

**A PROSPECTIVE OBSERVATIONAL STUDY ON THE USE OF INSULIN INFUSION IN COMPLIANCE WITH STANDARD OPERATING PROCEDURES IN CARDIAC SURGERY AND MEDICAL INTENSIVE CARE UNITS****Robin Jose\*<sup>1</sup>, Alwin Jose<sup>1</sup>, Rinto Paul Raju<sup>1</sup>, Christy Sara Andrews<sup>1</sup>, Soumya Shaji<sup>1</sup> Apollo James<sup>2</sup> and Siva Kumar T.<sup>3</sup>**<sup>1</sup>Pharm D Interns, Department of Pharmacy Practice, Nandha College of Pharmacy, Erode, Tamilnadu.<sup>2</sup>Assistant Professor, Department of Pharmacy Practice, Nandha College of Pharmacy, Erode, Tamilnadu.<sup>3</sup>Principal, Nandha College of Pharmacy, Erode, Tamilnadu.**\*Corresponding Author: Robin Jose**

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**ABSTRACT**

Hyperglycemia is encountered as a major issue for increasing morbidity, mortality and length of stay in critically ill patients with or without the history of diabetes. A good control over the patient's glucose level is essential for the improvement of patient outcome. For a tight glucose control, proper adherences with the standard operating procedures are very essential. The aim of the study was to determine the compliance of use of insulin infusion with standard operating procedures (SOPs) in cardiac surgery and medical intensive care units of a tertiary care hospital. The study was conducted in the intensive care unit for 3 months with 150 patients who were receiving insulin infusion. For this study, an insulin infusion safety protocol audit tool was prepared as per protocol, which includes the following parameters: initial Glucose Random Blood Sugar (GRBS) assessment, accuracy in Insulin dilution, Labelling of syringe infusion pump and administration of Insulin in increments according to patient need. The compliance of these parameters with the standard operating procedures was evaluated. At the end of the study a progressive improvement in the adherence to the standard operating procedures were observed. All medical practitioners must follow a standard insulin infusion protocol in a hospital. A daily auditing is very useful for ensuring the rational use of insulin.

**KEYWORDS:** Hyper glycemia, diabetes mellitus, Insulin infusion, Standard operating procedures, Insulin algorithms, syringe infusion pumps.

**INTRODUCTION**

Hyperglycemia is encountered as a risk factor for Diabetic patients, Non-diabetic cardiac and surgery patients who are admitted in the critical care units.<sup>[1,2]</sup> Hyperglycemia in critically ill patients can worsen the complications of electrolyte imbalances, impairing the host defenses, risk of sepsis, which then leads to multiple organ dysfunction of the patient and can even lead to death.<sup>[3,4]</sup> In Non-diabetic surgery patients, surgical procedures results in many metabolic imbalances that can affect the normal glucose homeostasis in the body. Hyperglycemia is induced in surgical patients by hyper metabolic stress response caused by the increased production of counter regulatory hormones that causes alteration in carbohydrate metabolism, insulin resistance and increased hepatic gluconeogenesis.<sup>[5,6]</sup> This will increase the risk of post-operative sepsis, endothelial dysfunction and cerebral ischemia.<sup>[7,8]</sup> For cardiac patients admitted in cardiac care units, hyperglycemia will increase the incidence of myocardial infarction and stroke, also increases the chances of deep sternal wound

infections in open heart surgery patients.<sup>[9]</sup> A study conducted by Furnay AP *et al* on continuous intravenous insulin infusion reduces the incidence of deep wound infection in diabetic patients after cardiac surgical procedures shows reduction in major infectious morbidity with insulin infusion perioperatively in diabetic patients undergoing open heart surgery.

Patients with no history of diabetes were found to be hyperglycemic during their hospital stay, and showed higher mortality rate and length of stay than patients with history of diabetes.<sup>[10,11]</sup> A tight glucose control has reduced these events in both diabetic and non-diabetic patients in the hospital.

In the critical care units, the target range for glycemic control in non-surgical diabetic patients (including type 1 and type 2) are considered in between 80-140 mg/dL. For surgical patients with or without the history of diabetes, the target range is considered in between 110-140mg/dL.<sup>[12,13]</sup> The Insulin administered through

infusion is preferred for the glycemic control in critically ill patients. Due to short half-life of insulin in the body, a rapid delivery of insulin is needed to patients and can be achieved through insulin infusions.<sup>[14]</sup>

A standard operating procedure (SOP) should be followed in every institution to maximize the benefits and reduce the risk of insulin infusion. This institution follows Texas diabetes council infusion protocol as a standard operating procedure of insulin infusions. For insulin administration for all kind of patients who are admitted in ICUs, the Texas diabetes council has designed an easy and affordable tool called as insulin algorithms to start a patient on insulin, to design an effective dosing regimen of insulin to the patients to prevent them from the events of hyperglycemia and hypoglycemia.<sup>[15]</sup>

The aim of this study is to evaluate the adherence of practice with standard operating procedures (SOPs) of insulin in the medical and cardiac surgery intensive care units of a tertiary care hospital and to analyze the use of algorithm in the intensive care units.

