



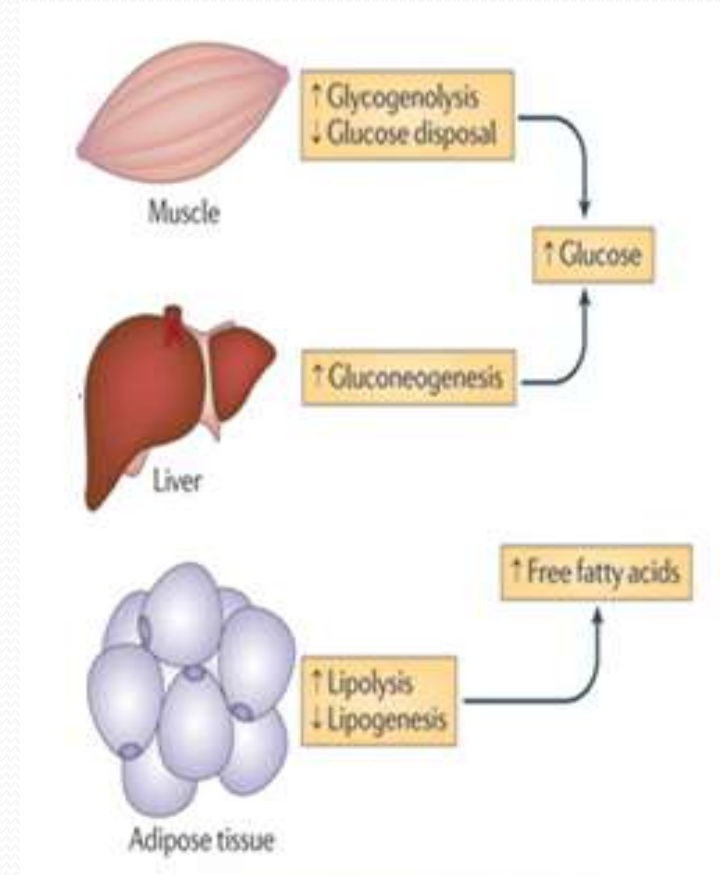
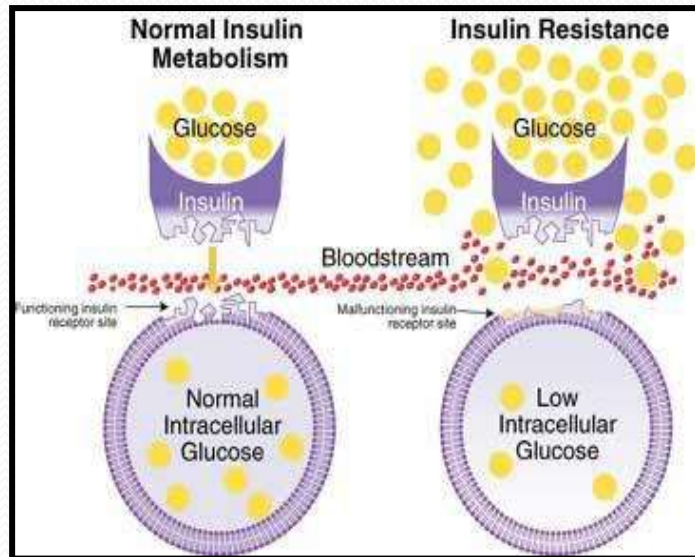
# PERİOPERATİVE İNSULİN DİRENCİ VE SONUÇ PARAMETRELERİ ÜZERİNE ETKİSİ

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Manisa**

# İNSÜLİN DİRENCİ

- Dokuların, insülin hormonuna yanıt vermemesidir.



# İNSÜLİN REZİSTANSI

- ❑ Kardiyovasküler hastalıklar için bağımsız risk faktörüdür.
- ❑ Trombozis ve inflamasyonu artırır.

ENDOTEL DİSFONKSİYONU

# Periop İnsülin Resistansı Popülasyon



# Major Cerrahiye Metabolik Yanıtlar

## İNSÜLİN REZİSTANSI

## HİPERGLİSEMİ



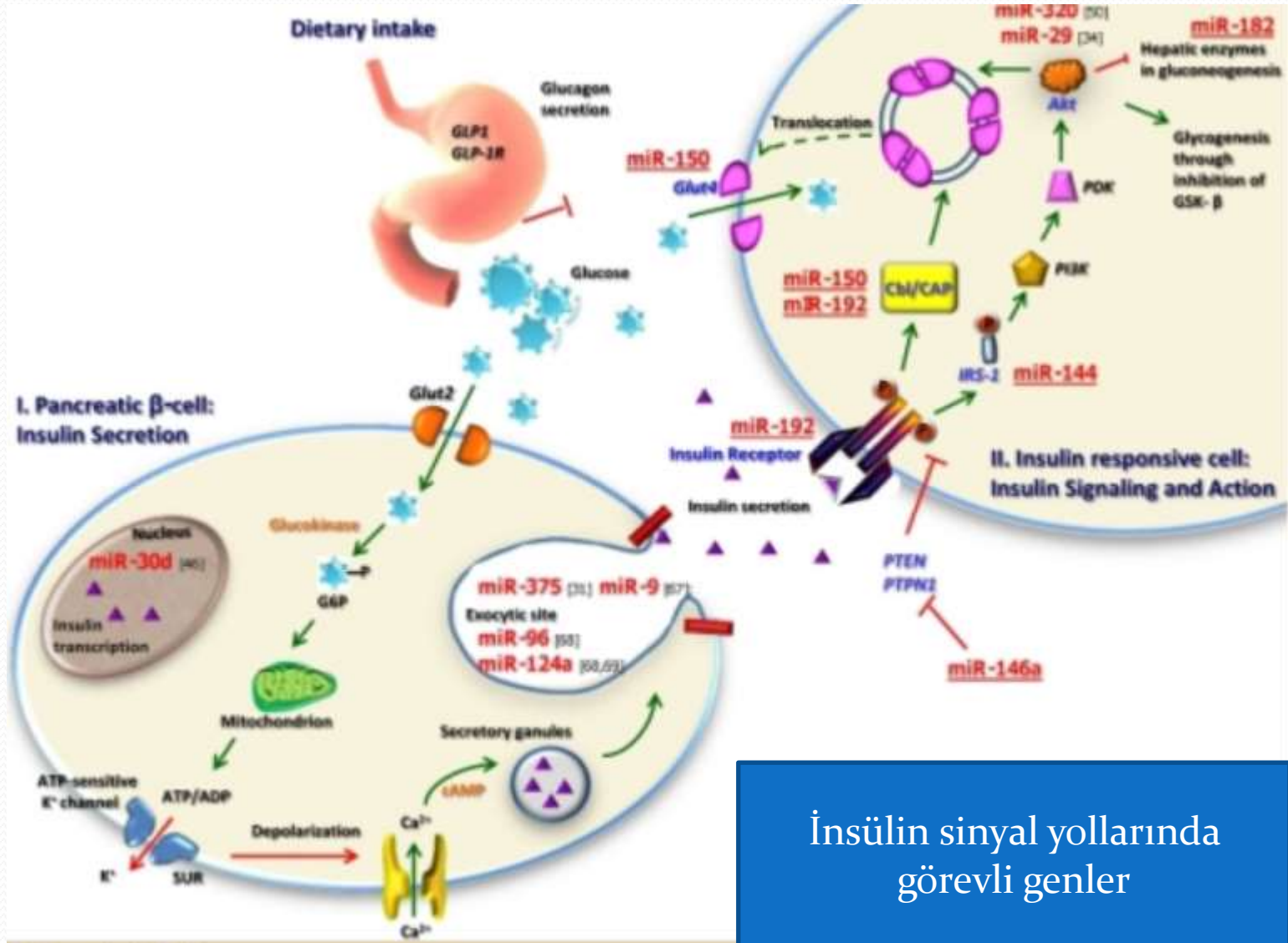
Glukojenoliz, Glikoneogenesis, Lipoliz, GLK kulanımı az.

