat lab results, insulin administration), and to ensure follow-up visits were scheduled. The pharmacist's role was to interview patients, identify contributing factors to acute hyperglycemia, obtain consent, oversee nurses, ensure the protocol ran efficiently, provide basic self-management education tailored to the patient's needs during the protocol, and coordinate care if the patient had insufficient resources to maintain a supply of medication and/or related supplies (meter, test strips, lancets, syringes).

Data Collection, Analysis, and Confidentiality

Participants were assigned a unique identifier to ensure no patient could be identified by reviewing the clinical data. Demographics and clinical data were recorded onto the data-collection form (see Appendix 3).

For all participants, the following data were collected: unique identifier, date of protocol, insurance, FSBS1, FSBS2, FSBS3, FSBS4, FSBS5 (as applicable), time of FSBS1 through time of FSBS5, weight, amount of insulin administered, time insulin was administered, time venous blood was obtained, basic metabolic panel (BMP) results for sodium, potassium, chloride, CO_2, BG, creatinine, blood urea nitrogen (BUN), urinalysis (UA) results, blood ketone results, second insulin dose (if given) and time of second insulin dose (if given), and factors contributing to high BG (medications, diet, recent illness, and/or personal stress). Personal stress included lack of housing or transportation, lack of personal support, recent emotional stress (death in the family, undergoing divorce), and financial stressors. Multiple factors could be indicated.

The primary objective of this study was to determine what proportion of patients could successfully achieve a BG level of <300 mg/dL within 4 hours. The secondary objective was an exploratory analysis of patient factors related to the primary objective (which factors may make the protocol more or less appropriate?).

Patients that failed to achieve a BG level of <300 mg/dL were assessed as protocol failures. To assess the potential association between protocol failure and baseline BG, an independent-measure *t*-test was conducted, using baseline BG level as the dependent measure, and protocol success or failure as the independent measure. Additional Fisher's exact tests were conducted to assess the potential association between reasons for failure and protocol failure. Additionally, various basal metabolic electrolyte levels were compared, based on protocol success or failure as the independent measure, and the various electrolyte measures as the dependent measure.

An exploratory analysis using logistic regression was conducted in an effort to assess the association between protocol outcome (success/failure as the dependent variable) and several independent variables, including ethnicity, baseline blood sugar, patient weight, and total time to goal. This analysis may assist in establishing what, if any, various independent variables were significantly associated with protocol success or protocol failure.

For all analyses, the a-priori alpha level was 0.05. All data management and analyses were performed in Stata (Version 10, StataCorp LP., Texas, USA).[9]

RESULTS

The baseline patient demographics are shown in Table 1. Results are summarized in Table 2. Of note, average initial FSBS level was 484 mg/dL, and over half (56%) had state Medicaid insurance. Average final FSBS level (*n*=27) was 274 mg/dL. Three readings displayed on the screen as "HI," signified that the BG level was >600 mg/dL on the Aviva glucometer (Accu-Chek® Aviva; Roche Ltd., Indianapolis, Indiana, USA). Average time to achieve FSBS levels of <300 mg/dL was 2.35 hours, and 20 out of 27 patients (74%) achieved an FSBS level of <300 mg/dL within 4 hours. Seven protocol failures were secondary to nonclinical issues, such as patient contact barriers (after hours, transportation, telephone). We excluded one patient with large blood ketones who was referred to the ED, because outpatient treatment was inappropriate. Patients that failed to achieve a BG level of <300 mg/dL were assessed as protocol failures. Table 3 depicts the exploratory analysis using logistic regression to assess the potential association between protocol outcomes (success/failure as the dependent variable) and several independent variables, including baseline BG level, race, weight, and total time to goal. As can be seen, the variables of patient weight and

Table 1. Demographics.

Patients, *n*=27	***n* (%)**
Caucasian	9 (33)
African-American	17 (63)
Hispanic	1 (4)
Female	21 (78)
Male	6 (22)
Average age (years)	47
Payor mix, *n*=27	***n* (%)**
Medicaid	15 (56)
Medicare	6 (22)
Commercial insurance	5 (19)
Self-pay	1 (4)

Table 2. Results of the use of a hyperglycemia protocol.