## MATERIALS AND METHODS

### Study Design

A Prospective observational study was conducted in the medical and cardiac surgery intensive care unit of a tertiary care hospital with 150 patients from March 2017 to May 2017 (3 months). This study was approved by hospitals ethical committee. An insulin infusion safety

protocol audit tool including four parameters was prepared as per standard protocol of Texas diabetes council. Compliance or non-compliance with these parameters was noted. Those parameters including initial GRBS (glucose random blood sugar) assessment, accuracy of insulin dilutions, insulin dilutions mentioned on the syringe infusion pump and insulin administered in increments according to patient need. The auditing was conducted on 50 patients on each month. An educational class on SOPs of insulin was taken by the clinical pharmacy department to the ICU physicians and nursing staffs. Finally, the compliance to the SOPs was again evaluated.

### Texas diabetes council IV insulin infusion protocol in ICU

- Target glucose level for diabetic patients (including type 1 and type 2): 80-140 mg/dL
- Target glucose level for surgery patients with or without type 1 and 2 Diabetes mellitus: 80-110mg/dL.
- Insulin Standard drip dilution: 100units/100ml 0.9% Normal saline (1 unit/ml)

Approved IV Insulins include Regular, Aspart and Glulisine can be used

- Bolus dose and initial infusion rate: Divide initial glucose random blood sugar (GRBS) by 100, then round nearest 0.5 units for bolus and initial infusion rate.
- Insulin algorithms shown in Table 1.

**Table 1: Insulin algorithm- Texas diabetes council.**

Algorithm 1		Algorithm 2		Algorithm 3		Algorithm 4	
Glucose	units/h	Glucose	units/h	Glucose	units/h	Glucose	units/h
<70	Off	<70	Off	<70	Off	<70	Off
70–109	0.2	70–109	0.5	70–109	1	70–109	1.5
110–119	0.5	110–119	1	110–119	2	110–119	3
120–149	1	120–149	1.5	120–149	3	120–149	5
150–179	1.5	150–179	2	150–179	4	150–179	7
180–209	2	180–209	3	180–209	5	180–209	9
210–239	2	210–239	4	210–239	6	210–239	12
240–269	3	240–269	5	240–269	8	240–269	16
270–299	3	270–299	6	270–299	10	270–299	20
300–329	4	300–329	7	300–329	12	300–329	24
330–359	4	330–359	8	330–359	14	330–359	28
>360	6	>360	12	>360	16	>360	32

- Adjusting the infusion based on algorithms. In most patients (Type 1 and Type 2 diabetes mellitus, Non-surgical patients) dosing of insulin starts according to algorithm 1. For patients not controlled with Algorithm 1, or if patient with a history of coronary artery bypass graft, solid organ or islet cell transplant and receiving glucocorticoid therapy will start up with algorithm 2. For patients not controlled on Algorithm 2 will start up with algorithm 3 and algorithm 4 starts on the patients who are not controlled on Algorithm 3.
- Hourly monitoring is indicated for critically ill patients even if the blood glucose is stable.

### Data Collection Tools

Insulin infusion safety protocol audit tool, Patient insulin infusion chart and Patient diabetic chart.

### Study Criteria

#### Inclusion Criteria

All patients who were admitted in Intensive care units.

**Exclusion Criteria**

- Patients for which insulin is administered for the management of hyperkalemia
- Pediatric patients
- Patients shifted out from the ICU

**RESULTS**

A total number of 150 cases were collected. Among 50 patients audited on the 1<sup>st</sup> month, only 39 patients (78%) showed compliance for Random blood sugar to be checked before starting insulin infusion and at the time

of admission. The parameter of dilution showed 84% (42 patients) compliance in accordance with the SOP's. According to the SOP, dilution mentioned on the infusion pump was checked and it showed 72% compliance, remaining 29% was not showing compliance due to the unavailability of the dilution labels for the syringe infusion pumps. According to the distribution of patients on the insulin administration, 44 patients (88%) were administered insulin via syringe infusion pump in increment according to patient need.

