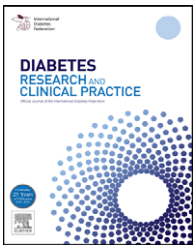
Contents lists available at ScienceDirect

Diabetes Research and Clinical Practice

journal homepage: www.elsevier.com/locate/diabres

International Diabetes Federation



Our experience of controlling diabetes in the peri-operative period of patients who underwent cardiac surgery

Ibrahim A. Emam *, *Andrew Allan*, *Khalied Eskander*, *Kareddula Dhanraj*, *El-Sayed Farag*, *Yasser El-Kadi*, *Wael Khalaf*, *S.R. Riad*, *R. Somia*

Department of Cardiac Surgery, King Fahd Military Medical Complex (KFMMC), Dhahran, Saudi Arabia

ARTICLE INFO

Article history:
Received 15 September 2009
Received in revised form
23 February 2010
Accepted 8 March 2010
Published on line 14 April 2010

Keywords:
Aortic valve replacement
Cardioplegia
Diabetes mellitus
Coronary artery bypass surgery

ABSTRACT

Aims: We have different protocols applied in our cardiac center for control of blood glucose (BG), we like to see which protocol can achieve our goal.
Methods: From a prospective study of 120 diabetic patients randomly assigned to either simple sliding scale or Braithwaite protocol who underwent open heart surgical procedures between 2005 and 2008. The study group included 80 patients treated with Braithwaite protocol; the control group included 40 patients treated with simple sliding scale in an attempt to maintain BG level less than 200 mg/dl.
Results: In the study group all the patients were under 200 mg/dl at the end of 48 h post-operatively, which was not achieved in the control group ($P < 0.01$). There was a significant reduction in hospital stay in the study group compared to the control group (mean in days $9.1 \pm 2.3/12.3 \pm 7.6$) ($P < 0.001$) and also there was no wound infection compared to the control group (0/5 cases).
Conclusion: The study showed that control of DM in peri-operative period using Braithwaite regimen was of great benefit and safety.

1. Introduction

Diabetes mellitus is a major risk factor for coronary artery disease and as such is a common co-morbid condition in patients undergoing cardiovascular surgery. Diabetes has been shown to be a significant factor in determining operative risks with a twofold to threefold increase in mortality and significant increase in sternal wound infection [1]. The stress of surgery itself results in metabolic perturbation that alter glucose homeostasis and persistent hyperglycemia is a risk factor for endothelial dysfunction [2], postoperative sepsis [3], impaired wound healing [4,5], and cerebral ischemia [6]. Hyperglycemia in the hospital is associated with increased mortality and morbidity and that meticulous glycemic control can improve clinical outcomes [7]. A number of regimens have been used to regulate BG usually combining a glucose infusion with an adjustable insulin infusion or variable subcutaneous (SC) insulin doses. Most cardiac units have some forms of insulin regimen but still BG control is variable. The algorithm of Braithwaite et al., was first published in Endocrine Practice by Markovitz et al. [8], then revised by Trence et al. [9], and subsequently modified to achieve a target range BG of 100–150 mg/dl. In this protocol the columns are selected to maintain the BG level within the target range. We are interested in seeing if her regimen was applicable to our patients in a Regional Cardiac Centre in Saudi Arabia.

2. Materials and methods

A total of 120 adults with diabetes who underwent open cardiac surgery from 2005 to 2008 in the cardiac surgery

* *Corresponding author at*: Department of Cardiothoracic Surgery, P.O. Box 946, Dhahran 31932, King Fahd Military Medical Complex, Cardiac Center, Saudi Arabia. Tel.: +966 554254968; fax: +966 38405876.
E-mail address: ibrahim7502002@hotmail.com (I.A. Emam).
0168-8227/$ – see front matter
doi:10.1016/j.diabres.2010.03.002

service of King Fahd Military Medical Complex (KFFMC) were included in a randomized prospective study to maintain tight glycemic control (BG between 100 and 150 mg/dl) within each group during running of insulin therapy with the goal of keeping BG level to be below 200 mg/dl especially at the end of first 48 h postoperatively.

