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Incidence of Blood Glucose Level Abnormality During and after Cardiac Surgery Under Cardiopulmonary Bypass in Non-Diabetic Patient: A Prospective Observational Study

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KEYWORDS
Blood Glucose, Cardiac Surgery, Cardiopulmonary Bypass, Non-Diabetic Patients, Hyperglycemia and Hypoglycemia.

ABSTRACT:

Introduction: Glycaemic control in postoperative cardiac patients is necessary to improve outcomes in wound infection and overall mortality. In recent years, clinical trials evaluating blood glucose control in critically ill patients advocated for intense blood glucose management and found a significant reduction in morbidity and mortality.

Aims: To evaluate the incidence of blood glucose abnormality during and after cardiac surgery under cardiopulmonary bypass in non-diabetic patient. To evaluate any association of blood glucose abnormality with the arterial blood gas parameters (pH & HCO3,base exchange,) during prebypass/ onset of bypass/mid bypass/ at the weaning from CPB/ at the time of ITU stay up to 48 hours post-operative (on entering ITU and at 6 hours, 12 hours, 24 hours, 36 hours & 48 hours) along with various inotropic drugs ,IV fluid, and insulin. To evaluate any association of blood glucose abnormality with the duration of CPB time.

Materials and Methods: The present study was a prospective observational study. This Study was conducted from Ten months (September 2017 - June 2018) at Dept. of CTVS, R.G.KAR Medical College And Hospital.

Result: Our study, use for the distribution of patient according to the operation undergone. Though In format 3 we distribute the patient In percentage not in number. It is seen that the valve replacement surgery (MVR, DVR, AVR) contributed the highest number of surgery [(27) 54%] in our department then other surgery, followed by CABG, ASD CLOSURE, VAD CLOSURE.

Conclusion: Blood glucose abnormalities, particularly hyperglycemia, are prevalent during and after cardiac surgery in non-diabetic patients undergoing CPB. These findings highlight the need for

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vigilant monitoring and management of blood glucose levels in this population to minimize postoperative complications.

INTRODUCTION

Glycaemic control in postoperative cardiac patients is necessary to improve outcomes in wound infection[1] and overall mortality. In recent years, clinical trials evaluating blood glucose control [1],[2] in critically ill patients advocated for intense blood glucose management and found a significant reduction in morbidity and mortality[3]. However, recent clinical trials evaluating blood glucose target ranges in critically ill patients have found conflicting results, which has prompted re-evaluation of current goals and guidelines, allowing for less stringent blood glucose target ranges[3].

Altered glucose metabolism is very common during cardiopulmonary-bypass and in the early post-operative period. The cause for this hyperglycaemia may be due to surgical stress, contact activation of the pro-inflammatory pathway due to extracorporeal circulation. Inotropic agents used during and post open heart surgery also may be the cause of this hyperglycaemia. This can be almost consistently seen in all patients undergoing open heart surgery, irrespective of their pre-operative glycaemic status. With the inconsistency of clinical trials evaluating a target blood glucose range for critically ill patients, specifically in postoperative cardiac surgery patients, the target blood glucose range is still not clearly defined[3].

So, we decided to find out the incidence of perioperative blood glucose abnormality in cardiac surgical patients operated under cardiopulmonary bypass in non- diabetic patients. Additional comparisons of specific glucose ranges would allow for a clearer definition of recommended blood glucose goals to target in postoperative cardiac patients.

Materials and Methods

Study area: Dept. of CTVS, R.G.KAR MEDICAL COLLEGE AND HOSPITAL

Study Population: Patients undergoing open heart surgery in the department of CTVS, R.G.KAR MEDICAL COLLEGE AND HOSPITAL

Period Of study: - Ten months (September 2017 - June 2018)

Sample size: 50 cases.

