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Predictors of Suboptimal Glycemic Control for Hospitalized Patients with Diabetes: Targets for Clinical Action

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ABSTRACT

- *Objective:* Suboptimal glycemic control (SGC) puts hospitalized patients with diabetes at risk for poor outcomes. The purpose of this study was to quantify factors with predictive capacity to identify patients at risk for SGC during hospitalization.
- Methods: 32 baseline and demographic variables were extracted from the electronic records of 23,100 patients with diabetes hospitalized between 2009 and 2012. The rate of blood glucose values between 70 and 180 mg/dL was calculated for each patient. A predictive model for SGC was developed using regression modeling, standardized coefficients, and classification tree analysis. Odds ratios (ORs) were calculated to isolate adjusted odds of SGC for top predictors.
- *Results:* The final predictive model included 13 variables (C statistic = 0.88). HbA1c (OR, 0.60 [95% confidence interval {CI}, 0.58–0.61]), admission blood glucose (OR, 0.91 [CI, 0.91–0.92]), and steroid use (OR, 0.06 [CI 0.04–0.08]) were the highest-ranking predictors of SGC. HbA1c and SGC had a strong linear relationship (R^2 = 0.99), with increasing odds for SGC as HbA1c increased. Admission blood glucose and SGC had a polynomial relationship (R^2 = 0.95); increasing odds for SGC until 240 mg/dL; then odds started decreasing. Steroid use showed a steady threefold increase in odds for SGC across all rates of use.
- *Conclusions:* Poor preadmission diabetes control and inpatient steroid use strongly predict SGC. A range of thresholds for these predictors was empirically determined, providing a basis for targeted therapies on admission. Guidelines incorporating empirically derived thresholds should enhance the ability to achieve optimal glycemic control for hospitalized patients with diabetes.

Current recommendations for glycemic control of hospitalized patients include use of multidisciplinary diabetic care teams and standardized insulin order sets [1,2], yet there is still uncertainty how best to target such protocols for patients with diabetes at risk for suboptimal glycemic control [2,3]. Many factors are theorized to hinder optimal inpatient glycemic control, such as steroid use [4,5], comorbid states [6], severity of illness [7,8], and preadmission glycemic control [9,10]. However, there currently exists little evidence of these factors' ability to predict suboptimal glycemic control (SGC). Identifying straightforward predictive factors of SGC would provide a clinically meaningful basis for targeted therapy. The purpose of this study was to describe the prevalence of a range of potential risk factors in a diverse hospitalized patient population with a secondary diagnosis of diabetes (types 1 and 2), and to determine which factors were predictive of SGC.

METHODS

A retrospective cohort study design was used to identify factors predictive of inpatient SGC for patients admitted to any of 3 hospitals aligned with Sharp HealthCare ("Sharp"), a community-based, nonprofit integrated health system headquartered in San Diego, California, that serves more than 27% of the county's 3 million-plus residents each year.

Inclusion Criteria

We extracted data for 23,100 patients hospitalized between January 2009 and December 2012 with a second-

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ary diagnosis of diabetes (types 1 and 2), a length of stay (LOS) ≥ 3 days, and a minimum of 2 point-of-care (POC) blood glucose tests per day. The LOS and blood glucose minimum are standard criteria for Sharp glycemic monitoring to ensure a minimum quantity of blood glucose monitoring for glycemic management.

Glycemic Control (Independent Variable)

Glycemic control was defined as POC blood glucose values within the target range of 70 to 180 mg/dL during hospitalization. POC tests outside that range were defined as SGC. This range was determined based on current Sharp benchmark targets and was not adjusted for total number of blood glucose values.

Predictive Variables

A framework for potentially relevant patient and clinical care factors associated with suboptimal glycemic control was developed based on literature review and input from Sharp clinical experts. Administrative and clinical patient characteristics, including patient demographic, clinical status and care process factors were operationalized into 32 variables that were extracted from Sharp's data warehouse (see **Table 1**). The majority of variables were selected to be identifiable on or shortly after admission, although operationalization of some variables in this study was done with administrative rather than clinical data. Steroid use and ICU stay were operationalized for the entire admission because of clinician interest: while it is generally known fairly soon after admission whether a patient will be admitted to an ICU or if steroids will be administered, the study question from the clinician standpoint was not so much if steroids or ICU stay predicted SGC but how much ICU or steroid use was predictive. Diabetes management was operationalized for the entire admission and included as a covariate to account for lack of glycemic management as a cause of suboptimal glycemic control. Other variables, such as patient LOS and mean blood glucose for admission were extracted for descriptive purposes only and not included in the model.