# Perioperatif İnsülin Rezistansı

## CERRAHİ STRES

- KPB**
- Hipotermi**
- Isınma-KPB dan  
uyanma**
- İlaçlar: adrenalin,  
dopa, dopamin**

# İnsülin Rezistansının Patogenezisi



İnsülin sinyal yollarında görevli genler

# Kardiyak Cerrahide Metabolizma

- ❑ Enerji kaynağı olarak yağın kullanımı artar.
- ❑ Karbonhidratlara bağımlılık azalır.
- ❑ Enerji tüketimi belirgin değişmez.

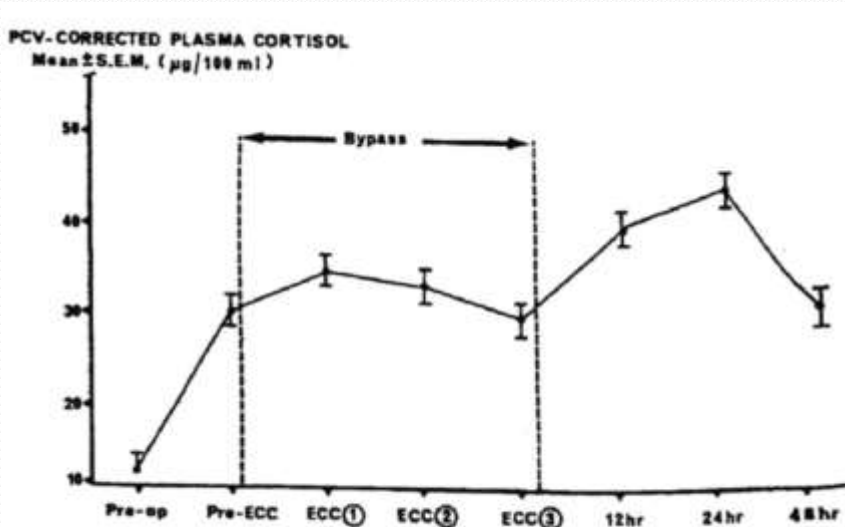


Figure 4 Levels of plasma cortisol in a group undergoing cardiac surgery with CPB. Preop = preoperatively; ECC = extracorporeal circulation. Reprinted with permission from reference 14. © 1976 Lippincott Williams & Wilkins.





# İnsülin Rezistansı- Endotel Disfonksiyonu

Retinopati

Nefropati

Nöropati

Aortik sklerozis

Myokard infarktüsü

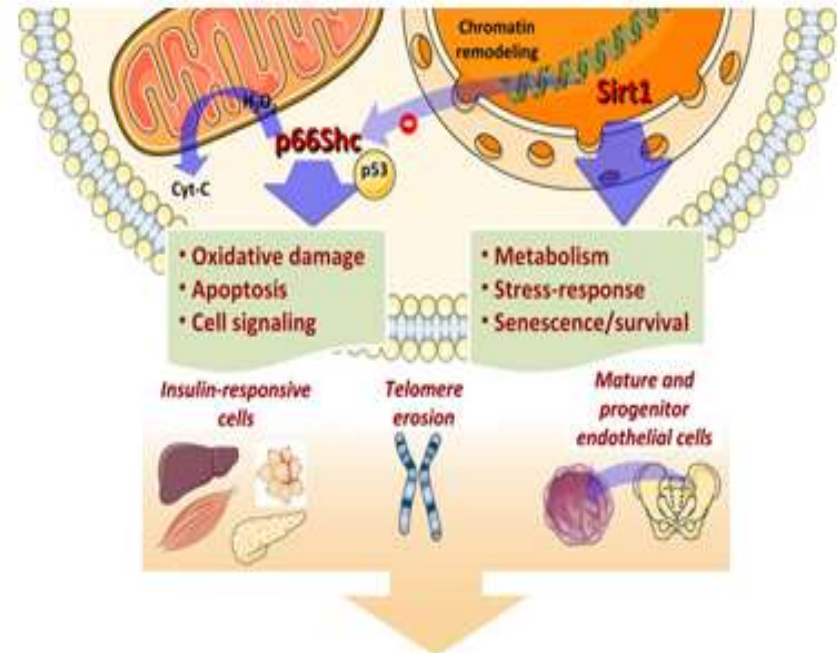
Anjina pektoralis

Periferal vasküler

hast.

Anjiogeneziste deęişiklik, eNOS regülasyonunda bozulma, tamir defektleri.

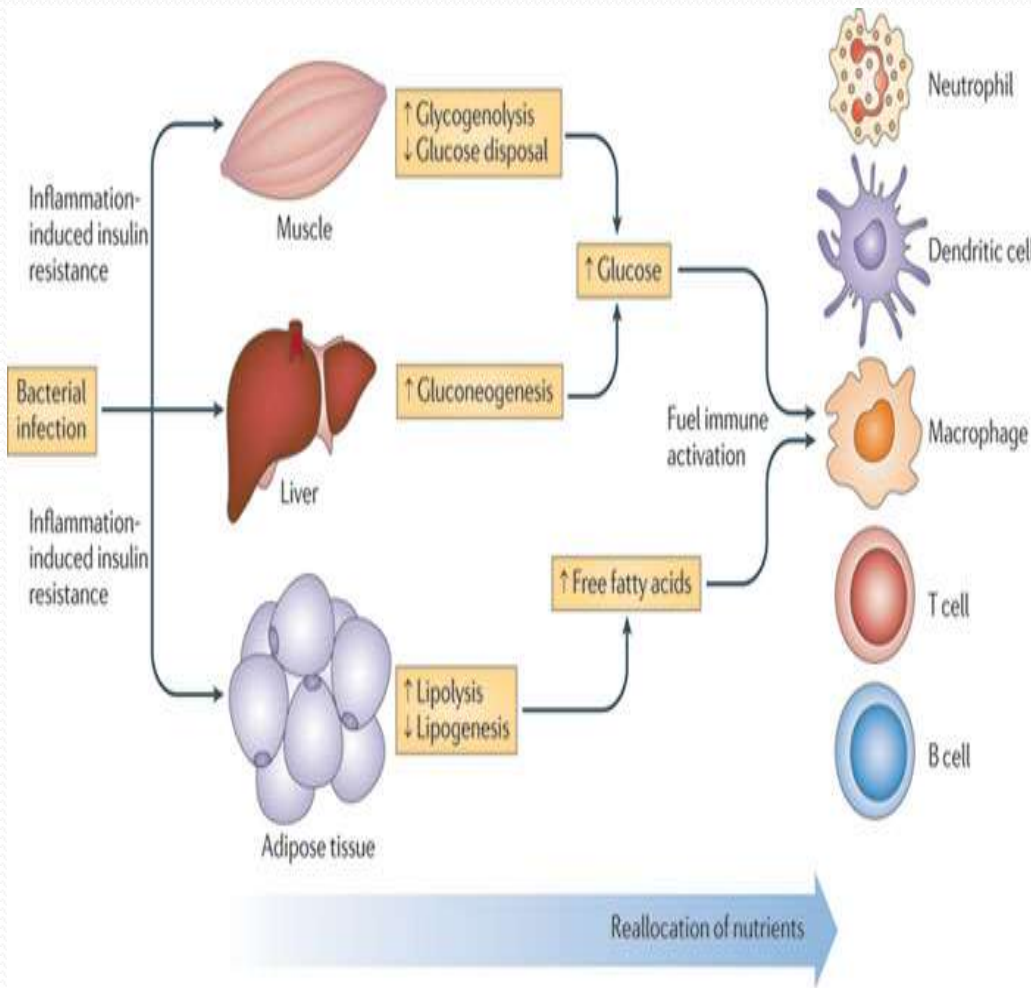
The molecular interrelationship between the longevity genes Sirt1 and p66Shc in the induction of insulin resistance and endothelial dysfunction.