Initial FSBS >600 mg/dL	4/27 (15%)
Average initial FSBS (*n*=23)	484 mg/dL
Average venous glucose (*n*=21)	367 mg/dL
Average final FSBS (*n*=27)	274 mg/dL
Average time to achieve BG <300 mg/dL	2.35 hours
Average fall in glucose between FSBS1 and FSBS2	144 mg/dL
Average time between FSBS1 and FSBS2	1.45 hours
Patients that did not decrease by 75 mg/dL in the first hour	4*
Protocol success	20/27 (74%)
Protocol failure	7/27 (26%)
Follow-up within 72 hours	27/27 (100%)

*Three of the four received a second insulin dose.
BG=blood glucose; FSBS=fingerstick blood sugar.

Table 3. Fisher's exact test. Assessing the relationships between various causes of hyperglycemia (medications, diet, personal stress) and protocol success.

Variable name	**Protocol success: No**	**Cause for failure: Yes**	***P* value**
Medicines			
No	2	5	
Yes	5	15	0.85
Diet			
No	5	2	
Yes	12	8	0.59
Illness			
No	5	2	
Yes	17	3	0.43
Personal stress			
No	3	4	
Yes	17	3	0.05

total time to goal were significantly associated with the odds of successful outcome. There was also a significant association between personal stress and protocol failure. Table 4 depicts the outcome of the Fisher's exact tests, assessing the relationships between the various reasons for hyperglycemia (medications, diet, and personal stress) and protocol failure. Weight and baseline BG levels became significantly associated with decreased odds of protocol success (P=0.05 and P=0.04, respectively). Table 5 depicts the results of the independent-measures t-tests of electrolytes from a BMP when the participants were grouped by success or failure. Note that there was a significant difference between the two groups regarding sodium levels, with the protocol success group having a higher, and statistically significant, mean sodium level than the failure group (P=0.01). There was no difference between the two groups of participants (success or failure) with regard to initial FSBS (mean failure 535.29 mg/dL [standard deviation (SD) 73.97], mean success 489.2 mg/dL [SD 58.46], P=0.17). All patients >65 years of age failed (n=2). There was no statistically significant difference between the two groups of participants with regard to initial venous glucose (mean venous glucose in the failure group was 406 mg/dL [SD 55.28], and mean venous glucose in the success group was 351 mg/dL [SD 62.08], P=0.072).

DISCUSSION

These preliminary data were generated in a "real-world" primary-care setting. It is hoped that these results can serve as preliminary data to demonstrate the effectiveness of this

Table 4. Logistic regression. Relationship of patient characteristics to protocol failure.

Variable	Odds ratio	Standard error	z	$P>(z)$	95% CI
African-American	Referent	Referent	Referent	Referent	Referent
White	0.1749816	0.2225771	–1.37	0.171	0.0144631, 2.117011
Baseline BG	0.9770231	0.0108552	–2.09	0.036	0.9559773, 0.9985322
Weight	0.9824874	0.0089038	–1.95	0.050	0.9651904, 0.9896569
Total time to goal	0.1908757	0.1610927	–1.96	0.050	0.0365061, 0.9980126

Logistic regression: number of observations=27; P=0.00308; log likelihood=–11.007311; pseudo R2=0.2876.
BG=blood glucose; CI=confidence interval.

Table 5. Independent-measure t-tests.

Variable	Observation (n)	Mean (SD)	95% CI	P value
Sodium				
Failure	6	135.55 (1.95)	133.50, 37.60	
Success	15	138.27 (1.97)	137.18, 39.36	0.010
Potassium				
Failure	6	4.3 (0.22)	3.74, 4.86	
Success	15	4.20 (0.16)	3.82, 4.51	0.63
Chloride				
Failure	6	95.17 (3.97)	91.00, 99.33	
Success	15	98.07 (2.96)	96.43, 99.71	0.15

CI=confidence interval; SD=standard deviation.

protocol in a larger study. As the incidence of diabetes continues to increase, primary care will continually be challenged to find effective diabetes-management strategies, particularly strategies to lower costs. It was hypothesized that the protocol would be successful within 4 hours for two reasons. Firstly, 4 hours is the average duration of rapid-acting insulin analogs, and secondly, utilizing one exam room for more than 4 hours would significantly alter patient flow. Our average time to goal was 2.35 hours, significantly less than hypothesized. Most of the statistically significant results can be explained clinically. Firstly, personal stress correlated with protocol failure because cortisol, which is increased during stress responses, opposes insulin action, and worsens insulin resistance. Secondly, protocol success was more likely with higher-corrected sodium values. Serum sodium increases with dehydration, and most hyperglycemic patients are dehydrated from polyuria.

