2023

Insulin Utilization in Post-Operative Open Heart Surgery Patients

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Background

- According to the Society of Thoracic Surgeons guidelines, blood glucose (BG) should be maintained <180 mg/dL following cardiac surgery.[1]
- The Portland Diabetic Project demonstrated reduced patient morbidity and mortality after cardiac surgical procedures when maintaining a strict BG goal of <150 mg/dL with continuous insulin infusion (CII) within the post-operative 72-hour timeframe.[2]
- There is limited evidence to demonstrate the need for intense BG management with CII for non-diabetic patients.[3-6]
  - Piatti *et al.* (2017): patients with a fasting BG (FBG) <130 mg/dL who transitioned from a CII to a basal-bolus insulin regimen before the 72-hour post-operative period maintained targeted BG levels and had decreased LOS and infections. [5]
  - Stahnke *et al.* (2014): all post-operative open-heart patients, regardless of diabetes status, had similar BG levels when transitioned early from CII to basal insulin on post-op day (POD) 1 with significantly lower hypoglycemic episodes compared to those who transitioned on POD 2.[6]
- The study's site-specific hospital protocol for the management of BG after open-heart procedures is POCT-based dosing in addition to nutritional subcutaneous insulin doses during the post-operative 72-hour period.
- There is currently limited data to demonstrate the effectiveness, safety, and compliance for using the current institutional protocols to achieve the institution-specific BG goal range of 90-140 mg/dL.

Purpose

To evaluate and identify patient populations who may benefit in an early transition from CII to a basal-bolus insulin regimen after open-heart procedures.

Objectives

Primary Outcomes
- Percentage of time in goal BG range (90-140 mg/dL)
- Total amount of insulin infused over 72 hours post-operatively

Secondary Outcomes
- The amount of insulin infused at 0-24, 24-48, and 48-72 hours post-operatively
- Hypoglycemic events
- Utilization of dextrose 50 (D50) rescue
- Deep sternal wound infections (DSWI)
- % of appropriate insulin administration per protocol
- Length of stay (LOS)

Methods

Study Design
- Institutional Review Board (IRB) approved
- Single-center, retrospective, observational chart review study at a large tertiary medical center from April 2022 to June 2022

Inclusion Criteria
- 18 years of age or older
- Received CII for 72 hours after cardiac surgery during hospital admission

Exclusion Criteria
- Did not receive CII post-operatively
- Had one of the following procedures: heart transplant, TAVR, impella removal, emergent or unplanned open-heart surgery
- Cardiac intensive care unit (CICU) stay over 7 days

Baseline Characteristics

Characteristics on Admission	A1c <5.7% (n=21)	A1c 5.7-6.4% (n=23)	A1c >6.5% (n=17)	All A1c (n=61)	P-value
Age, median	63.3 (10.8)	65.9 (10.1)	64.5 (6.2)	64.6 (9.4)	0.6658
Sex:					
Male	16 (76%)	18 (78%)	14 (82%)	48 (79%)	0.927
Female	5 (24%)	5 (22%)	3 (18%)	13 (21%)	
BMI:					
<18.5	0 (0%)	0 (0%)	0 (0%)	0.0%	
18.5-24.9	5 (24%)	3 (13%)	3 (18%)	11 (18%)	0.3322
25-29.9	10 (48%)	11 (48%)	4 (24%)	25 (41%)	
>30	6 (29%)	9 (39%)	10 (59%)	25 (41%)	
PTA insulin use	0 (0%)	0 (0%)	7 (41%)	7 (11%)	<.0001