ENDOTHELIAL DYSFUNCTION – INSULIN RESISTANCE

Avogaro A et al. J Am Heart Assoc 2013;2:e000282

# İnsülin Rezistansı- İnflamasyon- İnfeksiyon



- ❑ Lökosit kemotaksisi
- ❑ Fagositik aktivitede
- ❑ Bakterisidal kapasitede

**AZALMA**

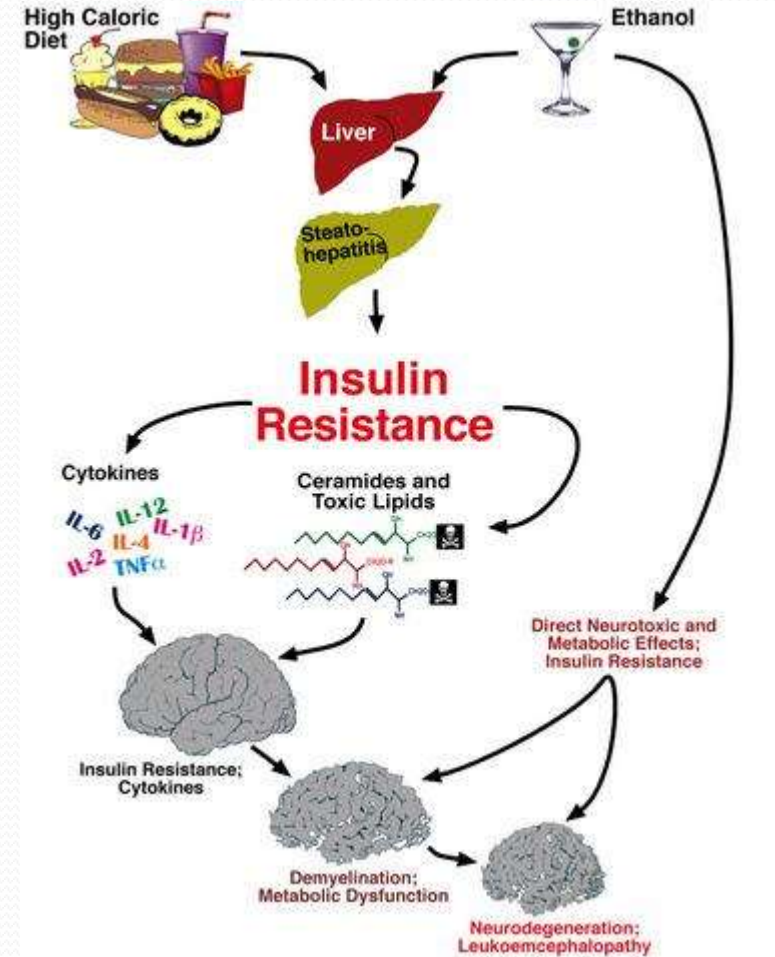
# İnsülin Rezistansı- Nörodegeneration

Oksidatif streste artma

Pro-inflamatuar  
aktiavasyonda artma

Nöro-dejenerasyon

Demiyelinizasyon

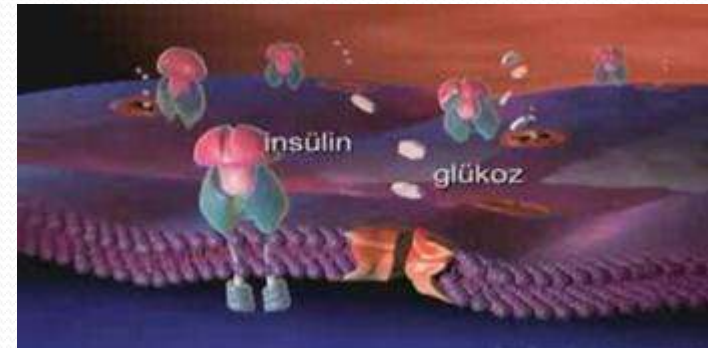


# Perioperatif İnsülin Direnci Yönetimi

- İnsülin ile tedavi yöntemleri (İnsülin - GIK infüzyon)
  - Kan şekeri takip yöntemleri
  - Hedeflenen değerler
  - Hedefe ulaşmada başarı derecesi
- önem kazanıyor.

# Glisemi kontrolünde amaç

- ❑ Hipoglisemiden kaçınma.
- ❑ Sıvı- elektrolit dengesinin sürdürülmesi.
- ❑ Hiperglisemiden kaçınılması.
- ❑ Ketoasidozisin / hiperozmalaritenin önlenmesi.



# Intraoperatif glukoz kontrol edilmeli

100 mg üzerinde AKŞ deęerin her 20 mg/dL artışı  
post operatif advers olayları % 34 artırıyor.

# GLİSEMİK HEDEF

## SIKI glisemik kontrol yararlıdır.

### □ Van Den Berghe

80-110 mg/dL, medikal-cerrahi YB

Daha az komplikasyon ve

Daha mortalite (% 34).

# Sıkı (stright, tight,intensive ) glisemik kontrol ?

- Kan glukozu değerlerinin yakın takibi
- Hedef değer
- Klinik protokoller



# Diabetiklerde İntra-op ve YB da insülin infüzyonu

Table 1. Comparison Among Major Studies in Recent Literature on Tight Blood Glucose Control

Study	n	Nondiabetics	Diabetics	OR	ICU	Target (mg/dL)	Effectiveness	Definition of hypoglycemia (mg/dL)	Hypoglycemia (% of patients)	Operator
Van den Berghe et al. <sup>5</sup>	765	Yes	Yes	Yes	Yes	80-110	Mean daily BGL = 103 mg/dL	<40	5.1	MD + study nurse
Gandhi et al. <sup>7</sup>	199	Yes	Yes	Yes	Yes	80-100	Mean perioperative BGL > target at all times	<60	5	MD + study nurse
Furnary et al. <sup>8</sup>	2612		Yes	Yes	Yes	150-200	Mean postoperative BGL = 177 ± 30 mg/dL	NR	NR	MD
Ouattara et al. <sup>9</sup>	205		Yes	Yes		100-180	18 % of patients with BGL >200 mg/dL during surgery	<40	1.2	MD
Chaney et al. <sup>14</sup>	20	Yes		Yes		100-150	Mean BGL on CPB = 246 ± 75 mg/dL	<60	40	MD
Taylor et al. <sup>15</sup>	95	Yes	Yes		Yes	80-110	Mean time to BGL <110 mg/dL = 13.6 hrs	<40	3.4	Nurse
Goldberg et al. <sup>16</sup>	118	Yes	Yes		Yes	100-139	57.6% of BGL within target range	<60	0.2	Nurse
Zimmerman et al. <sup>17</sup>	168	Yes	Yes		Yes	80-150	61% of BGL within target range	<40	7.1	Nurse
Groban et al. <sup>18</sup>	188	Yes		Yes		80-120	23 % of patients with a maximal BGL <150 mg/dL	<70	12	MD
Carr et al. <sup>19</sup>	737	Yes	Yes	Yes	Yes	80-130	75 % of patients with BGL <130 mg/dL	<50	7.7	Nurse

ICU = Intensive care unit; NR = not reported; BGL = blood glucose level.

- Glisemik hedefler değişken
- İnsülin ile tedavi yöntemleri değişken
- Hipoglisemi riski

**Dynamic Tight Glycemic Control During and After Cardiac Surgery Is Effective, Feasible, and Safe**

Patrick Lacomte, MD\* —Anesth Analg 2008;107:51-8

# Non- Diabetiklerde intra-op sonuçlar

**Table 1.** Comparison Among Major Studies in Recent Literature on Tight Blood Glucose Control

Study	n	Nondiabetics	Diabetics	OR	ICU	Target (mg/dL)	Effectiveness	Definition of hypoglycemia (mg/dL)	Hypoglycemia (% of patients)	Operator
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Zimmerman et al. <sup>17</sup>	168	Yes	Yes		Yes	80-150	61% of BGL within target range	<40	7.1	Nurse
Groban et al. <sup>18</sup>	188	Yes		Yes		80-120	23 % of patients with a maximal BGL <150 mg/dL	<70	12	MD
Carr et al. <sup>19</sup>	737	Yes	Yes	Yes	Yes	80-130	75 % of patients with BGL <130 mg/dL	<50	7.7	Nurse

ICU = intensive care unit; NR = not reported; BGL = blood glucose level.