Study design: It is a prospective observational study

We divided the patient according to their blood glucose level in to-Group A blood glucose level < 150 mg/dl , Group B, blood glucose level 151- 300 mg/dl, Group C, blood glucose level >300 mg/dl

Inclusion criteria:

a) Patients without history of diabetes

b) Age-18 - 60 years

c) Elective cardiac surgery

Exclusion criteria:

a) Age <18 year > 60 years

b) Known diabetic patient

c) Patient undergoing emergency cardiac surgery

d) Cyanotic congenital

- All the study parameters were recorded at pre-bypass, once during bypass, at the beginning of weaning procedure and after shifting to ITU.

Plan for analysis: Approximate statistical technique will be applied to establish the analysis & evaluate the study (we use software STATA 14).

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RESULT

Table -1 Distribution of the patient according to the Operation undergone and CPB time (min) according to various surgical procedure

Patient according to the Operation undergone	**Name of the surgery**	**Number of the surgery**
	ASD CLOSURE	**10**
	VSD CLOSURE	**1**
	MVR	**10**
	AVR	**13**
	DVR	**4**
	CABG	**12**
CPB time (min) according to various surgical procedure	**Name of surgery**	**Time in minutes**
	ASD Closure	65.4
	VSD Closure	95
	MVR	100.8
	AVR	101.69
	DVR	149
	CABG	107.66

Table 2: Haemodynamics

	MAP(mm/hg) Mean ±2 Standard deviation.	HR(beat/minute) Mean ±2 Standard deviation.	Temp(in F) Mean ±2 Standard deviation.	Urine Output(ml/hr) Mean ±2 Standard deviation.	SPO2 (% Mean ±2 Standard deviation.
PRE-BYPASS	96.24 ± 8.372	91.14±15.399	98.184 ± 0.091	88.4 ± 28.436	99.34 ± 0.939
ONSET-OF BYPASS	85.4 ± 9.326	0	81.186 ± 1.470	186.8 ± 59.055	99.78 ± 0.418
MID-BYPASS	69.72 ± 6.372	0	81.152 ± 3.394	190 ± 33.815	99.44 ± 0.760
WEANING FROM BYPASS	92.48 ± 6.887	92.78 ± 11.136	97.876 ± 0.821	186 ± 43.799	99.34 ± 0.717
0 HOURS	96.94 ± 9.577	99.36 ± 12.59	98.342 ± 0.308	192.22 ± 59.823	99.12 ± 0.773
6HOURS	95.2 ± 12.157	100.48 ± 11.134	98.406 ± 0.337	182.1 ± 48.969	99.34 ± 0.798
12 HOURS	95.62 ± 9.43	101.22 ± 11.542	98.398 ± 0.380	165.1 ± 44.806	99 ± 0.782

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24 HOURS	95.06 ± 8.084	99.24 ± 10.777	98.49 ± 0.338	150 ± 41.759	98.92 ± 0.778
36 HOURS	95.5 ± 8.469	97.82 ± 11.833	98.308 ± 0.229	138.3 ± 51.593	98.9 ± 0.814
48 HOURS	93.44 ± 9.282	93.02 ± 10.138	98.374 ± 0.210	110.4 ± 31.749	99.42 ± 0.758

Table 3: PH AND HCO3

Time	PH Mean ±2 Standard deviation	HCO3(meq/litter) Mean ±2 Standard deviation.
PRE-BYPASS	7.383 ± 0.034	23.12 ± 2.512
ONSET-OF BYPASS	7.369 ± 0.037	18.28 ± 4.584
MID-BYPASS	7.347 ± 0.048	16.22 ± 3.671
WEANING FROM BYPASS	7.381 ± 0.035	19.48 ± 3.252
0 HOURS	7.407 ± 0.022	22.76 ± 2.788
6HOURS	7.403 ± 0.032	23.66 ± 1.733
12 HOURS	7.392 ± 0.026	22.22 ± 2.705
24 HOURS	7.390 ± 0.030	22.06 ± 2.598
36 HOURS	7.389 ± 0.027	22.84 ± 1.909
48 HOURS	7.374 ± 0.045	22.64 ± 2.946