The average venous glucose was lower than the average initial FSBS for two reasons. Firstly, stat labs were difficult to obtain in a timely manner, and patient interviews were conducted in-between initial FSBS and venous blood drawn. Secondly, some patients received the first dose of insulin prior to the venous blood draw. The 4-hour "stopwatch" began at the time the initial FSBS was taken. Rather than wait ≥1 hour(s) to receive venous glucose results, the first dose of insulin was based on the initial FSBS value. By itself, baseline BG was not associated with protocol success or failure. Using multivariate logistic regression, we found baseline BG did become associated with protocol failure. Multivariate analysis also showed increasing weight correlated with decreased odds of protocol success by 3%. Obesity contributes to insulin resistance and the higher the initial BG, the more difficult it is to achieve a reduction in a timely manner.

Lessons Learned

In improving our diabetes population at large, a culture shift has been observed in both patients and providers. FSBS >400 mg/dL in an outpatient physician visit represents poorly controlled diabetes. Although fear of insulin exists in any diabetes population, the concept that insulin is required to reduce BG out of the "dangerous" range has at least been taken into consideration by patients and providers. Due to the fact that this protocol focuses on hydration, patients understand drinking water will help reduce high BG levels, in the clinic or at home. An effective outpatient hyperglycemia protocol must address hydration and insulin, because both are required for BG to decrease in a timely manner. Based on provider feedback, deciding who must be referred to the ED is clearer. The main limitation in this study is small sample size. Our results may not be generalizable to small practice settings and to practices without any formal diabetes education services. Fortunately, 100% of participants were available for follow-up within 72 hours; none had been to the ED and no patients were hospitalized. Despite the benefit of having an ADA-recognized diabetes program on-site, not all study participants could be seen for continued diabetes education, because the payer for the majority of study patients did not include adult diabetes education as a covered benefit (see Table 1).

Practical Aspects

In order to appropriately triage patients with acute hyperglycemia, a team approach is required. As study patients could potentially need 4 hours in the clinic, keeping them in the same exam room was not feasible. After venous labs were drawn, patients were

managed either in the diabetes education service or in the same-day appointment clinic. Responsibility for the final FSBS must be assigned to a healthcare professional before patient discharge. The use of a blood ketone meter is convenient and reimbursable. Blood ketones should be assessed as soon as possible after a FSBS level of >400 mg/dL is identified, so that patients inappropriate for the outpatient protocol (ie, patients with large blood ketones) can be referred to the ED immediately. With increasing primary-care practices having access to diabetes educators and/or clinical pharmacists, the need for a simple, consistent approach to hyperglycemia management is needed. Diabetes self-management training (DSMT) programs with the ability to receive reimbursement can bill for the diabetes education provided in this type of service (using G-codes G0108)[10] on the same day as a physician office visit (evaluation and management codes). We were also successful in using outpatient critical-care codes, which receive higher reimbursement than established office visits (CPT code 99291, a billing code used to reflect higher acuity outpatient visits or patient encounters).

CONCLUSION

The use of an outpatient hyperglycemia protocol was successful in achieving a FSBS level of <300 mg/dL within 4 hours in 20 out of 27 (74%) nonacutely ill primary-care patients. Outpatient interventions to address acute hyperglycemia need further investigation. Although this study evaluated an acute issue, primary-care clinics need improved chronic-care models, because keeping patients with diabetes in a system of care allows for resolution of issues leading up to acute hyperglycemic episodes. Managing acute hyperglycemia in the outpatient setting could potentially decrease the frequency of hyperglycemia and diabetes emergencies, and DKA- and HHS-related hospital admissions.

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B.A. researched data, and wrote the manuscript. F.L. reviewed/edited the manuscript. D.H. contributed to discussion, and wrote the manuscript. B.A. is the guarantor for this article, and takes responsibility for the integrity of the work as a whole. This study was funded by the Yamanouchi Foundation, University of Oklahoma College of Pharmacy. There are no other competing interests.