Age, gender, race, ethnicity, payor, facility and LOS were extracted from Sharp's data warehouse. Medical vs. surgical stay and major diagnostic category was determined from administrative diagnosis coding. Body mass index (BMI) was extracted from Sharp's electronic health record. Risk of mortality and severity of illness were calculated using 3M APR-DRG proprietary software using administrative diagnosis coding. Comorbidities were determined based on administrative diagnosis codes per published guidelines [11]. Glycosylated hemoglobin (HbA1c) was obtained on admission for patients with a secondary diagnosis of diabetes as part of Sharp's multidisciplinary diabetes care management program and extracted from the electronic health record. Admission blood glucose was defined as the first documented POC blood glucose after admission. ICU stay was calculated as a continuous variable: the percent of LOS spent in the ICU. Steroid use was similarly calculated, and defined as oral or intravenous administration of any quantity or dosage of the following corticosteroids during each day of hospitalization: dexamethasone, hydrocortisone, prednisone, and/or methylprednisone. Adherence to Sharp's multidisciplinary diabetes care management program was measured by use of standardized insulin order sets. Sharp uses evidence-based order sets for continuous infusion and subcutaneous insulin management; subcutaneous orders include basal and rapid-acting insulin. We calculated the total time a person was on an order set during hospitalization by subtracting any time a patient did not have insulin ordered from the total LOS. This was transformed into a variable documenting the percent of LOS the patient was on an insulin order set. Average blood glucose for admission was calculated for all documented POC blood glucoses during admission, omitting the admission blood glucose (the first POC blood glucose of the admission).

Analysis

Univariate analyses including *t* tests and chi-square tests were conducted to investigate the unadjusted association between variables and glycemic control. Good glycemic control was defined as 90% of all POC blood glucose tests between 70 and 180 mg/dL based on empirical distribution and organization targets. A predictive model of inpatient glycemic control was then developed using a backward stepwise multivariable logistic regression approach. The data were split into a model building and validation set. Variables were included that represented both baseline and transitional state during the hospital stay to account for potentially mediating effects and a sensitivity analysis was conducted with them in and out of the final model to assess impact. Standardized coefficients were calculated to rank order variables in the model allowing indication of the variables with the greatest predictive impact on the outcome. Further investigation

Table 1. Demographic Characteristics of Total Sample and By Level of Glycemic Control

	Total Sample		Best Control Quartile*		Worst Control Quartile*		
Variables	**Total or Mean**	**% or SD**	**Total or Mean**	**% or SD**	**Total or Mean**	**% or SD**	***P***
Female sex†	11,642	50.4	2891	50.0	3007	51.7	0.16
Age in years†	68	14.2	69	14.0	65	15.0	< 0.001
Race†							< 0.001
White	10,297	44.6	2782	48.1	2624	45.1	
Black	1608	7.0	424	7.3	394	6.8	
Asian	2177	9.4	476	8.2	470	8.1	
Other	434	1.9	119	2.1	99	1.7	
Unknown	8568	37.1	1984	34.3	2230	38.3	
Ethnicity†							< 0.001
Non-Hispanic	15,412	66.8	4016	69.4	3875	66.6	
Hispanic	6972	30.2	1588	27.5	1768	30.4	
Unknown	700	3.0	181	3.1	174	3.0	
Comorbidity history†							
Cerebrovascular disease	2753	11.9	760	13.1	649	11.2	< 0.01
Chronic pulmonary disease	6501	28.2	1524	26.3	1803	31.0	< 0.001
Mild liver disease	1622	7.0	364	6.3	456	7.8	0.009
Moderate liver disease	542	2.4	118	2.0	169	2.9	0.006
Renal disease	8007	34.7	1703	29.4	1858	31.9	< 0.001
Acute myocardial infarction	1194	5.2	255	4.4	261	4.5	< 0.001
Congestive heart failure	7653	33.2	1819	31.4	1782	30.7	< 0.001
Peripheral vascular disease	3831	16.6	875	15.1	869	14.9	< 0.001
Dementia	265	1.15	80	1.4	66	1.1	0.25
Rheumatic disease	552	2.4	138	2.4	149	2.6	0.55
Peptic ulcer disease	444	1.9	114	2.0	82	1.4	0.004
Paraplegia	657	2.9	174	3.0	152	2.6	0.56
Cancer	2097	9.1	554	9.6	481	8.2	0.002
Metastatic carcinoma	933	4.0	272	4.7	182	3.1	< 0.001
Risk of mortality†							< 0.001
Mild risk	4437	19.2	1240	21.4	1372	23.6	
Moderate risk	8407	36.4	2214	38.3	2188	37.6	
Major risk	6738	29.2	1599	27.6	1596	27.4	
Severe risk	3386	14.7	703	12.2	634	10.9	