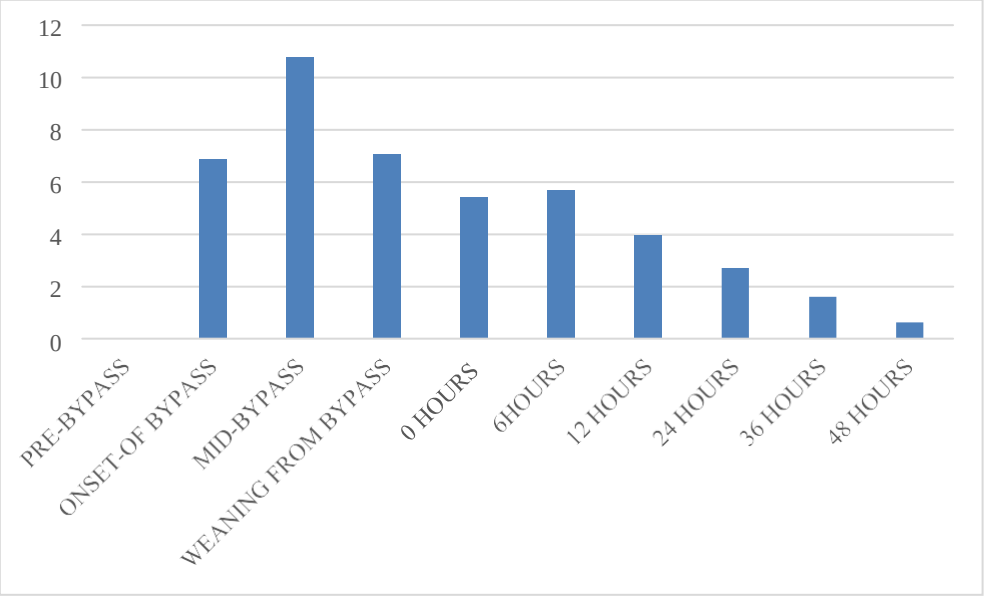

Figure 1: Insulin Requirement

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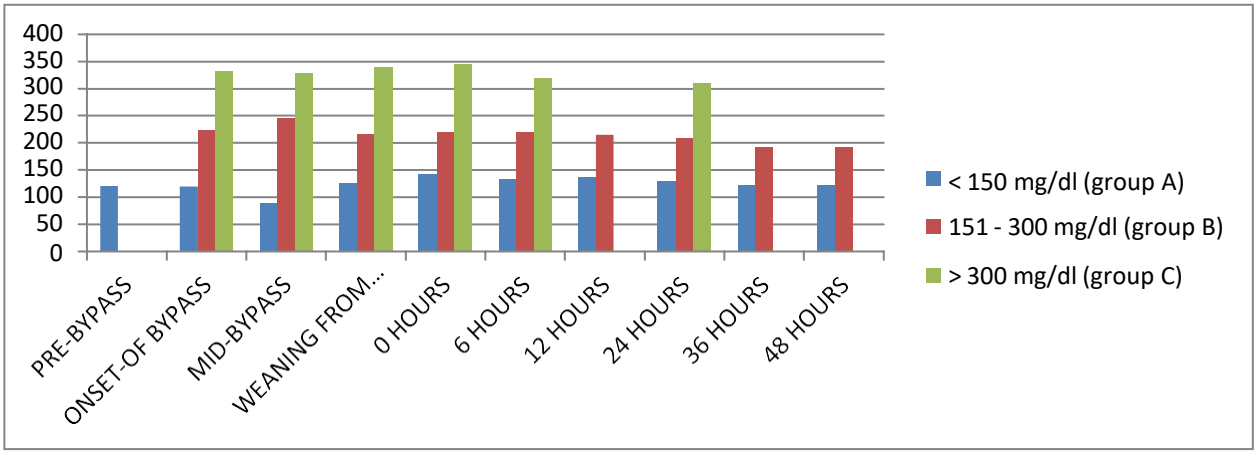

Figure 2: Mean CBG level (mg/dl)

Our study, use for the distribution of patient according to the operation undergone. Though In format 3 we distribute the patient In percentage not in number. It is seen that the valve replacement surgery (MVR, DVR, AVR) contributed the highest number of surgery [(27) 54%] in our department then other surgery, followed by CABG, ASD CLOSURE, VAD CLOSURE.