- Glisemik hedefler değişken
- İnsülin ile tedavi yöntemleri değişken
- Hipoglisemi riski

**Dynamic Tight Glycemic Control During and After Cardiac Surgery Is Effective, Feasible, and Safe**

Patrick Lacombe, MD\* *Anesth Analg* 2008;107:51-81

Poor Intraoperative Blood Glucose Control Is Associated with a Worsened Hospital Outcome after Cardiac Surgery in Diabetic Patients. Quattara A et al. Anesth 2005

## Diabetik hastalarda

- İntra-operatif >200 mg/dL (kötü glisemi yönetimi) vs 150-200 mg/dL (sıkı glukoz,Portland)

### Post-operatif morbiditenin prediktörleridir.

Periop. İnotrop ve intraortik balon gereksinimi

Mekanik ventilasyon gereksinimi

Diyaliz gerektiren ABY, Nörolojik problemler

Pozitif kan kültürü, septik şok

# Kardiyak cerrahide peri-operatif sıkı glukoz kontrolü

- ❑ Preop diyabetik durumdan bağımsız olarak  
Postoperatif morbidite ve ölümleri azalma
- ❑ Diyabetiklerde immun fonksiyonları düzelme
- ❑ İnsizyon yeri enfeksiyonunu azalma oluşturur.

*Anderson RE et al. Are even impaired fasting blood glucose levels preoperatively associated with increased mortality after CABG surgery? Eur Heart J 2005*

*Patel KL: J WOCN ■ July/August 2008*

# İnsülin tedavi protoller

## Intensive Insulin Therapy in Critical Care

A review of 12 protocols

*Diabetes Care* 30:1005–1011, 2007

Table 1—Comparison of insulin infusion protocols

Author	Target glucose (mg/dl)	Bolus insulin		Changes in insulin infusion based on changes in glucose			Basis of changes in insulin rate		Steps for insulin adjustment [n/calculations (Y/N)]	Time to goal glucose
		Initial	Add	Direction	Velocity	Resistance	R or I	U ± %		
Bode	100–150	Y*	N	N	Y	Y	R	U	3/N	NR
Boord	120–180	N	N	N	N	N	R	U	1/Y	NR
Chant	90–144	N	Y	Y	Y	N	R	U+%	2/Y	15 h
Davidson	<180	N	N	N	N	Y	R	Multiplier	3/Y	7.5–10.5 h
Furnary	100–150	Y	Y	Y	Y	Y	R	U+%	2/Y	NR
Goldberg	100–139	Y	N	Y	Y	N	R+I	U+%	3/Y	9.0 h
Kanji	80–110	N	N	Y	Y	Y	R	U+%	2/Y	11.3 ± 7.9 h
Krinsley	<140	N	N	N	N	N	R	U	1/N	NR
Marks	120–180	N	N	N	N	N	R	U	1/N	NR
Van den Berghe	80–110	N	N	N	Y	N	R	U+%	2/Y	12–24 h
Watts	120–180	N	Y	N	N	N	R	U	1/N	8 h
Zimmerman	101–150	Y	Y	N	N	N	R+I	U+%	2/Y	2.1 h

See REFERENCES for complete citations. Protocols are all nursing driven with physician input written only for protocols by Bode and Van den Berghe. Bolus. Initial bolus = Y; Y\* = variable dose based on physician input; Add = additional boluses based on glucose level. Changes in insulin infusion: Direction = reflect whether subsequent glucose levels are increasing or decreasing; Velocity = reflects changes based on the rate (amount) of decline in glucose; Resistance = adjustments based on patient's resistance to insulin. Basis of insulin change: R = rate changed based on glucose range; I = rate change based on insulin infusion rate; U = changes made in units of insulin; % = changes based on a percentage of the current insulin infusion rate; Multiplier = adjustment of insulin dose using a multiplier incorporated into a formula for calculation. Insulin adjustment: include number of steps and if calculations are needed. Time to goal: reported as median values, range, or mean ± SD. NR, not reported

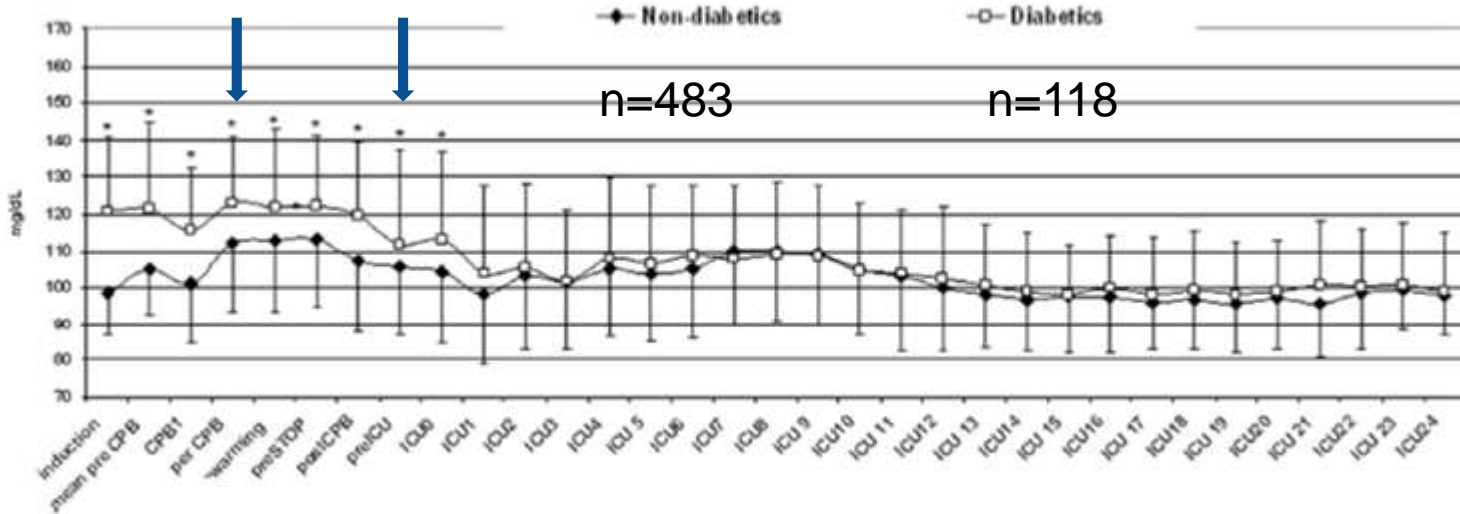
# Kardiyak cerrahi sırasında glisemi kontrolünü zorlařtıran faktörler

- KPB dan uyanma
- Isınma
- İnotropik ajanlar
- Kan transfüzyonları
- Anemi

# Dynamic Tight Glycemic Control During and After Cardiac Surgery Is Effective, Feasible, and Safe

Patrick Lacombe, MD\* Anesth Analg 2008;107:51-8]

Modifiye ALGIP insülin inf. tedavi protokolü Hedef: 80-110 mg/dL



- 18.893 kan örneği. %68 hedeflenen değer.
- Cerrahi sırasında; non-DM % 71, DM % 60'inde hedefe ulaşıyor.
- YB da hedefe iki grup ta da ulaşıyor.
- Hipoglisemi < 60 mg / dL: non-DM % 0.12, DM % 018

# Dynamic Tight Glycemic Control During and After Cardiac Surgery Is Effective, Feasible, and Safe

Patrick Lacomte, MD\* Anesth Analg 2008;107:51-8]

Figure 1. The Aalst Glycemia Insulin Protocol for cardiac surgery with cardiopulmonary bypass (80–110 mg/dL). C = column.