(continued on page 4)

of the optimal classification points for the variables was conducted to indicate best differentiation of good glycemic control. Significant variables from the multivariable logistic regression were included in an exploratory classification tree analysis that recursively partitioned data in order to improve the fit, with optimal splitting identified

Table 1. *(continued)*

Variables	Total Sample		Best Control Quartile*		Worst Control Quartile*		
	Total or Mean	% or SD	Total or Mean	% or SD	Total or Mean	% or SD	*P*
Severity of illness†							< 0.001
Mild	1407	6.1	464	8.0	354	6.1	
Moderate	7128	30.9	1914	33.1	2033	35.0	
Major	10,331	44.8	2483	42.9	2660	45.8	
Severe	4102	17.8	895	15.5	743	12.8	
Medical stay (vs. surgical)†	15,229	66.0	3689	63.8	4276	73.5	< 0.001
Major diagnostic category†							< 0.001
Circulatory	5317	23.0	1330	23.0	1074	18.5	
Digestive	2311	10.0	791	13.7	427	7.3	
Musculoskeletal	2471	10.7	660	11.4	682	11.7	
Respiratory	2776	12.0	478	8.3	1046	18.0	
Other	10,209	44.2	2526	43.7	2588	44.5	
BMI†							< 0.001
Normal	3576	15.5	829	14.3	785	13.5	
Overweight	4629	20.1	1163	20.1	1077	18.5	
Obese	6761	29.3	1724	29.8	1860	32.0	
Admission blood glucose, mg/dL†	153	57.7	122	25.7	198	72.2	
Admission HbA1c, %†	7.35	1.9	6.15	0.8	8.53	2.2	< 0.001
Admission HbA1c, mmol/mol†	57	20.8	44	8.7	70	24	
% LOS on steroids†	0.17	0.3	0.07	0.2	0.27	0.4	< 0.001
% LOS in ICU†	0.1	0.3	0.1	0.2	0.1	0.2	< 0.001
% LOS on insulin order set†	0.7	0.3	0.7	0.4	0.8	0.3	< 0.001
Payor†							< 0.001
HMO/PPO	3175	13.8	881	15.2	796	13.7	
County Medical Services	786	3.4	150	2.6	258	4.4	
Medi-Cal	4171	18.1	866	15.0	1160	19.9	
Medicare	14,393	62.4	3775	65.3	2414	58.7	
Uninsured	559	2.4	113	2.0	189	3.3	
Facility†							< 0.001
1	4923	21.3	1135	19.6	1231	21.2	
2	7194	31.2	1684	29.1	2111	36.3	
3	10,967	47.5	2966	51.3	2475	42.6	
Average blood glucose for admission, mg/dL	157.1	38.6	122.7	13.8	206.3	36.2	< 0.001
LOS	7.3	9.0	6.9	8.1	5.8	5.0	< 0.001

LOS = length of stay; POC = point of care; SD = standard deviation.

*Best control quartile includes patients with 76% or more POC blood glucose values within the 70-180 mg/dL range. Worst control quartile includes patients with 25% or less POC blood glucose values within the 70-180 mg/dL range.