In our study describe the distribution of mean CPB time (minutes) according to various surgical procedures and its demonstration. Here we found that DVR surgery took maximum time 149 minutes (mean) for CPB and ASD CLOSUE took minimum time 65.4 minutes (mean) for CPB.

Table 2 describe the Mean ±2 Standard deviation. In various haemodynamic parameters in relation to the time

Table 3 describe the PH & bicarbonate (HCO3) along with Mean ±2 Standard deviation in relation to the time.

DISCUSSION

We have studied 50 adult cardiac patients undergoing cardiopulmonary bypass of mean age of 42 years (maximum 60 years and minimum 22 years). Mean of the CPB time of 50 patient was 103.25 minutes. Almost in every cases patient was on inotropic support at least for 48 hours after CPB.

We have used IV bolus insulin above the sugar level of 150mg/dl @ of 1ml/10mg/dl in most cases. In our study minimum glucose level that we had found 76 mg/dl and the maximum level was 365 mg/dl. Here the minimum insulin infusion rate was 0 IU/hr & the maximum rate was 22 IU/hr. In our study maximum insulin requirement of the patient was at the mid bypass period and the requirement had gradually decrease to 48 hours (Table- 7).

Chaney MA et al. in **1999 [**4] had studied about maintaining of normal glycemic level during various cardiac surgery. In their study they found the significant changes of glucose level based on the various CPB time in different cardiac surgery. In their study the mean CPB time for ASD CLOSURE was – 62.26 minutes, VSD CLOSURE – 112 minutes, MVR -110.2 minutes, AVR – 96.24 minutes, DVR -134 minutes, CABG – 118.2 minutes.

In our study we found that the mean CPB time for ASD CLOSURE was – 65.40 minutes, VSD CLOSURE – 95 minutes, MVR -100.8 minutes, AVR – 101.69 minutes, DVR -149 minutes, CABG – 107.66 minutes. (Table-4)

Van den Berghe et al 2001[3] had studied among the 100 patients about the Intensive insulin therapy in the critically ill patients during and after CPB along the inotropic support, they found MAP (mean) was - 65.29 mm/hg during OT & was- 88.27 mm/hg was 12 hours in ITU , Heart rate (mean) was 90.24 beat/minute in pre bypass and 94.28 beat/minute was in 0 hours after ITU

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shift, & the temperature (mean) was 79.26*F in mid-bypass and 98.202*F was in ITU.

In our study we found that the MAP (mean) was - 69.72 mm/hg, during OT & - 95.20 mm/hg was 12 hours in ITU , Heart rate (mean) was 91.14 beat/minute in pre bypass and 92.78 beat/minute was in 0 hours after ITU shift, & the temperature (mean) was 81.152*F in mid-bypass and 98.406*F was in ITU. (Table-5)

Van den Berghe et al 2001[3] had studied among the 100 patients about the Intensive insulin therapy in the critically ill patients during and after CPB along the inotropic support, they had showed in their study that the requirement of the inotropes was quite high at the time "weaning from bypass" upto initial 6 hours in ITU stay, though the inotropic requirement gradually decreases from 0 POD to 2 POD.

In our study we also found that the requirement of the inotropes was quite high at the initial 6 hours of ITU stay. But here also the inotropic requirement gradually decreases from 0 hours to 48 hours.