Outcomes

Outcomes	A1c <5.7% (n=21)	A1c 5.7-6.4% (n=23)	A1c >6.5% (n=17)	P-Value
Primary Outcome				
% of time in goal BG range 90-140 mg/dL, mean (SD)	84% (10)	84% (13)	65.4% (17)	0.0003
Total units insulin infusion over 72 hours, mean (SD)	116.8 (64.8)	128.3 (68.7)	244.9 (112.8)	0.0001
Secondary Outcomes				
Total units of CII use, mean (SD)				
0-24 hours	43.0 (19.4)	40.0 (18.9)	74.1 (41.5)	0.0033
24-48 hours	43.4 (30.7)	51.1 (34.6)	89.4 (48.6)	0.0012
48-72 hours	30.4 (21.9)	37.2 (25.4)	81.3 (43.7)	<.0001
Hypoglycemic events, n (% yes)	6 (29%)	5 (22%)	2 (12%)	0.4524
D50 rescue used, n (% yes)	4 (19%)	3 (13%)	2 (12%)	0.7858
Sternal wound infection, n (% yes)	0%	0%	0%	NA
% of appropriate CII administration per protocol, mean (SD)	95% (6)	94% (6)	93% (7)	0.4727
% of appropriate nutritional insulin administration per protocol, mean (SD)	26% (35)	9% (17)	5.3% (9)	0.1071
LOS, median (q1, q3)	5.2 (4, 6)	5.3 (4, 6)	5.5 (5, 6)	0.7841

BMI Subgroup Analysis

Outcomes	BMI 18.5-24.9 (n=11)	BMI 25-29.9 (n=25)	BMI >30 (n=25)	P-Value
Primary Outcome				
% of time in goal BG range 90-140 mg/dL, mean (SD)	79% (17.3)	80.7% (15.0)	76.4% (15.9)	0.3992
Total units insulin infusion over 72 hours, mean (SD)	113.4 (71.1)	125.3 (85.0)	207.5 (100.4)	0.0007
Secondary Outcomes				
Total units of CII use, mean (SD)				
0-24 hours	42.6 (24.8)	42.8 (20.9)	61.8 (37.7)	0.0536
24-48 hours	36.4 (29.7)	47.2 (37.4)	81.0 (41.7)	0.0004
48-72 hours	34.4 (30.9)	35.3 (37.2)	64.7 (33.2)	0.0015
Hypoglycemic events, n (% yes)	3 (27%)	7 (28%)	3 (12%)	0.3341
D50 rescue used, n (% yes)	3 (27%)	5 (20%)	1 (4%)	0.089
Sternal wound infection, n (% yes)	0%	0%	0%	NA
% of appropriate CII administration per protocol, mean (SD)	96% (4)	94% (7)	93% (6)	0.3164
% of appropriate nutritional insulin administration per protocol, mean (SD)	20% (30)	14% (29)	11% (18)	0.5922
LOS, median (q1, q3)	6 (5, 7)	5 (4, 6)	5 (4, 6)	0.1125

Discussion

- 61 patients met inclusion and exclusion criteria.
- Most non-diabetic and pre-diabetic patients (84%) remained in goal BG range of 90-140 mg/dL in the 72-hour post-operative period (p=0.0003).
- The average total units of insulin infused over 72 hours post-operatively was significantly lower for non-diabetic and pre-diabetic patients (p=0.0001).
- Additionally, diabetic patients consistently required significantly more insulin infused at each 24-hour interval post-operatively compared to non-diabetic and pre-diabetic patients (p<0.05).
- There was no significant difference in adverse effects, including the number of hypoglycemic events, D50 rescue, DSWI, and LOS among the three groups.
  - Notably, there were discrepancies between the number of hypoglycemic events and D50 rescue administration.
- Compliant administration per protocol for insulin infusion and nutritional insulin boluses was not significantly different between groups.
  - All groups had an average of >90% compliance for appropriate CII administration.
  - Nutritional insulin bolus administered appropriately was low across all groups.
- Among the BMI subgroup, there was no significant difference in the percentage of time in goal BG range or hypoglycemic events (p>0.05). Patients with obesity had significantly higher insulin infusion requirements over 72 hours post-operatively.

Study Limitations
- Retrospective, non-randomized study.
- Select data pulled from electronic health record (EHR) via retrospective chart evaluation by single reviewer.
- Manual computation of continuous data for total CII administered and percentage of appropriate insulin administration per protocol.
- Inconsistent EHR documentation of the percentage of meals consumed and nutritional insulin bolus administered.

Conclusion

Non-diabetic and pre-diabetic patients without obesity required less insulin infusion over 72 hours after open-heart procedures to maintain goal BG levels and had no significant difference in adverse events. These patients may benefit from an early transition to a basal-bolus insulin regimen after open-heart procedures.

Going Forward

Future research should evaluate clinical outcomes with a standardized CII + nutritional insulin to a basal-bolus dosing regimen, with defined criteria of patients who would be eligible for this early transition in BG management strategy.

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