GLYC. RANGE mg/dL ↓	C 1 IU/h	C 2 IU/h	C 3 IU/h	C 4 IU/h <b>START</b>	C 5 IU/h	C 6 IU/h	C 7 IU/h	C 8 IU/h	C 9 IU/h	C 10 IU/h
>600	Do not use when glycemia > 600 mg/dL and/or in case of ketoacidosis									
451-600	4.4	8.8	13.2	17.6	22.0	26.4	30.8	35.2	39.6	44.0
385-450	3.6	7.2	10.8	14.4	18.0	21.6	25.2	28.8	32.4	36.0
334-384	3.0	6.0	9.0	12.0	15.0	18.0	21.0	24.0	27.0	30.0
290-333	2.5	5.0	7.5	10.0	12.5	15.0	17.5	20.0	22.5	25.0
251-289	2.1	4.2	6.3	8.4	10.5	12.6	14.7	16.8	18.9	21.0
217-250	1.7	3.4	5.1	7.2	8.5	10.2	11.9	13.6	15.3	17.0
188-216	1.4	2.8	4.2	5.6	7.0	8.4	9.8	11.2	12.6	14.0
163-187	1.2	2.4	3.6	4.8	6.0	7.2	8.4	9.6	10.8	12.0
151-162	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0
141-150	0.9	1.8	2.7	3.6	4.5	5.4	6.3	7.2	8.1	9.0
131-140	0.8	1.6	2.4	3.2	4.0	4.8	5.6	6.4	7.2	8.0
121-130	0.7	1.4	2.1	2.8	3.5	4.2	4.9	5.8	6.3	7.0
111-120	0.6	1.2	1.8	2.4	3.0	3.6	4.2	4.8	5.4	6.0
106-110	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0
101-105	0.4	0.9	1.3	1.8	2.2	2.7	3.1	3.6	4.0	4.5
96-100	0.4	0.8	1.2	1.6	2.0	2.4	2.8	3.2	3.6	4.0
91-95	0.3	0.7	1.0	1.4	1.7	2.1	2.4	2.8	3.2	3.5
85-90	0.3	0.6	0.9	1.2	1.5	1.8	2.1	2.4	2.7	3.0
80-84	0.2	0.5	0.7	1.0	1.2	1.5	1.7	2.0	2.3	2.5
75-79	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
70-74	0.1	0.3	0.4	0.6	0.7	0.9	1.0	1.2	1.3	1.5
60-69	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
< 60	0	0	0	0	0	0	0	0	0	0

IV insulin continuous infusion by pump  
(50IU Actrapid in 50 mL saline : 1mL = 1 IU)  
**START** in column 4

If glycemia range has decreased :  
**stay in same column**

If glycemia range has not decreased or increased :  
**go 1 column to the right**

If glycemia is between 85 – 110 mg/dL :  
**stay in same column**

If glycemia < 85 mg/dL :  
**go 1 column to the left !**  
(treat hypoglycemia if glycemia < 70 mg/dL)

BGL	G30%	ACTION
60-69	20 mL (1 amp = 6 g) IV push	Go 1 column to the left Check BGL after 15 min
50-59	30 mL (1½ amp = 9 g) IV push	Repeat if necessary
< 50	40 mL (2 amp = 12 g) IV push	Contact physician if BGL remains 2 x < 60 mg/dL.

During rewarms on cardiopulmonary bypass, go 3 columns to the right. Stay in the same column during the entire rewarms period, regardless of glycemic range. When esophageal temperature > 36°C, go 3 columns back to the left and continue protocol.

CONTACT ATTENDING PHYSICIAN WHEN :
BGL stays 2 x < 60 mg/dL after correction of hypoglycemia
BGL after normalization remains 2 x > 200 mg/dL
Insulin infusion > 24 IU/h
Infusion rate 2 x ≤ 0.2 mL/h
K <sup>+</sup> < 4 mEq/L
Oral feeding is restarted (transition to SC insulin)



# Kardiyak Cerrahi YB da İnsülin İnfüzyonu Gerektiren Durumlar

- ❑ Pre-operatif insülin tedavisi almakta olan
- ❑ İntra-operatif insulin infüzyon hızı  $>2$  U/h
- ❑ Hemodinamik durumu stabil olmayan
- ❑ YB da uzun kalması beklenen hastalar.

# SIKI-AGRESİF Glukoz Kontrolü Yararlı Değildir.

- ❑ VISEP: The Efficacy of Volume Substitution  
and insulin Therapy in Severe Sepsis, 2008
- ❑ NICE-SUGAR: Normoglycemia in Intensive Care  
valuation-Survival Using Glucose Algorithm Regulation,  
2009
- ❑ Glucontrol study. 2009

## Perioperative glycaemic control for diabetic patients undergoing surgery.

Buchleitner AM<sup>1</sup>, Martínez-Alonso M, Hernández M, Solà I, Mauricio D.

### SIKI-AGRESİF Glukoz Kontrolü Yararlı Değildir

- ❑ DM=694 Yoğun (İntensive) glisemik kontrol  
DM=709 Konvensyonel glisemik kontrol
- ❑ The Cochrane Library, MEDLINE, EMBASE, LILACS, CINAHL and ISIS (February 2012 ‘ e kadar).
- ❑ Randomised controlled 12 çalışma
- ❑ Perioperatif normoglisemi: 140-180 mg/dL,  
< 200 mg

## **Perioperative glycaemic control for diabetic patients undergoing surgery.**

Buchleitner AM<sup>1</sup>, Martínez-Alonso M, Hernández M, Solà I, Mauricio D.

Yoğun (İntensive) glisemik kontrol vs Konvensiyonel glisemik kontrol

Enfeksiyöz komplikasyonlar

Kardiyovaskular olaylar

Mortalite

arasında fark yok.

Hipoglisemi riski artmış

# KPB' lı Kardiyak Cerrahide Optimal İnsülin Tedavi Yöntemi

## Konensiyonel yöntemler

- ❑ Standart İnsülin Ted (İV, SC).
- ❑ Kombine intravenöz ve subkutanöz insülin
- ❑ Kombine İnsülin + glukoz+ K

## Agresive yöntemler

- ❑ Protokollerle belirlenen yöntemleri

# Perioperatif İnsülin Direncinin Yönetiminde Testler

## STANDART TESTLER

- ❑ AKŞ
- ❑ Oral glucose tolerans test
- ❑ Açlık plazma insülin

## DİNAMİK TEST;

- ❑ GLUKOZ CLAMP TEKNIĞİ; (GINF)
- ❑ IVGTT

## STATİK TEST

- ❑ QUICKI skoru:  
Quantitative Insulin Sensitivity:  
(log AKŞ + log açlık plazma insülin)
- ❑ HOMA-IR: homeostatic model assessment- insulin resistance

# Accuracy and precision of commonly used methods for quantifying surgery-induced insulin resistance

*Eur J Anaesthesiol* 2014; 31:110–116

**ALTIN  
STANDART**

Cerrahinin (total kalça rep, non-DM) neden olduğu

% 45 Hiperinsülinemik- Normoglisemik-glukoz clamp

% 26 IVGTT

% 4 QUICKI

% 3 HOMA

**STATİK TESTLER  
OLDUĞUNDAN DÜŞÜK  
ÖLÇÜYOR.**

Klamp tek: 5 mU/kg/h  
insülin sabit inf.  
% 50 DEX değişen hız  
inf. Normoglisemi

# Intraoperative Management of Hyperglycemia in the Cardiac Surgical Patient

Semin Thorac Cardiovasc Surg 18:330-338 © 2006 I

Table 1 Comparison of Published Insulin Protocols for Intraoperative Control of Glucose in Cardiac Surgery with CPB

Reference	Diabetic Subjects?	Hypothermic CPB?	Insulin Protocol Group	Comparison Group	Improved Intraoperative Glucose?	Improved Postoperative Glucose?
Kuntschen <sup>24</sup>	No	No	Hyperinsulinemic normoglycemic clamp (n = 9)	No treatment (n = 8)	Yes—normoglycemia achieved	Yes
Rassias <sup>11</sup>	Yes	No	Infusion (n = 13)	Sliding scale bolus (IV) (n = 13)	Yes, but not normoglycemic	Yes
Rassias <sup>9</sup>	No	No	Infusion (n = 15)	No treatment (n = 15)	No	Yes
Chaney <sup>10</sup>	No	Yes, 28°C	Infusion (n = 10)	No treatment (n = 10)	No	Yes
Groban <sup>65</sup>	No	Yes, 34°C	Infusion (n = 188)	Placebo (n = 193)	Yes, but not normoglycemic	Yes
Carvahlo <sup>67</sup>	Both yes and no	Yes, 32–34°C	Hyperinsulinemic normoglycemic clamp Diabetic (n = 10); nondiabetic (n = 7)	Sliding scale bolus (IV) Diabetic (n = 11); nondiabetic (n = 19)	Yes—normoglycemia achieved	Yes
Smith <sup>68</sup>	Yes	Yes, 32°C	Hyperinsulinemic normoglycemic clamp	Nondiabetics receiving no treatment	Yes—see text	Yes



# Diyabet Tanılı Hastalarda

- Preoperatif gliseminin kontrol altında olması  
intraoperatif hipergliseminin derecesini etkiler mi ?  
morbidite ve mortaliteye katkısı nedir ?
- 19 preoperatif risk değerlendirme skorlarından  
yalnızca 8 inde DM yer almaktadır.