All patients were admitted at least 24 h before surgery, and baseline investigations, including fasting blood glucose levels, were obtained. There were no differences between both groups with respect to age, gender, body mass index (kg/m^2), antibiotic prophylaxis, skin preparation bypass time, and all patients received left internal mammary artery as one of the grafts in all coronary artery bypass surgery. All patients who underwent cardiac surgery were using non-pulsatile cardiopulmonary bypass with hypothermia to 32 °C and cold blood cardioplegia without substrate enhancement. None of both groups were on corticosteroids but small number of both groups was on small doses of catecholamine, both group had the same degree of uncontrolled diabetes (70%) but the degree of uncontrolled diabetes was more towards the study one. The patient demographics are summarized in Table 1.

All 80 patients in the study group were commenced on intravenous (IV) insulin infusion according to the Braithwaite protocol [11] (Table 2) on the evening before surgery or sooner if (BG ≥ 150 mg/dl) and to be applied as following (Table 3):

- 50 units of regular insulin (RI) mixed with 50 ml of 0.9% saline (1 ml = 1 unit RI).
- The target level of BG was 100–150 mg/dl.
- The BG check every 1 h by finger stick testing and started with the second column if the BG ≥150 mg/dl.
- The BG check every 1 h until the patients had the criteria of stability at this time the test was done every 2 h (stability means that the patients were in the target range for 4 h).
- The next higher columns were switched under the following circumstances.

Table 1 – Clinical characteristics of the study and control groups.

	Study group (n = 80)	Control group (n = 40)
Age (years)[a]	58	56
Gender		
Male	64 (80%)	32 (80%)
Female	16 (20%)	8 (20%)
Body mass index (kg/m^2)[a]	30.5	29.6
Cardiopulmonary bypass time (min)	85	84
Diabetes		
Type 1	0	0
Type 2	80(100%)	40 (100%)
Treatment		
Oral	60 (75%)	28 (70%)
Subcutaneous	12 (15%)	8 (20%)
Both	8(10%)	4 (10%)
On admission		
Controlled diabetes	24 (30%)	12 (30%)
Uncontrolled diabetes	56 (70%)	28 (70%)
Degree of uncontrolled		
Mild (125–200 mg)	24 (42.9%)	20 (71.4%)
Moderate (201–360 mg/dl)	24(42.9%)	8 (28.6%)
Severe (more than 360)	8 (14.2%)	0
Coronary artery bypass	76 (95%)	40 (100%)
Mitral valve repair	2 (2.5%)	0
Aortic stenosis	2 (2.5%)	0

[a] Expressed as means.

1. BG ≥200 mg/dl for 1 h and decreasing <30 mg/dl during the past 1 h.
   - Example A: BG 300 mg/dl, 250 mg/dl → same column (as BG > 200 mg/dl and reduction > 30 mg/dl).

Table 2 – Algorithm for intravenous insulin infusion: protocol of Braithwaite et al. [11].

Column 1		Column 2		Column 3		Column 5		Column 5		Column 6	
BG, mg/dl	U/h	BG, mg/dl	U/h	BG, mg/dl	U/h	BG, mg/dl	U/h	BG, mg/dl	U/h	BG, mg/dl	U/h
<70	Off	<70	Off	<70	Off	<70	Off	<70	Off	<70	Off
70–79	Off	70–79	Off	70–79	Off	70–79	Off	70–79	0.5	70–79	1
80–89	Off	80–89	Off	80–89	Off	80–89	0.5	80–89	1	80–89	1.5
90–99	Off	90–99	Off	90–99	0.5	90–99	1	90–99	1.5	90–99	2
100–109	Off	100–109	0.5	100–109	1	100–109	1.5	100–109	2	100–109	3
110–129	0.5	110–129	1	110–129	1.5	110–129	2	110–129	3	110–129	4
130–149	1	130–149	1.5	130–149	2	130–149	3	130–149	4	130–149	6
150–179	1.5	150–169	2	150–179	3	150–169	4	150–179	6	150–169	8
180–209	2	170–189	2.5	180–209	4	170–189	5	180–209	8	170–189	10
210–269	3	190–209	3	210–239	5	190–209	6	210–239	10	190–209	12
270–329	4	210–254	4	240–269	6	210–229	7	240–269	12	210–229	14
330–389	5	225–299	5	270—299	7	230–269	8	270–299	14	230–249	16
≥390	6	300–345	6	300–329	8	270–309	10	300–329	16	250–269	18
		364–389	7	330–359	9	310–349	12	330–359	18	270–309	20
		≥390	8	360–389	10	350–389	14	360–389	20	310–349	24
				≥390	11	≥390	16	≥390	22	350–389	28
										≥390	32

BG = blood glucose; u/h = units of insulin infused/hour.