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APPENDIX 1

This protocol is designed to assist primary-care providers in creating an individualized plan of care for adult patients who present with hyperglycemia or diabetic ketoacidosis (DKA). This protocol is not intended to replace sound medical judgment or clinical decision-making. Clinical judgment determines the need for adaptation in all patient-care situations; more stringent or less stringent interventions may be necessary.

Primary care assessment[1-5]	
Problem	Patient with symptomatic hyperglycemia
Assessment	Assess: • Hemodynamic status: volume status/degree of dehydration • Vomiting and ability to take p.o. • Medication compliance • Identify precipitating event leading to high glucose, (eg, infection, MI, omission of insulin, CNS event, pancreatitis) • Examine for occult infection (eg, skin, feet, UTI, cellulitis, sacral decubitus) • Symptoms of hyperglycemia • Diabetes-related complications • Social and medical history (eg, EtOH) • Rule out pregnancy if clinically relevant • Presence of ketonemia and acid-base disturbance

Labs and tests	• FSBS per clinic glucometer
	• Stat labs:
	  • glucose (lab), CBC, and BMP for Na, K, Cl, CO_2, BUN, SCr
	  • UA, check urine ketones; if positive or if unable to void, check serum ketones
	• Calculate or measure serum osmolarity, anion gap based on plasma glucose and clinical finding (see below)
	• If considering osmotically active substance other than glucose, measure osmolar gap
	• Consider blood and/or urine cultures
	• Consider chest x-ray
	• Pregnancy test if clinically relevant
	• Consider EKG

Diagnosis based on clinical findings and lab results	• Determination of diagnosis
	  • hyperglycemic (DX code 790.6)
	  • HHS (DX code 250.2)
	  • ketosis without acidosis
	  • DKA (DX 250.1)
	  • other acid-base disturbance (ie, lactic acidosis, alcoholic acidosis)

BMP=basic metabolic panel; BUN=blood urea nitrogen; CBC=complete blood count; CNS=central nervous system; DKA=diabetic ketoacidosis; DX=diagnosis code; EKG=electrocardiogram; HHS=hyperglycemic hyperosmolar syndrome; MI=myocardial infarction; p.o.=oral; SCr=serum creatinine; UA=urinalysis; UTI=urinary tract infection.

Calculations	
Calculation of effective serum osmolarity	$2[Na^+ + K^+] + \frac{(\text{glucose in mg/dL})}{18} + \frac{BUN}{2.8}$
Correction of serum sodium	$[Na^+] + 1.6 \times \frac{[\text{glucose in mg/dL}] - 100}{100}$
Calculation of the anion gap	$[Na^+] - [Cl + HCO_3]$

BUN=blood urea nitrogen.

Table 1. American Diabetes Association clinical practice guidelines (annual January supplement). Diagnostic criteria for DKA and HHS.[6]

	DKA			
	Mild	**Moderate**	**Severe**	**HHS**
Plasma glucose (mg/dL)	>250	>250	>250	>600
Arterial pH	7.25-7.30	7.00-7.24	<7.00	>7.30
Serum bicarbonate (mEq/L)	15-18	10 to <15	<10	>15
Urine ketones*	Positive	Positive	Positive	Small
Serum ketones*	Positive	Positive	Positive	Small
Effective serum osmolality (mOsm/kg)†	Variable	Variable	Variable	>320
Anion gap‡	>10	>12	>12	Variable
Alteration in sensoria or mental obtundation	Alert	Alert/drowsy	Stupor/coma	Stupor/coma

Reproduced from: Kitabchi AE, Umpierrez GE, Miles JM, Fisher JN. Hyperglycemic Crises in Adult Patients with Diabetes. Diabetes Care. 2009;32(7):1335-1343. © 2009 by the American Diabetes Association.
*Nitroprusside reaction method.
†Calculation: 2[measured Na (mEq/L)] + glucose (mg/dL)/18.
‡Calculation: $(Na^+) - (Cl^- + HCO_3^-)$ (mEq/L). See text for details.
DKA=diabetic ketoacidosis; HHS= hyperglycemic hyperosmolar syndrome.

Admission strategy

Consider hospital ED referral if:

- hemodynamically unstable
- unable to take or maintain p.o. intake
- newly diagnosed type-1
- other apparent medical/surgical reasons
- severely dehydrated patient presents to clinic after 3:00 PM

Guideline authors: Becky Armor, Pharm.D., CDE, Frank Lawler, MD, Allene Jackson, MD, Kalyanakrishnan Ramakrishnan, MD.
ED=emergency department; p.o.=oral.

