

# Incidence of Superficial and Deep Surgical Site Infections in Post Cardiac Surgery Patients with Pre-Operative HBA1C $\geq 7\%$ Compared to Those Having Pre-Operative HBA1C $< 7\%$

TUFAIL AHMAD<sup>1</sup>, SOBIA SIDDIQUE<sup>2</sup>, ABUBAKAR SADIQ<sup>3</sup>

<sup>1,2</sup>Resident Cardiac Surgery Armed Forces Institute of Cardiology AFIC /NIHD Rawalpindi

<sup>3</sup>Resident Paeds Cardiology Armed Forces Institute of Cardiology AFIC /NIHD Rawalpindi

Corresponding author: Tufail Ahmad, Email: [horizonstar89@gmail.com](mailto:horizonstar89@gmail.com), Cell: 03001402333

## ABSTRACT

**Objectives:** The main objective of the study is to find the Incidence of superficial and deep surgical site infections in post cardiac surgery patients with pre-op HBA1C  $\geq 7\%$  compared to those having pre-op HBA1C  $< 7\%$ .

**Material and methods:** This cross-sectional study was conducted in Armed forces institute of cardiology AFIC /NIHD Rawalpindi during 1st October 2022 to 30 November 2022. Data was collected with the permission of ethical committee of hospital. All the patients who met the inclusion and exclusion criteria were selected for the study. As a routine practice at the cardiac surgery outpatient clinic of our hospital, HbA1c levels of diabetic patients are examined along with other routine examinations approximately 7–10 days before the surgery.

**Results:** The data was collected from 354 patients of age range was  $58.98 \pm 4.56$  years. According to analysis that was performed to investigate the mortality predictivity, age, gender, input ejection fraction, HbA1c levels and preoperative albumin levels were found to be associated with mortality. In the group with HbA1c $\geq 7$ , the ejection fraction was lower ( $p=0.027$ ) and mortality was higher ( $p=0.008$ ).

**Practical Implications:** Increased level of HbA1c $>7$  in cardiac surgery patients is considered to be the increased incidence of SSI.

**Conclusion:** Increased level of HbA1c $>7$  in cardiac surgery is considered to be the increased incidence of SSI. We also found that good peri-operative control of RBS associated with decreased rate of SSI after cardiac surgery.

**Keywords:** Cardiac, HbA1c, Diabetic, Surgery, Ejection fraction

## INTRODUCTION

Despite proper precautions, surgical site infections (SSI) remain a major challenge, comprised 18.4% of all acute care-associated infections, an incidence similar to that of hospital-acquired pneumonia or urinary tract infections, and result in an estimated 16,049 deaths per year. The incidence of SSIs is projected to increase as an aging population and increasing obesity lead to more procedures<sup>1</sup>.

The risk of SSI varies according to type and duration of surgery, with a higher risk in emergency and/or intra-abdominal surgery involving penetration of hollow viscera, and substantially lower risk in other types of surgery. Immunosuppressed, obese and diabetic patients are also at higher risk<sup>2</sup>. The Centers for Disease Control and Prevention and the American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) each divide SSI into 3 distinct types based on the anatomic level of the infection: superficial incisional, deep incisional, and organ space. Superficial SSIs are more prevalent than deep/organ-space SSIs but generally require less aggressive interventions. In contrast, deep/organ-space SSIs often require invasive management with intravenous antibiotics, percutaneous drainage procedures, and reoperations. Despite these clinical differences, research studies and quality improvement initiatives often group these SSI types together to increase the overall event rate, with the hope that this will increase the likelihood of detecting a significant change in performance after an intervention. However, this aggregation of potentially different disease processes could actually have negative implications for quality measurement or improvement if the clinical processes of care that lead to superficial SSI are different than the processes that lead to deep or organ-space SSI<sup>3</sup>.

Glycosylated haemoglobin (HbA1c) is one of the most frequently studied parameters for outcome prediction in cardiac surgery. HbA1c test is a blood test used to measure the efficacy of antidiabetic therapy and, sometimes, to diagnose diabetes. A glycosylation reaction occurs when haemoglobin is exposed to blood sugar<sup>4</sup>. The glycosylation reaction is defined as adherence of sugar molecules in the blood to haemoglobin, resulting in structural changes. During 120 days of erythrocyte lifespan, the rate of

glycosylation of haemoglobin increases in parallel with the blood glucose levels<sup>5</sup>.

In addition, hemoglobin A1c (HbA1c) as an established indicator of blood glucose control during the previous 3 to 4 months can be easily assessed independent of a patient's prandial state and serve for diagnosing pre-/diabetes. In diabetic patients undergoing cardiac surgery, HbA1c levels predict intraoperative insulin sensitivity and outcome parameters including infection rate. Suboptimal HbA1c levels ( $>6\%$  for non-diabetic,  $>7\%$  for diabetic patients) correlate with higher mortality for both diabetic and non-diabetic patients undergoing major surgery<sup>3</sup>.