**Table 2: Assessment of compliance with the SOPS using the insulin infusion audit tool parameters.**

Month	Insulin infusion audit tool parameters			
	Initial GRBS assessed	Insulin dilution done accurately	Labelling done on syringe infusion pump	Insulin administered as increments based on protocol
March	78%	84%	72%	88%
April	88%	90%	86%	94%
May	100%	98%	98%	96%

On analyzing the compliance for the final month, a significant improvement in compliance with insulin infusion audit tool parameters was found. Assessing of Initial GRBS was done on every patient (100%

compliance), Insulin dilution done accurately in 98% of patients, labelling done on syringe infusion pump was done in 98% patients and for 96% patients, insulin was administered in increment as per protocol.

**Table 3: Overall selection of Insulin Algorithm in medical intensive care unit (MICU).**

ICU category	Month	Total no: of patients	Insulin algorithm use			
			No: of patients started with Alg.1	No: of patients started with Alg.2	No: of Patient's directly administered with Alg.3	No: of Patient's directly administered with Alg.4
MICU (critically ill patients with type 1 and 2 diabetes mellitus)	March	27	0	3	18	6
	April	29	9	15	3	2
	May	33	30	3	0	0

*MICU – medical intensive care unit.*

While comparing the overall insulin algorithm use in MICU for each month, direct use of algorithm 3 and 4 was found more in March month, and reduced in the

month of May. A progressive increase in the use of algorithm 1 was found at end of the month.

**Table 4: Overall selection of Insulin Algorithm in cardiac surgery intensive care unit (CSICU).**

ICU category	Month	Total no: of patients	Insulin algorithm use			
			No: of patients started with Alg.1	No: of patients started with Alg.2	No: of Patient's directly administered with Alg.3	No: of Patient's directly administered with Alg.4
CSICU (Patient underwent cardiac surgeries including type 1 and 2 diabetic patients and non- diabetic patients)	March	22	0	3	8	11
	April	18	0	8	6	4
	May	21	0	15	4	2

*CSICU - cardiac surgery intensive care unit.*

While evaluating patients admitted in CSICU, increased number of patients directly administered with algorithm 3 and 4 in March month. In May month, number of patients directly administered with algorithm 3 and 4

were decreased and number of cases started up with algorithm 2 were increased.

## DISCUSSION

In intensive care units, hyperglycemia in patients with or without the previous history of diabetes is considered to have a great impact on increasing mortality rates and poor patient outcomes. A proper adherence with the insulin infusion standard operating procedures will substantially reduce the mortality rates among those patients.

Initial GRBS assessment, accurate insulin dilutions, labelling on syringe infusion pump and insulin administered in increments according to patient needs are necessary for the proper compliance with the SOP's. GRBS should be checked for every patient admitted in the ICU. This helps to select the appropriate insulin algorithm and to set glycemic targets for the patients. Dilution of insulin is an important parameter to be cross checked prior insulin administration. It is necessary to check whether insulin is diluted in Normal saline in 1:1 ratio only. And it should be always done in the presence of a clinical pharmacist. It's important to mention the dilution and infusion rate on the label of syringe infusion pump. This helps the nursing staffs and the doctors to easily recognize the dilution and rate without going through patient charts. For this, an initiative was taken by hospital's clinical pharmacy department to issue dilution labels with specific color coding to make it easy to understand any given dilutions. Then the administration of insulin infusion to patients in increments should be always done by considering the algorithm chart. In the present study, the survey reports of the first month showed a less compliance with the standard operating procedures of insulin infusion. Based on these reports an educational program was conducted for the health care providers in the ICU regarding standard operating procedures and importance of rational use of insulin. The survey reports of the following months showed better compliance with the SOP's and insulin infusion algorithm was kept to all the patient bedsides for the health care professionals to make use of it.

According to insulin infusion protocol, all patients admitted in ICU must be begin with low delivery algorithm 1 or 2 to reduce hypoglycemia induced by insulin in the patients. A patient should be only treated with algorithm 3 and 4, if the blood sugar was not controlled by algorithm 1 and 2. By assessing the total algorithm use during 3 months in both ICU, there was a significant change in the selection of algorithm. The direct use of Algorithm 3 and 4 was found to get reduced in both ICU.

## CONCLUSION

The presence of hyperglycemia was found to be a major cause for increased morbidity and mortality in critically ill patients regardless the reason for their admission. Adequate control of blood sugar is only achieved through adherence with the SOPs more than applying the practical experiences of the ICU staffs. By making understand the potential benefits of the of Insulin

infusion protocol to the health care professionals, an overall improvement in compliance with SOPs of insulin was found at the end of this study. A daily auditing will help to maintain this compliance in the Intensive care unit.

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