†Variable included in model building.

over all variables at all possible split points. Classification tree cut-off points were used to further develop models identifying odds ratios for various thresholds for the top three predictive variables. A series of logistic regression

Table 2. Final Predictive Model Ranked by Standardized Coefficients

Variable	Unit	Wald Chi-Square	Pr > Chi Sq	Standardized Estimate*	Odds Ratios (95% CI)
Intercept		1571.67	< 0.001		
HbA1c	.5	1365.61	< 0.001	-1.087	0.595 (0.580–0.610)
Admission blood glucose	5	782.34	< 0.001	-0.595	0.913 (0.907–0.918)
% LOS on steroids	2	233.91	< 0.001	-0.261	0.055 (0.038–0.079)
Renal disease vs. none	1	114.20	< 0.001	-0.153	0.552 (0.495–0.615)
Extreme ROM vs mild ROM	1	60.77	< 0.001	-0.139	0.495 (0.414–0.59)
Obese vs. normal weight	1	52.91	< 0.001	0.139	1.708 (1.479–1.973)
Severe ROM vs. mild ROM	1	19.64	< 0.001	-0.087	0.706 (0.606–0.824)
Overweight vs. normal weight	1	20.23	< 0.001	0.079	1.412 (1.215–1.64)
Facility 1 vs. 3	1	21.96	< 0.001	-0.076	0.738 (0.65–0.838)
Facility 2 vs. 3	1	20.86	< 0.001	-0.075	0.761 (0.677–0.856)
Moderate ROM vs. mild ROM	1	10.39	0.00	-0.061	0.794 (0.69–0.913)
Missing value vs. normal weight	1	9.10	0.00	0.056	1.256 (1.083–1.455)
Respiratory vs. circulatory MDC	1	10.18	0.00	-0.052	0.743 (0.62–0.892)
Musculoskeletal vs. circulatory MDC	1	12.21	0.00	-0.052	0.731 (0.614–0.872)
Mild liver disease vs. none	1	9.58	0.00	-0.048	0.719 (0.584–0.886)
Moderate/severe liver disease vs. none	1	9.15	0.00	-0.047	0.571 (0.397–0.821)
Uninsured vs. Medicare	1	7.66	0.01	0.042	1.553 (1.137–2.12)
Male vs. Female	1	9.72	0.00	0.042	1.163 (1.058–1.278)
Cerebrovascular disease vs. none	1	8.48	0.00	0.039	1.226 (1.069–1.407)
Chronic pulmonary disease vs. none	1	4.00	0.05	0.028	1.117 (1.002–1.245)
Other vs. circulatory MDC	1	1.64	0.20	-0.021	0.926 (0.824–1.042)
County medical services vs. Medicare	1	1.67	0.20	0.020	1.187 (0.915–1.538)
Medi-Cal vs. Medicare	1	1.46	0.23	-0.017	0.926 (0.818–1.049)
No ROM vs. mild ROM	1	1.40	0.24	-0.016	0.638 (0.304–1.342)
HMO/PPO vs. Medicare	1	0.82	0.36	0.013	1.074 (0.921–1.252)
Underweight vs. normal weight	1	0.15	0.70	-0.005	0.917 (0.593–1.418)
Digestive system vs. circulatory MDC	1	0.13	0.72	0.005	1.033 (0.866–1.231)

MDC = major diagnostic category; ROM = risk of mortality.

*Adjusted

models were then run with differing cut points of top 3 predictors to isolate adjusted odds of good glycemic control. Analytic data set building and statistical analyses were completed using SAS 9.4.

RESULTS

Patient Characteristics

Table 1 shows patient demographic and clinical characteristics for the entire sample and for the top quartile (76% or greater POC blood glucose values within target range) and bottom quartile (25% or less POC blood glucose values within target range). Unadjusted results show a significant difference across quartiles for all factors except age, gender, dementia, rheumatic disease and paraplegia. Patients in the bottom 25th percentile (ie, the poorest control) were more likely than the total population to have a higher admission blood glucose (198 mg/dL vs. 153 mg/dL), higher HbA1c (8.53 [70mmol/mol] vs. 7.35 [57mmol/mol), a medical (74% vs. 66%) and/or respiratory (18% vs. 12%) diagnosis, corticosteroid use (17% vs. 27%), an insulin order set use (80% vs. 70%) and higher mean blood glucose during hospitalization (206.3

vs. 157.1 mg/dL). Patients with poorest control were less likely that the total population to have a high risk of mortality (11% vs. 15%) and severity of illness (13% vs. 18%). They also had less ICU care (8% vs. 13%), and a shorter LOS (5.82 vs. 7.82 days).

