THE COST OF POSTOPERATIVE HYPERGLYCEMIA IN CARDIAC SURGERY PATIENTS

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Background

Postoperative hyperglycemia is associated with increased mortality and morbidity including nosocomial infections, renal insufficiency and other serious complications.

Studies have shown that the association between postoperative hyperglycemia and adverse outcomes is stronger among patients without pre-existing diabetes than among patients with diabetes.

In light of the detrimental effect on patient prognosis, glycemic control is thought to be considerably relevant from an economic perspective. However, there is lack of evidence on the economic impact of postoperative hyperglycemia in cardiac surgery.

Objective

To examine the costs associated with post-operative hyperglycemia in cardiac surgery patients with and without pre-existing diabetes.

Methods

Subjects: 4317 patients (≥18 years old) who underwent cardiac surgery in 2010 in 9 U.S. hospital participating to the Cardiothoracic Surgery Network (CTSN). 972 (22.5%) had pre-existing diabetes.
Data: Prospectively collected clinical data were linked to patient level financial data obtained from the University Health System Consortium (UHC) or directly from the sites.
Statistical Analysis: Generalized Linear Model with a log link function and a gamma distribution was used to adjust for patient-related covariates. The incremental costs, i.e. the extra costs specifically attributable to hyperglycemia in patients with and without diabetes, were calculated using the recycled prediction method. Standard errors and confidence intervals were derived by 1000 bootstrap resampling runs.

Funding and Disclosures

Results

The average age was 66.3 years for diabetic and 63.8 years for non-diabetic patients; 66% of the patients were male among both diabetic and non-diabetic.

Baseline Characteristics [a]

	Diabetes (N=972)			No diabetes (N=3345)		
	Hyperglycemia[b] (N=684)	No Hyperglycemia (N=288)	P-value	Hyperglycemia (N=1195)	No Hyperglycemia (N=2150)	P-value [c]
Cormobidities						
CHF [d]	234 (34.2)	101 (35.1)	0.80	336 (28.1)	489 (22.7)	0.0006
Ejection fraction	53.5 (40.0, 60.0)	51.0 (40.0, 60.0)	0.67	55.0 (45.0, 60.0)	55.0 (50.0, 60.0)	<.0001
Prior card. surg.	138 (20.2)	49 (17.0)	0.25	283 (23.7)	389 (18.1)	0.0001
PVD [e]	120 (17.5)	48 (16.7)	0.74	116 (9.7)	157 (7.3)	0.01
Cerebrovascular Accident	90 (13.2)	37 (12.9)	0.90	121 (10.1)	170 (7.9)	0.03
Lung Disease	122 (17.8)	58 (20.1)	0.40	180 (15.1)	269 (12.5)	0.04
Hypertension	619 (90.5)	264 (91.7)	0.56	866 (72.5)	1485 (69.1)	0.04
Operative						
Surg. hours	4.5 (3.6, 5.5)	4.4 (3.6, 5.3)	0.12	4.6 (3.6, 5.7)	4.1 (3.4, 5.2)	<.0001
Sternotomy	653 (95.5)	270 (93.8)	0.26	1109 (92.8)	1857 (86.4)	<.0001
Surgery status			0.92			<.0001
Elective	407 (59.5)	174 (60.4)		848 (71.0)	1656 (77.0)	
Urgent	250 (36.6)	104 (36.1)		304 (25.4)	456 (21.2)	
Emergent	27 (4.0)	10 (3.5)		43 (3.6)	38 (1.8)	
Procedure type			0.90			<.0001
Isolated CABG	309 (45.2)	140 (48.6)		272 (22.8)	511 (23.8)	
Isolated valve	135 (19.7)	53 (18.4)		359 (30.0)	798 (37.1)	
CABG + valve	101 (14.8)	41 (14.2)		163 (13.6)	202 (9.4)	
Transpl /VAD	23 (3.4)	11 (3.8)		50 (4.2)	26 (1.2)	
Thoracic aortic	17 (77.3)	5 (22.7)		90 (7.5)	109 (5.1)	
Other	99 (14.5)	38 (13.2)		261 (21.8)	504 (23.4)	