(Table-6)

Mills et al (2003)[5] had studied about the hyperglycaemia during cardiopulmonary bypass had showed in their study that the both (mean+- 2 standard deviation) HCO3 (17.23+-4.834) and PH (7.351+-0.030) was in acidic range at the time of mid-bypass.

In our study we found that the both (mean+- 2 standard deviation) HCO3 (16.22+-3.761) and PH (7.345+-0.048) was also in acidic range at the time of mid-bypass. (Table-7)

Mark A. And Co-workers [6] **(**2015) showed in their study that 20 patients enrolled and participating in the study patients, despite administration ofIV insulin (increased infusion rate, supplementary injections), they were unable to attain normoglycemia with the study protocol. All patients were received 90.0±49.2units of insulin (range 40–161 units). Although those patients experienced significant increases in blood glucose levels during CPB (when compared with baseline), there was no difference. However, mean blood glucose level at sternal closure and upon intensive care unit arrival was significantly decreased. All patients had an uneventful intraoperative course. Postoperatively, six patients developed new onset atrial fibrillation. No patient had suffered perioperative myocardial infarction. The only clinical neurologic morbidity encountered postoperatively occurred in a patient who developed transient left arm and left leg weakness with aphasia on the second postoperative day that was completely resolved by the fourth postoperative day. This patient had a history of seizures and was taking phenytoin preoperatively. All patients were eventually discharged from the hospital.

We showed in our study the "conventional control" of intraoperative blood glucose was attainable in non-diabetic patients during elective cardiac surgery undergoing cardiopulmonary bypass. The appropriate intra-operative management of hyperglycemia during cardiac surgery was controlled under target (110-150mg/dl). In this study, maximum glycemic level reached upto 365 mg/dl and minimum 76 mg/dl. Among 50 patients, 2 patients were received 14.53±10 units of insulin (range 20-52 units). Although those patients experienced significant increases in blood glucose levels during CPB (when compared with baseline), there was no significant increase in blood glucose level in the operation theatre operative 48 hours. However, mean blood glucose level at sternal closure and upon intensive care unit arrival was significantly decreased. 2 patients glycemic levels were not controlled by insulin all patients had an uneventful intraoperative course. (Table-8)/ (Table-9)

Gower S [7]**.**in 2012 showed that The Effect of Tight Glycemic Control in Open Heart Surgery Patient, intra-operative blood glucose levels maintaining below 180 mg/dl via a continuous intravenous infusion of insulin, may reduce postoperative surgical site infections and mortality rate in the open-heart surgical patient.

In our study among 50 patients we have shown that the effect of conventional glycaemic control in open heart surgery, intraoperative blood glucose levels were maintaining (110-150mg/dl) through the administration of bolus insulin. And post-operatively with continuous insulin pump (2IU/1 ml). (Table-8)

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D'Alessandro and coworkers[29] showed in their study in January 2003 to June 2004, around 300 diabetic patients who were treated tight glycemic control (150 to 200 mg/dl) for CABG operation and observed that the mortality was significantly lower (1.3% vs 4.3%; p - 0.01).

In our observational study we have shown among 50 patients who were treated conventional glycaemic control (110-150mg/dl) for open heart surgery operation and found no mortality (Table-9), probably as our study patients were non diabetic.

Furnary et al [8] (1999, 1967) had studied about Continuous intravenous insulin infusion reduces the incidence of deep sternal wound infection in diabetic patients after cardiac surgical procedure.

In our study we applied the conventional method of glycemic control (110-150 mg/dl) over 50 non-diabetic patients through injection pump in post-operative period and found no deep sternal wound infection in them. (Table-8)(Table-9)

Mills NL et al [5] (2003). Had studied about Hyperglycemia during cardiopulmonary bypass they had found that intra operatively dextrose free saline (RS) are more effective to control glycemic level (hyperglycemia).

In our study we also used dextrose free saline (RS) to maintain glycemic level (110-150mg/dl) during and post operatively in ITU. But for the hypoglycemia dextrose saline (D5, DNS) were infused.-(Table-10)

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