# The Association of Preoperative Glycemic Control, Intraoperative Insulin Sensitivity, and Outcomes after Cardiac Surgery

J Clin Endocrinol Metab, September 2010, 95(9):4333–4344

iyi kontrol edilmiş DM ( $HbA_{1c} < \% 6.5$ ) vs edilmemiş DM ( $> 6.5$ )

TABLE 1. Demographics

	Non-DM	DM	
		$HbA_{1c} < 6.5\%$	$HbA_{1c} > 6.5\%$
n	143	61	60
Age (yr)	$65 \pm 14$	$68 \pm 9$	$66 \pm 10$
Body mass index ( $kg/m^2$ )	$27.5 \pm 5.1$	$28.5 \pm 5.7$	$29.2 \pm 5.9$
Gender (male/female)	100/44	43/18	48/12
<b><math>HbA_{1c}</math> (%)</b>	<b><math>5.4 \pm 0.3</math></b>	<b><math>6.1 \pm 0.3^*</math></b>	<b><math>7.6 \pm 0.9^{*h}</math></b>
Diabetes treatment	17 (12)	10 (16)	18 (30)
Euro score	$3.0 \pm 1.8$	$3.2 \pm 1.5$	$3.1 \pm 1.8$
Ejection fraction (%)	$52 \pm 11$	$51 \pm 12$	$50 \pm 12$
ACE inhibitors	79 (55.2)	36 (59.0)	42 (61.0)
$\beta$ -Blockers	98 (68.5)	47 (77.0)	48 (70.0)
Ca channel-blockers	34 (23.8)	21 (34.4)	20 (29.0)
Statins	98 (68.5)	48 (78.7)	54 (78.3)
Corticosteroids	6 (4.2)	2 (3.3)	3 (4.3)
Insulin	0	14 (23.0)	19 (27.5)
Thiazolidinediones	0	3 (4.9)	5 (7.2)
Biguanides	0	31 (50.8)	35 (50.7)
Sulfonylureas and meglitinides	0	14 (23.0)	16 (23.2)
Hematocrit (%)	$39.0 \pm 5.5$	$38.7 \pm 5.0$	$38.5 \pm 5.6$
Creatinine ( $mg/dL$ )	$1.3 \pm 1.0$	$1.3 \pm 1.1$	$1.4 \pm 1.1$
<b>Fasting blood glucose (<math>mmol/L</math>)</b>	<b><math>5.6 \pm 0.8</math></b>	<b><math>6.6 \pm 1.6^*</math></b>	<b><math>8.5 \pm 2.1^{*h}</math></b>
Mean aortic pressure (mm Hg)	$84 \pm 13$	$83 \pm 14$	$83 \pm 17$
CABG	86 (60.1)	35 (57.3)	43 (62.3)
Valve	29 (20.3)	12 (19.7)	12 (17.4)
CABG and valve	28 (19.6)	14 (23.0)	14 (20.3)
Aortic cross clamp time (min)	$85 \pm 33$	$84 \pm 28$	$86 \pm 31$
CPB time (min)	$104 \pm 42$	$107 \pm 45$	$108 \pm 43$
Minimum temperature during CPB ( $^{\circ}C$ )	$33.7 \pm 1.1$	$33.9 \pm 1.5$	$34.0 \pm 1.4$
Duration of surgery (min)	$218 \pm 63$	$217 \pm 55$	$211 \pm 56$

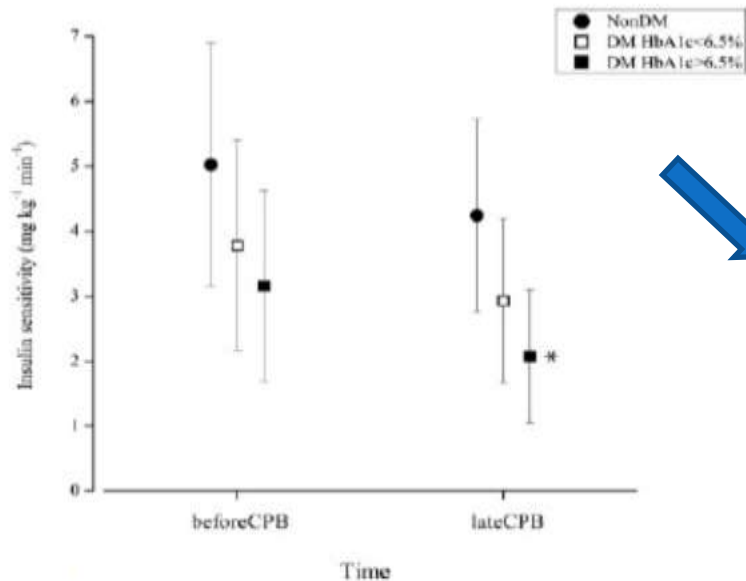
Data are expressed as mean  $\pm$  SD or number (percent). DM, Diabetes mellitus; ACE, angiotensin-converting enzyme.

\*  $P < 0.05$  non-DM vs. DM  $HbA_{1c} > 6.5\%$ .

<sup>h</sup>  $P < 0.05$  DM  $HbA_{1c} < 6.5\%$  vs. DM  $HbA_{1c} > 6.5\%$ .

<sup>\*</sup>  $P < 0.05$  non-DM vs. DM  $HbA_{1c} < 6.5\%$ .

Hb A1c arttıkça peri-operatif insülin duyarlılığı azalıyor.



**FIG. 1.** Insulin sensitivity in nondiabetic and diabetic patients before and during late CPB (DM HbA<sub>1c</sub> <6.5% = good glycemic control group; DM HbA<sub>1c</sub> >6.5% = poor glycemic control group). Data are expressed as means ± SD. The dextrose infusion rate

**TABLE 2.** Stepwise multiple regression analysis

Variable	$\beta$ -Coefficient	P
Nondiabetic patients		
Body weight (kg)	-0.301	<0.001
Fasting blood glucose (mmol/liter)	-0.180	0.015
Creatinine ( $\mu$ mol/liter)	0.142	0.049
Diabetic patients		
HbA <sub>1c</sub> (%)	-0.494	<0.001
Body mass index (kg/m <sup>2</sup> )	-0.222	0.004

Standardized  $\beta$ -coefficients of correlations between intraoperative insulin sensitivity and variables in nondiabetic and diabetic patients.