Predictive Modeling

The final multivariable logistic regression model had a c-statistic of 0.88. Model variables are detailed in **Table 2** and rank ordered by standardized coefficient. The predictive performance was found to be robust when we examined the performance by splitting the data and running the model on a validation data set. The factor most predictive of glycemic control was HbA1c (OR, 0.60 [95% confidence interval {CI}, 0.58–0.61]), followed by admission blood glucose (OR, 0.91 [CI, 0.91–0.92]) and treatment with corticosteroids (OR, 0.06 [CI 0.04–0.08]). Other statistically significant predictive factors in the model included renal disease, BMI, risk for mortality, facility, major diagnostic category, liver disease, payor status, gender, cerebrovascular disease and COPD (see Table 2 for odds ratios). Additional analyses were conducted excluding variables potentially assessed after admission (insulin management, steroid use, and ICU) and possibly associated with the outcome. The results remained the consistent and we present the full final model here.

Classification tree analysis resulted in the same top 3 predictors, but in a different order. The analysis also provided cut-off values that predict suboptimal glycemic control. Classification tree analysis showed admission blood glucose was the most influential predictor, with 164.5 mg/dL indicating the optimal cut-point for prediction of SGC, followed by HbA1c with an optimal cut-off point of 6.65% indicating prediction of SGC, followed by treatment with corticosteroids, with an optimal cut-off point of 24% of the LOS on corticosteroids indicating prediction of SGC.

The **Figure** presents adjusted odds of good glycemic control calculated with a series of logistic regression models at different cut points of admission blood glucose, HbA1c, and treatment with corticosteroids, based on classification tree results. HbA1c had a strong linear relationship with SGC (R^2= 0.99), with higher odds for SGC as HbA1c values increased. Admission blood glucose had a polynomial relationship with SGC (R^2 = 0.95), with increasing odds for SGC as admission blood glucose values increased to approximately 240 mg/dL, above which the trend reversed. Steroid use showed no change in odds with increasing use during admission: a person on steroids for any length of time during admission had the same threefold increased odds for SGC.

DISCUSSION

Evidence of patient characteristics that consistently predict suboptimal glycemic control during hospitalization is needed to better inform clinical decisions for inpatient glycemic management. Hospitalized patients would greatly benefit from glycemic protocols that incorporate risk stratification tools based evidence-based risk factors for poor glycemic control [12]. The science of inpatient glycemic management is in its infancy, however, and currently there is limited evidence to help identify at-risk populations and guide effective management for at-risk patient populations [13]. This study provides important data that can be used to develop risk stratification tools with implications for improved glycemic management of hospitalized patients with diabetes. Among the 32 factors included in the final multivariate logistic model (Table 2), 10 were statistically significant predictors of SGC. The top 3 predictors of SGC were HbA1c, admission blood glucose, and steroid use. These are straightforward, easily accessed factors that can become the basis for effective risk stratification and targeted clinical therapies.

This study showed that the degree of diabetes control prior to admission, as measured by HbA1c, is one of the strongest predictors of inpatient SGC. Patients with poorly controlled diabetes pre-admission had significantly higher rates of SGC than patients admitted with good diabetes control. Furthermore, there was a strong linear relationship between degree of pre-admission diabetes control and glycemic control during hospitalization: the higher the HbA1c on admission, the higher the odds are for poor glycemic control during hospitalization (Figure). The odds of SGC increased more than fivefold at an HbA1c of just 6.7% (50 mmol/mol) and continued to increase linearly as HbA1c increased. This increase occurred despite the fact that patients with poorly controlled pre-admission diabetes were found to have a significantly greater rate of insulin treatment using standardized order sets (which included basal and rapid-acting insulin) than the total sample in this study. So although patients with poorly controlled diabetes pre-admission were actively managed using evidence-based insulin order sets to control glycemia throughout their hospitalization, this did not translate to better glycemic