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APPENDIX 2

Adult symptomatic hyperglycemia protocol orders

Date
Name
MRN
Providers notified of protocol initiation: ☐ Attending physician:
☐ Becky Armor, Pharm.D., CDE

Outpatient treatment

For Blood Glucose (BG) above 400 mg/dL in a known diabetic patient:

☐ Order stat labs: BMP, CBC, Urinalysis and urine culture if clinically indicated.
☐ Give 0.15 units/kg of rapid acting insulin (Novolog, NovoNordisk, Princeton, New Jersey, USA) SQ into abdomen.
☐ Check blood ketones. Meter available in Silver clinic (Precision Xtra, Abbott Laboratories. Abbott Park, Illinois, U.S.A.).
☐ Check for STAT lab results. Establish oral or IV hydration.
☐ Recheck FSBS in 1 hour.
☐ Hydrate with 1 L (1000 mL) orally or IV. Consider IV hydration with 1 L NS over 1 hour if clinically indicated to maintain hemodynamic stability.If IV hydration is needed, patient may be managed in the Green clinic with assigned nurse or MA.
☐ At first hour: Page PharmD provider with BG result. If BG is below 300, discharge. If BG is above 300, page PharmD provider for second insulin dose to administer. Follow up on stat lab results. Continue maximal hydration.
☐ Recheck FSBS in 1 hour.
☐ At second hour: If BG is below 300, discharge. If BG is above 300, page PharmD provider for the next insulin dose to administer.
☐ Recheck FSBS in 1 hour.
☐ At third hour: If BG is below 300, discharge. If BG is above 300, page PharmD provider for the next insulin dose to administer.
☐ Recheck FSBS in 1 hour.
☐ Re-establish diabetes drug therapy.
☐ Review patient instructions below, especially the need to force calorie free liquids and eat on schedule.
☐ Consider pharmacotherapy referral for intensification of diabetes treatment and basic self-management education.
☐ Provide patient with written instructions for follow-up care (yellow copy).
☐ Schedule return appointment or phone follow-up within 72 hours.

BG=blood glucose; BMP=basic metabolic panel; CBC=complete blood count; FSBS=fingerstick blood sugar; IV=intravenous; MA=medical assistance; NS=normal saline; STAT=lab order results are needed as soon as possible; SQ=subcutaneous.

Patient Instructions:

1. Force calorie free fluids today (water, Crystal Light, diet Sprite, diet 7-Up).
2. Resume your diabetic diet.
3. Resume your usual diabetes medicines.
4. Check your blood sugar every 3-4 hours today. If your bedtime blood sugar is GREATER THAN 300, call the after-hours physician on call at 271-4311.
5. Your next clinic appointment is:

APPENDIX 3

Data collection form

Time in:
Time out:

ID number	Weight (#)	(kg)				
Clinic	Temp:					
BP	Insurance	Insurance 2				
Date:						
Mental status *						

Insulin:						
Insulin 1		Insulin 2		Insulin 3		Insulin 4
Dose: (units)		dose		dose		dose
Time:		time		time		time
Fingersticks:						
FSBS 1 time:		FSBS 2 time:		FSBS 3 time:		FSBS 4 time:
FSBS 1 result:		FSBS 2 result:		FSBS 3 result:		FSBS 4 result:
Hydration:						
IV hydration (in mLs)						
p.o. hydration (in ounces)						
Initial Labs:						
Time BMP collected:						
Time stat results available:						
BMP Results:	Na^+	K^+	SCr	BUN	Cl^-	CO_2 glucose
Blood ketones						
UA:						
Other:						
LPN time in 15 min increments						
MD time in 15 min increments						
PharmD time in 15 min increments						

Reason for hyperglycemia:	Noncompliance ☐ meds ☐ diet ☐ both	☐ Infection	☐ MI, stroke	☐ Personal stress	☐ Illicit drugs

BMP=basic metabolic panel; BUN=blood urea nitrogen; Cl=chloride; FSBS=fingerstick blood sugar; IV=intravenous; LPN=licensed practical nurse; MD=medical doctor; MI=myocardial infarction; Pharm D=doctor of pharmacy; SCr=serum creatinine; UA=urinalysis.