Hedef 150-200 mg/dL

## Diabetik Hastalarda Post-op Klinik Sonuçlar

**TABLE 3.** Outcomes

n	Non-DM	DM	
		HbA <sub>1c</sub> <6.5%	HbA <sub>1c</sub> >6.5%
	143	61	69
<b>Major complications</b>	9 (6.2)	7 (11.5)	12 (17.4) <sup>a</sup>
Death	3 (2.1)	2 (3.3)	4 (5.8)
IABP	3 (2.1)	1 (1.6)	2 (2.9)
Dialysis	2 (1.4)	1 (1.6)	3 (4.3)
Stroke	1 (0.7)	2 (3.3)	1 (1.6)
Severe Infection	3 (2.1)	2 (3.3)	6 (8.7) <sup>a</sup>
Septic shock	1 (0.7)	0 (0)	1 (1.4)
Pneumonia (requiring ventilation)	1 (0.7)	1 (1.6)	3 (4.3)
DSWI	1 (0.7)	1 (1.6)	2 (2.9)
<b>Other complications</b>			
Minor infection	14 (9.8)	8 (13.1)	19 (27.5) <sup>a,b</sup>
Pneumonia (not requiring ventilation)	5 (3.5)	3 (4.9)	5 (7.2)
Superficial wound infection	6 (4.2)	5 (8.2)	8 (11.6) <sup>a</sup>
UTI	8 (5.6)	4 (6.6)	8 (11.6)
Blood transfusion			
RBC	88 (61.5)	41 (67.2)	52 (75.4) <sup>a</sup>
Units/patient	3.0 (2.0–5.0)	2.5 (2.0–5.0)	3.0 (2.0–6.0)
FFP	34 (23.8)	19 (31.1)	26 (37.7) <sup>a</sup>
Units/patient	3.0 (2.0–4.0)	2.9 (2.1–4.0)	4.0 (2.0–6.6)
Platelets	27 (18.9)	18 (29.5)	28 (40.6) <sup>a</sup>
Units/patient	5.8 (5.0–10.0)	6.0 (5.0–7.5)	6.4 (5.0–10.2)
Blood glucose in ICU (mmol/liter)	7.8 ± 1.4	8.3 ± 1.9	9.3 ± 2.9 <sup>a,b</sup>
Creatinine (μmol/liter)	106 (90–131)	119 (100–144) <sup>c</sup>	135 (100–166) <sup>a</sup>
Intubation time (h)	7.8 (4.8–13.8)	8.8 (6.0–17.5)	9.3 (6.0–18.0)
ICU stay (h)	20 (19–26)	21 (20–44)	25 (20–46) <sup>a</sup>
Hospital stay (d)	8 (6–12)	8 (7–15)	11 (9–16) <sup>a</sup>

Data are expressed as number (percent), median (interquartile range), or mean ± sd. DM, Diabetes mellitus; IABP, intraaortic balloon pump; DSWI, deep sternal wound infection; UTI, urinary tract infection; RBC, red blood cell; FFP, fresh frozen plasma.

<sup>a</sup>  $P < 0.05$  non-DM vs. DM HbA<sub>1c</sub> >6.5%.

<sup>b</sup>  $P < 0.05$  DM HbA<sub>1c</sub> <6.5% vs. DM HbA<sub>1c</sub> >6.5%.

<sup>c</sup>  $P < 0.05$  non-DM vs. DM HbA<sub>1c</sub> <6.5%.

**The Association of Preoperative Glycemic Control, Intraoperative Insulin Sensitivity, and Outcomes after Cardiac Surgery** | Clin Endocrinol Metab, September 2010, 95(9):4338–4344

# Non- Diabetik Normoglisemik Kardiyak Cerrahi Hastalarında dis-GLİSEMİ ve İnsülin direnci insidansı nasıldır ?

Disglisemi: Açlık glukozu 108 - 126 mg/dL= 6-7 mmol/L

Diabetes : > 126 mg/dL= 7 mmol/L



# High Incidence of Insulin Resistance and Dysglycemia Amongst Nondiabetic Cardiac Surgical Patients

2012 by The Society of Thoracic Surgeons

## Non- Diabetik Normoglisemik

Table 1. Patient Metabolic Characteristics

Variable <sup>a</sup>	Male (n = 14)	Female (n = 3)	Total (N = 17)
Body mass index, kg/m <sup>2</sup>	28.9 ± 3.9	32.7 ± 4.4	29.8 ± 4.2
Waist circumference, cm	103 ± 12	108 ± 7.5	105 ± 11
FBG, mg/dL	97.3 ± 7.2	98.1 ± 7.3	97.3 ± 7.2
Fasting plasma insulin, mU/L	11.1 ± 7.6	9.1 ± 3.1	10.7 ± 6.9
Fasting C-peptide, pmol/mL	1.1 ± 0.5	0.9 ± 0.3	1.0 ± 0.4
HbA <sub>1c</sub> %	5.7 ± 0.2	5.6 ± 0.3	5.7 ± 0.3
Blood pressure, mm Hg			
Systolic	131 ± 21	138 ± 3	132 ± 19
Diastolic	77 ± 9	84 ± 4	78 ± 8
Lipid levels, mmol/L			
Total cholesterol	4.5 ± 0.9	4.9 ± 1.6	4.5 ± 1.0
Fasting triglyceride	1.9 ± 0.2	1.6 ± 0.3	1.8 ± 1.1
High-density lipoprotein	1.0 ± 0.3	1.3 ± 0.1	1.1 ± 0.3
GINF, mg/kg/min	3.4 ± 1.3	3.6 ± 2.1	3.5 ± 1.4
Glucose levels, mg/dL			
Peak intraoperative	158.6 ± 32.4 (118.9–227.0)	136.9 ± 45.0 (108.1–189.1)	154.9 ± 34.2 (108.1–227.0)
Mean postoperative	120.7 ± 14.4 (100.9–138.7)	126.1 ± 34.2 (100.9–154.9)	120.7 ± 16.2 (100.9–154.9)

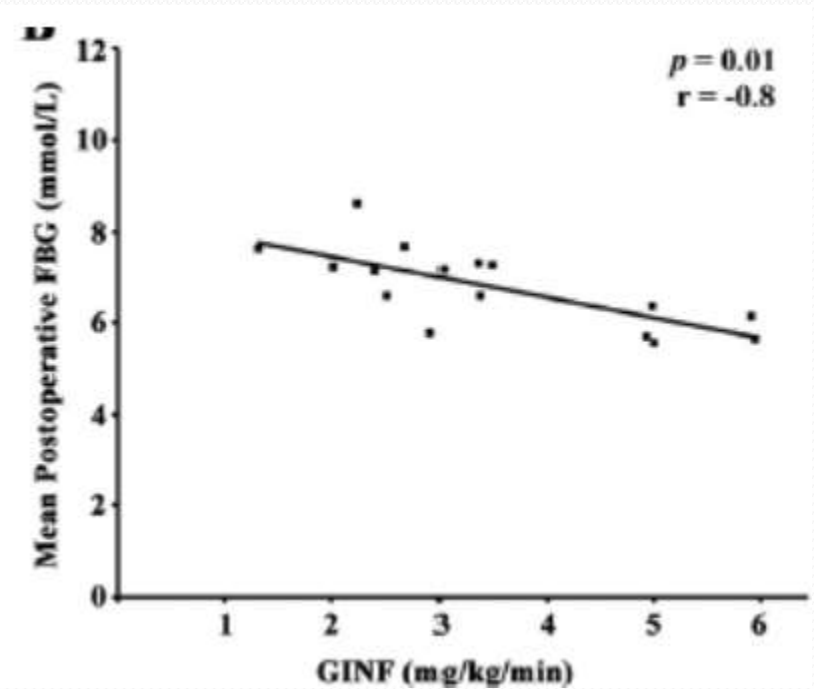
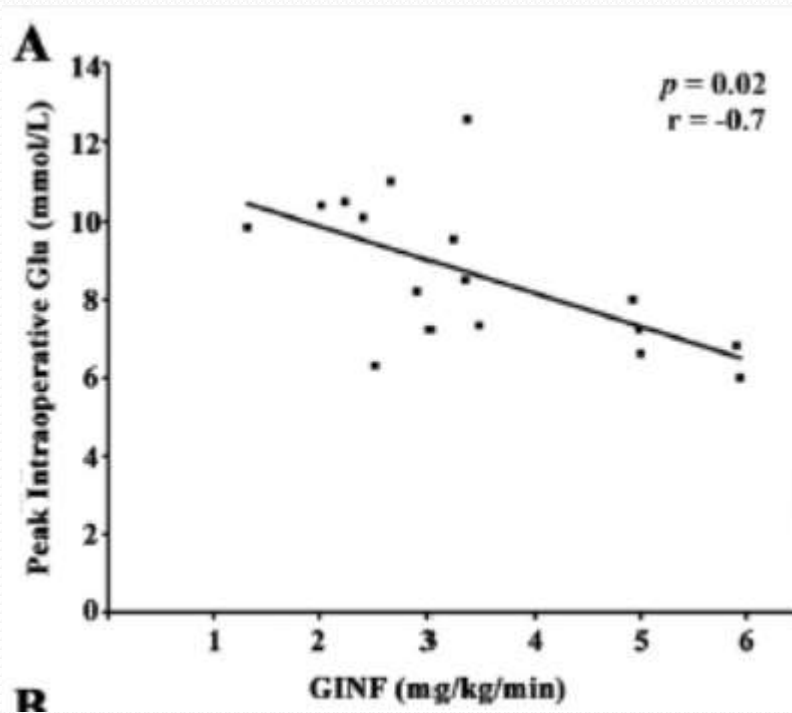
<sup>a</sup> Data expressed as mean ± standard deviation (range) unless otherwise specified.