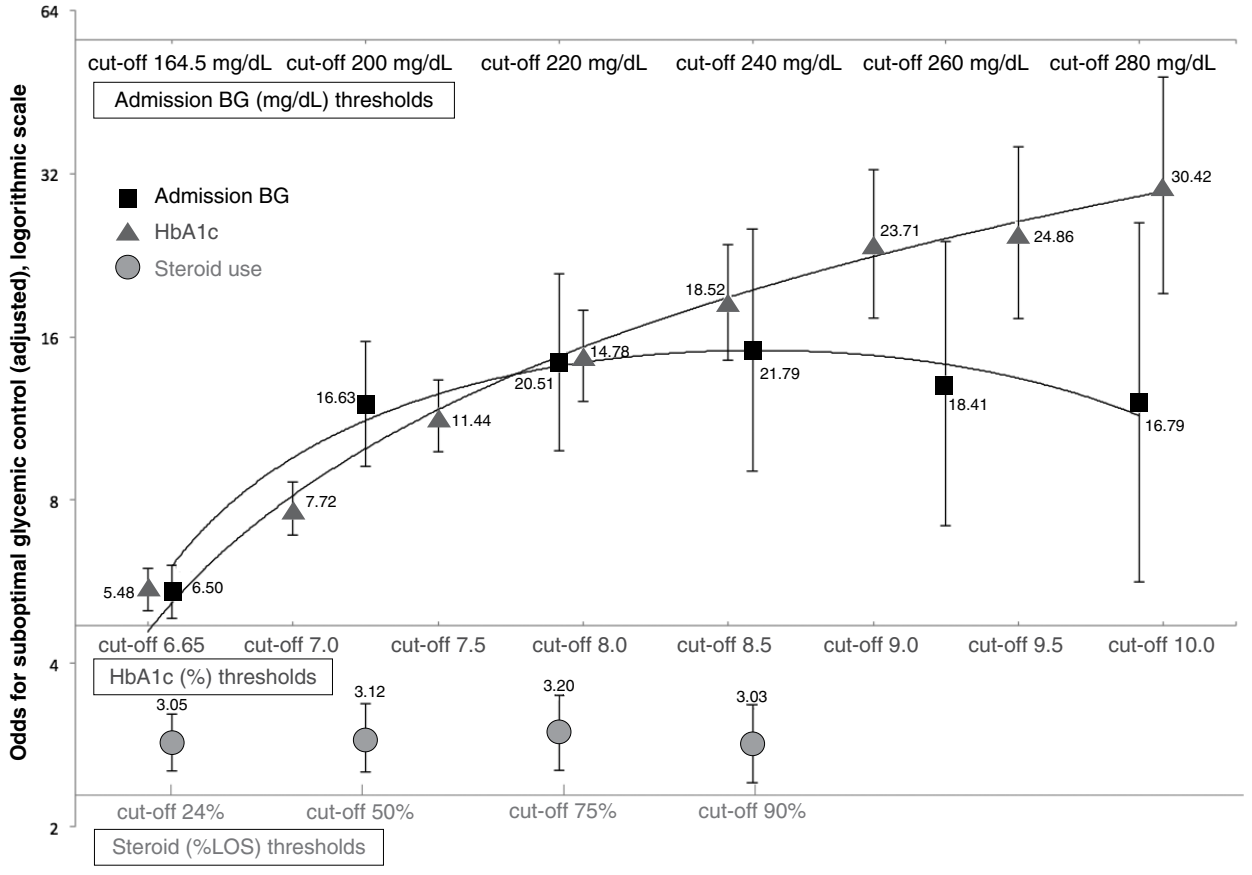

Figure. Odds of suboptimal glycemic control with increasing predictor thresholds. The range for admission blood glucose (BG) is 164.5–280 mg/dL (top horizontal axis), the range for HbA1c is 6.65–10.0 (middle horizontal axis), and the range for steroid use is 24–90% (bottom horizontal axis).

control. Boord et al [14] and Neubauer et al [15] found similar results in their evaluation of glycemic control in hospitalized patients: while insulin use was high, glycemic control remained suboptimal. Similarly, Schnipper et al [16] found that adherence to insulin orders per se were not associated with better glucose control. They noted that the majority of patients with continued elevated blood glucose values did not have changes made to their insulin orders in response to suboptimal blood glucose values. These observations and this study's findings suggest that fixed standardized subcutaneous orders may be more effective for well-controlled patients with diabetes than for patients with poorly controlled diabetes on admission. These patients need more frequent modifications to standard order sets based on clinical response during hospitalization to ensure good glycemic control.