The HbA1c test measures the rate of glycosylation; therefore, HbA1c provides information about the blood glucose profile belonging to the erythrocyte lifespan, which is past 2–3 months. Levels of  $\geq 7\%$  indicate poor blood glucose control. Although some articles in the literature argue that high HbA1c levels increase mortality and morbidity, there are studies arguing that there is no relation between them<sup>6</sup>. In a recent meta-analysis, Zheng et al. demonstrated that HbA1c levels were associated with non-fatal myocardial infarction after percutaneous coronary intervention. On the other hand, Qi et al. found a relationship between elevated HbA1c and atrial fibrillation<sup>7-8</sup>.

In literature, there is only one meta-analysis, which evaluated the importance of preoperative HbA1c for outcomes (complications) in cardiac surgical patient population.<sup>4</sup> The main issue of the studies including HbA1c is the various cut-off points that becloud the results. Moreover, various causes of increase in HbA1c make interpretation difficult. Therefore, the authors aimed to investigate the relationship between HbA1c and outcomes in cardiac surgery<sup>9</sup>.

The main objective of the study is to find the Incidence of superficial and deep surgical site infections in post cardiac surgery patients with pre-op HBA1C  $\geq 7\%$  compared to those having pre-op HBA1C  $< 7\%$ .

## MATERIAL AND METHODS

This cross-sectional study was conducted in Armed forces institute of cardiology AFIC /NIHD Rawalpindi during 1st October 2022 to 30 November 2022. Data was collected with the permission of ethical committee of hospital.

**Inclusion criteria**

- Both male and female
- Age > 18 years
- All patients underwent cardiac surgery

**Exclusion criteria**

- Those who do not want to participate.
- Pregnant females, lactating mothers, renal patients and those taking medication for any other medical problem.

**Data Collection:** Data was collected with the permission of ethical committee of hospital. All the patients who met the inclusion and exclusion criteria were selected for the study. As a routine practice at the cardiac surgery outpatient clinic of our hospital, HbA1c levels of diabetic patients are examined along with other routine examinations approximately 7–10 days before the surgery. The demographic and perioperative information of the patients for our study was obtained. All patients underwent cardiac surgery were included in the study. Patients were diabetic and non-diabetic. They were further divided into two groups based on HbA1c  $\geq$  7% and < 7%. Patients were analyzed for in-hospital mortality and Post-operative morbidity (Atrial fibrillation, duration of mechanical ventilation, length of ICU stay, Post-operative renal dysfunction and length of hospital stay

**Statistical Analysis:** Statistical analyses were performed using the programme Statistical Package for the Social Sciences 20.0 (SPSS Inc., Chicago, IL, USA), and the significance was set at  $p < 0.05$ .

**RESULTS**

The data was collected from 354 patients of age range was  $58.98 \pm 4.56$  years. According to analysis that was performed to investigate the mortality predictivity, age, gender, input ejection fraction, HbA1c levels and preoperative albumin levels were found to be associated with mortality. In the group with HbA1c  $\geq 7$ , the ejection fraction was lower ( $p=0.027$ ) and mortality was higher ( $p=0.008$ ).

Table 1: Peri-operative patient information according to the HbA1c value

	Hba1c <7	Hba1c $\geq 7$	P
Age	59.01 $\pm$ 7.61	58.98 $\pm$ 4.56	0.018
ASA	2	71	0.790
	3	123	
Preoperative Hct	37.59 $\pm$ 9.25	38.01 $\pm$ 4.98	0.671
Ejection fraction (EF)	50.01 $\pm$ 3.67	51.91 $\pm$ 4.67	0.027
Smoking	33 (20.6%)	25 (12.9%)	0.049
COPD	31 (19.4%)	33 (17%)	0.561
HT	73 (45.6%)	99 (51%)	0.291
Peripheral vascular disease	11 (6.9%)	19 (9.8%)	0.289
HL	33 (20.6%)	35 (18%)	0.410
Cerebrovascular disease	3 (1.9%)	3 (1.5%)	1.000
Duration of surgery (min)	249.02 $\pm$ 35.25	251.01 $\pm$ 45.06	0.201
Duration of ventilator support (min)	579.94 $\pm$ 567.39	1251.78 $\pm$ 7891	0.219
Duration of stay in intensive care unite (days)	2.34 $\pm$ 1.15	2.14 $\pm$ 1.36	0.801
Duration of stay in hospital (days)	8.14 $\pm$ 4.49	8.64 $\pm$ 5.15	0.491
Mortality	6 (3.8%)	22 (11.3%)	0.008

Overall more participants of group A had clean type of wound (9.6%), followed by clean contaminated (12.1%). Similarly, in group B, 90.4% participants had clean while 87.9% participants had a clean contaminated type of wound. No significance was found on the comparison of the type of wounds ( $p$ -value: 0.25).