[a] Continuous variables are expressed as median (IQR) and categorical variables as count(%).
[b] Hyperglycemic is defined as any glucose level that is greater than 180.
[c] Chi-squre test is conducted for categorical variables and Wilcoxon-Mann-Whitney test is conducted for continuous variables.
[d] Congestive heart failure
[e] Peripheral Vascular Disease

### Association between postoperative glucose levels and costs in patients with no pre-existing diabetes
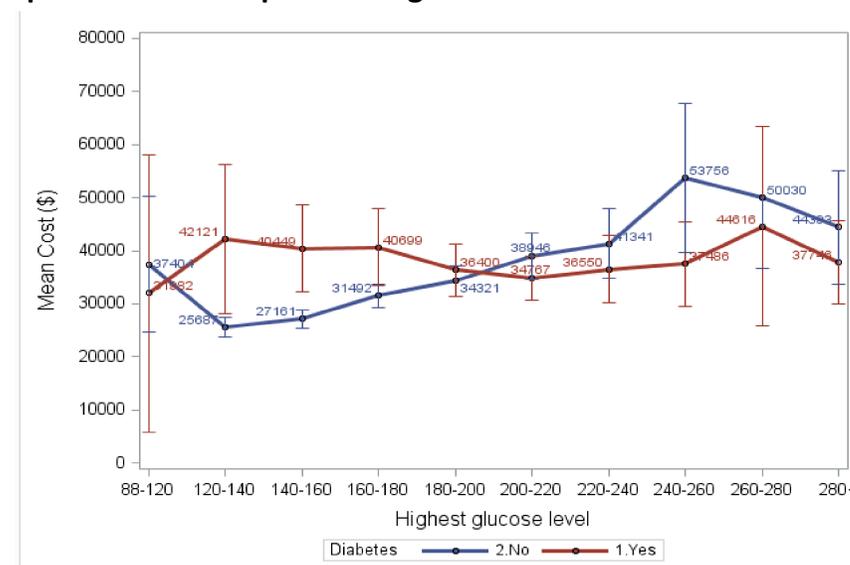
Increased costs in patients with no pre-existing diabetes

	Unadjusted mean cost difference($)		Incremental cost without adjusting for complications ($)	
	Diabetes	Non-diabetes	Diabetes	Non-diabetes
Hyperglycemia (>180) vs. No Hyperglycemia (≤180)	-3702 (-9399, 1995)	9655 (7347, 11964)	N/A*	2629 (1439, 3866)

* Hyperglycemia is not a significant predictor for diabetic population in the model, so the incremental cost could not be estimated.

Cost drivers associated with postoperative hyperglycemia
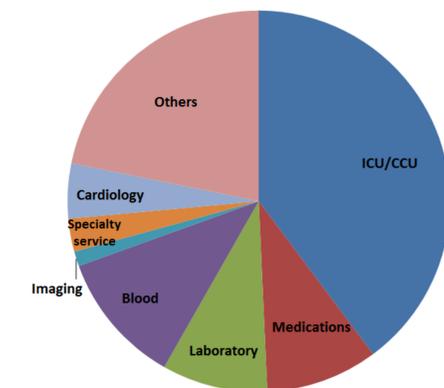
Increased complications in patients with no pre-existing diabetes

	Diabetes				Non-diabetes			
	Hyperglycemia	No Hyperglycemia	Δ Diff	P-value	Hyperglycemia	No Hyperglycemia	Δ Diff	P-value
Cardiovascular	49%	50%	-1%	0.80	48%	44%	4%	0.006
Neurological	11%	13%	-2%	0.33	10%	7%	3%	0.02
Pulmonary	29%	32%	-3%	0.38	29%	26%	3%	0.02
Renal	19%	19%	0%	0.96	13%	10%	3%	0.02
Infections	3%	4%	-1%	0.47	4%	2%	2%	0.0002

Conclusions

Along with well established patient safety concerns, considerable cost is at stake in our ability to optimize glucose management after cardiac surgery. As shown by our data, postoperative hyperglycemia was associated with:

1. A substantial increase in resource utilization among patients without a past history of diabetes, but not those with pre-existing diabetes.
2. A higher rate of infectious, renal, pulmonary, neurological and cardiovascular complications,. in patients without pre-existing diabetes.

Glucose management after cardiac surgery should differentiate patients based on their diabetic status in order to achieve optimal clinical and economic benefits.