This study confirmed the well known, highly correlated relationship between POC blood glucose and HbA1c. Rohlfing et al [17] previously documented a strong relationship (R = 0.82) between blood glucose and HbA1c in patients enrolled in the Diabetes Control and Complications Trial. Nathan et al [18] also documented a strong relationship (R = 0.84) between HbA1c and average blood glucose that was consistent across diverse populations. This study's findings show odds for SGC based on admission blood glucose followed a very similar trend as HbA1c, and both factors showed much greater odds for SGC than steroid use, independent of other factors.

Admission blood glucose was the second best predictor of SBC using regression modeling (Table 2) and the strongest predictor using classification tree analysis. Odds for SGC were both very high and remarkably similar for a concomitant range of admission blood

glucose and HbA1c values (Figure). The overlapping admission blood glucose range was 165 to 240 mg/dL, which corresponded to HbA1c values between 6.65 and 8.5 (49 mmol/mol–69 mmol/mol). The odds for SGC increased from a 6.5-fold increase in odds at 165 mg/dL to 22-fold increased odds at 240 mg/dL. This corresponded to a 5.5-fold increase in odds with HbA1c of 6.65 (49 mmol/mol) to a 19-fold increase in odds with HbA1c of 8.5 (69 mmol/mol).

Notably, an admission blood glucose as low as 164 mg/dL significantly increased the odds of SGC. This relatively mild hyperglycemia is not typically considered a signifier for difficult inpatient glycemic management. Furthermore, the odds of SGC continue to increase until admission blood glucose reached approximately 240 mg/dL, at which point the odds start declining (Figure). This suggests that only exceptionally elevated admission blood glucoses triggered prompt insulin treatment on admission. The data from this study suggests targeted action for an admission blood glucose as low as 164 mg/dL is just as necessary as for those admitted with a much higher blood glucose to ensure optimal glycemic control throughout hospitalization. Implications are that admission blood glucose may be an inexpensive, straightforward, and readily available predictor of SGC and marker for targeted clinical action, especially for hospitals that do not routinely order HbA1c labs during hospitalization.

Steroid treatment was the third strongest predictor of SGC. Additional analysis showed that any proportion of hospital stay with steroid administration resulted in a stable threefold increased odds for SGC, adjusting for other predictive factors (Figure). Developing insulin treatment therapies that are tailored to patients that will be administered steroids at any point during their hospitalization may be a reasonable strategy to reduce SGC in this population. Based on the results of this study and other Sharp data, Sharp is currently piloting a steroid insulin order set that is available in the electronic health record to hospital physicians for use with any patient that is administered steroids. The order set includes eating and non-eating standards, intensified meal dose coverage, a lower blood glucose threshold for starting correction dosing, and a diabetic nurse educator consult. Evaluation will include appropriate order set usage, rate of glycemic control and extreme blood glucose values.

Limitations

A limitation of this study is that it used observational data and was conducted within a single health care system, thus potentially reducing generalizability. Nevertheless, the sample size was large, there were many clinical and demographic characteristics to be leveraged in the analysis, the statistical approach utilized a complementary regression and classification approach to adjust and present the findings, and the sample included patients from three hospitals across San Diego County with diverse patient populations.

Conclusion

While much progress has been made understanding the need for appropriate glycemic management for patient with diabetes to reduce their risk for adverse outcomes, the knowledge base is still quite limited, especially regarding optimal glycemic limits for diverse patient populations. There is a need to identify predictors of SGC if risk stratification tools are to be built that can help target therapies with the potential to reducing the risk of poor glycemic control and adverse patient outcomes. This study identified 3 readily available factors—admission blood glucose, HbA1c and steroid use—that strongly predict SGC, controlling for other patient risk factors. In general, poor pre-admission diabetes control and inpatient steroid use strongly predict SGC, and the data suggests that earlier and frequently calibrated intervention may improve inpatient glycemic control for these patient populations. We identified a range of thresholds for these variables that may provide a basis for targeted treatment on admission. In conclusion, this study has important implications for meaningful use of readily available factors to identify patients at risk for SGC. Clinical therapies and guidelines incorporating empirically derived risk-stratification tools should enhance the ability to achieve the triple aim of better health, better care quality and more efficient care costs for hospitalized patient with diabetes.

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