Table2: Comparison of characteristics with the presence and absence of SSI

Demographics	SSI present	SSI absent	p-value
Type of wounds			
Clean	9.6%	90.4%	0.25
Clean/Contaminated	12.1%	87.9%	
Contaminated	33.3%	66.6%	
Dirty	33.3%	66.6%	

Table 3: Types of wounds in both groups

Demographics	Hba1c $\geq 7\%$	Hba1c <7%	p-value
Type of wounds			
Clean	553 (95.5%)	426 (95.9%)	0.85
Clean/Contaminated	23 (3.9%)	18 (4.0%)	
Contaminated	1 (0.1%)	2 (0.4%)	
Dirty	2 (0.3%)	1 (0.2)	
Overall SSI	69 (11.9%)	32 (7.19%)	0.011

There was no significant difference between both groups in BMI and EF.

Table 4: Difference between both groups in BMI and EF

	Group	Mean $\pm$ SD	T	P
EF	HbA1c >7	61.09 $\pm$ 5.67	1.810	0.081 (NS)
	HbA1c <7	60.01 $\pm$ 7.89		
BMI	HbA1c >7	34.56 $\pm$ 6.19	1.923	0.071 (NS)

SSI for wound infection required for 5 patients (20.8%) in HbA1c >7 group, while no patient re-admitted in other group ( $p=0.018$ ).

Table 5: Post-operative Surgical Site Infection (SSI) in the studied groups

		Group		P
		HbA1c <7	HbA1c >7	p-value
SWI	No. of patients	3	9	0.046
	%	12.5%	37.5%	
DSWI	No. of patients	1	1	Non-significant
	%	4.1 %	4.1%	
Saphenous	No. of patients	2	6	0.041
	%	8.3 %	25%	

**DISCUSSION**

Prevention of surgical site infections is important since it plays a significant role in hospital readmissions, prolonged stays, and greater financial burden. After doing thorough literature research, we came to the conclusion that many studies support the association between elevated HbA1c levels with increased risk for SSI<sup>10</sup>. This aligns with the findings of our study where patients with HbA1c levels greater than 6.5% were more likely to develop SSI as compared to those who had lower levels ( $p$ -value: 0.01). A study done by Kopp Lugli et al. found an overall 4.1 times increased risk of developing SSI. Raised HbA1c preoperatively is linked with an increased risk of infection, length of hospital stay and readmission in 30 days<sup>11</sup>.

However, it is worth mentioning that we also came across a few studies that either showed mixed results or did not find any conclusive relationship between HbA1c and SSI. In a 2019 study, the probability of developing surgical complications or readmission with respect to gender, age, or presence of hypertension was found to be nonsignificant<sup>12</sup>. Furthermore, no association between the type of wound and HbA1c levels was found in our study. In our study, we used HbA1c rather than fasting blood sugar (FBS) or RBS levels because HbA1c is a more accurate marker of glycemic control in comparison to RBS or FBS; levels of which can rise due to stress hyperglycemia in pre-operative patients<sup>13</sup>. Furthermore, even though candidates in our study had normal FBS/RBS levels before surgery, the group with HbA1c levels greater than 6.5% had a higher chance of developing SSI<sup>14</sup>.

HbA1c is a marker of variation in blood glucose levels. Fluctuation in glucose levels causes an increased production of free radicals which generates increased oxidative stress. In a study, it was established that acute and chronic fluctuations in blood glucose levels corresponded with elevated oxidative stress markers namely: urine 8-isoprostaglandin F2 $\alpha$ , serum thiobarbituric acid-reactive substance, and serum 8-hydroxydeoxyguanosin<sup>15-17</sup>. In addition, variation in glucose levels also induced a rise in serum level of the chronic inflammatory

marker (c-reactive protein), absence of antioxidants, and a greater incidence of microvascular complications. Other than increasing oxidative stress and inflammatory markers, hyperglycemia also harms the immune system by disrupting chemotaxis, phagocytosis, and overproduction of free fatty acids. All these factors altogether may lead to an increased risk of developing SSI<sup>18-20</sup>.

## CONCLUSION

It is concluded that increased HbA1c was associated with increased morbidity and mortality in patients undergoing cardiac surgery. Increased level of HbA1c>7 in cardiac surgery is considered to be the increased incidence of SSI. We also found that good peri-operative control of RBS associated with decreased rate of SSI after cardiac surgery.

### Recommendation

It is recommended that HbA1c should be measured in all cardiac surgery patients, even before and after.

### Conflicts of interest

There is no conflict of interest by authors.

### Funding

There is no funding association for this study.

### Ethical Approval

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