FBG = fasting blood glucose; GINF = glucose infusion rate; HbA<sub>1c</sub> = glycosylated hemoglobin.

# High Incidence of Insulin Resistance and Dysglycemia Amongst Nondiabetic Cardiac Surgical Patients

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İnsülin sensitivitesi düştükçe glukoz düzeyleri artıyor



# High Incidence of Insulin Resistance and Dysglycemia Amongst Nondiabetic Cardiac Surgical Patients

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- Preoperatif insülin rezistansının derecesi perioperatif disgliseminin belirtecidir.
- Preoperatif AKŞ glikometabolik durumun kötü göstergesidir.

Table 3. Correlations Between Surrogate Measures of Insulin Resistance, Whole Body Insulin Sensitivity, and Perioperative Dysglycemia

Variable	GINF r Value	FBG	
		Intraop r Value	Postop r Value
Fasting insulin	-0.50 <sup>a</sup>	0.58	0.46
TG/HDL ratio	-0.47	0.35	0.34
HOMA-IR	-0.69 <sup>b</sup>	0.48	0.48
QUICKI	0.74 <sup>b</sup>	0.58 <sup>a</sup>	0.57 <sup>a</sup>

Data corrected for age and sex. Multivariate linear regression. <sup>a</sup> $p < 0.05$ ; <sup>b</sup> $p < 0.01$ .

FBG = fasting blood glucose; GINF = glucose infusion rate; HDL = high-density lipoprotein; HOMA-IR = homeostasis model assessment of insulin resistance; Intraop = intraoperative; Postop = postoperative; QUICKI = Quantitative Insulin Sensitivity Check Index; TG = triglyceride.



# Metabolik Sendromda KVS ve SVH etyolojisi

## Koagulasyon Faktörleri

**ARTMIŞTIR:**

### PRO-KOAGULAN EĞİLİM

- 1- Fibrinojen
- 2- von Willebrand F.
- 3- F VIII,
- 4- Doku plazminojen aktivatörü
- 5- Plazminojen aktivatör inh -1



**İNFLAMMATUAR YANIT ARTMIŞTIR**

### PRO-İNFLAMMATUAR EĞİLİM

- 1- IL-6 için genetik polimorfizm
- 2- CRP artma



## ' Deadly Quartet '

1. İnsülin Rezistansı
2. Obezite
3. Hipertansiyon
4. Dislipidemi

- KARDİYO-VASKÜLER HASTALIKLAR
- POST-OPERA. STROKE



# MS postoperatif strok ve ABY gelişiminde bağımsız risk faktörü müdür ?

> BM 125 kg/m<sup>2</sup>

Triglycerides >150

HDL < 40 mg/dL

TA >130/85 mmHg

TABLE 1. Comparison of characteristics based on the presence or absence of metabolic syndrome

	Metabolic syndrome (n = 551)	No metabolic syndrome (n = 632)	P value
Age (y), mean ± SD	59 ± 8	59 ± 9	.36
Male (%)	460 (84)	535 (85)	.63
Three-vessel disease, n (%)	381 (69)	427 (68)	.57
Left main coronary stenosis ≥ 50%, n (%)	60 (11)	81 (13)	.32
Unstable angina, n (%)	85 (15)	101 (16)	.81
Previous cardiac surgery, n (%)	5 (0.9)	2 (0.3)	.26
Emergency surgery, n (%)	13 (2.3)	18 (2.8)	.60
Left ventricular ejection fraction (%), mean ± SD	63.1 ± 13.5	62.5 ± 13.6	.40
Congestive heart failure, n (%)	3 (0.5)	4 (0.6)	1.00
Body mass index (kg/m <sup>2</sup> ), mean ± SD	24.4 ± 2.5	22.7 ± 2.3	<.0001
Diabetes mellitus, n (%)	179 (33)	95 (15)	<.0001
Fasting blood sugar (mean ± SD)	116 ± 34	103 ± 30	<.0001
Hypertension, n (%)	210 (38)	176 (28)	<.0001
COPD, n (%)	1 (0.2)	5 (0.8)	.22
Peripheral vascular disease, n (%)	24 (4.5)	24 (3.8)	.66
Cerebral vascular disease, n (%)	35 (6.4)	34 (5.4)	.54
Chronic kidney disease, n (%)	170 (31)	227 (36)	.07
Preoperative dialysis, n (%)	12 (2.2)	7 (1.1)	.17
Preoperative IABP, n (%)	5 (0.9)	7 (1.1)	.78
Systolic blood pressure (mm Hg), mean ± SD	132 ± 18	127 ± 17	<.0001
Diastolic blood pressure (mm Hg), mean ± SD	77 ± 12	74 ± 12	.0001
LDL cholesterol (mg/dL), mean ± SD	148.1 ± 47.0	152.7 ± 48.8	.101
HDL cholesterol (mg/dL), mean ± SD	37.6 ± 10.4	47.2 ± 13.2	<.0001
Triglycerides (mg/dL), mean ± SD	213.0 ± 112.0	141.9 ± 95.1	<.0001
Current smoker, n (%)	398 (72)	453 (72)	.84
<b>Preoperative medications</b>			
Nitrate, n (%)	510 (93)	581 (92)	.82
ACE inhibitor, n (%)	21 (3.8)	15 (2.4)	.002
Beta blocker, n (%)	242 (44)	222 (35)	.02
Calcium antagonists, n (%)	296 (54)	200 (32)	<.0001
Aspirin, n (%)	214 (39)	264 (42)	.31
Total bypass time (min), mean ± SD	158 ± 84	159 ± 57	.92
Use of LITA, n (%)	285 (54)	311 (52)	.54
Distal anastomoses (mean ± SD)	2.5 ± 0.8	2.4 ± 0.8	.50
Reexploration for bleeding, n (%)	10 (1.8)	12 (1.9)	1.0
Hospital stay (d), mean ± SD	26.8 ± 23.0	28.0 ± 23.3	.38

ACE, Angiotensin II converting enzyme; COPD, chronic obstructive pulmonary disease; HDL, high-density lipoprotein; IABP, intra-aortic balloon pump; LDL, low-density lipoprotein; LITA, left internal thoracic artery; SD, standard deviation.

**Metabolic syndrome is an independent risk factor for stroke and acute renal failure after coronary artery bypass grafting**

# Metabolic syndrome is an independent risk factor for stroke and acute renal failure after coronary artery bypass grafting

The Journal of Thoracic and Cardiovascular Surgery • March 2009

MS postoperatif strok ve ABY gelişiminde bağımsız risk faktörüdür.

KABG geçiren olguların  
% 47 si metabolik sendromlu.

Metabolic syndrome (n = 551)      No metabolic syndrome (n = 632)

TABLE 2. Comparison of in-hospital outcomes based on the presence or absence of metabolic syndrome

	Metabolic syndrome	No metabolic syndrome	P value
In-hospital death (%)	1.5	0.9	.44
Stroke (%)	4.7	2.1	.014
Acute renal failure (%)	3.9*	1.1*	.003
Myocardial infarction (%)	2.7	3.3	.51
Respiratory insufficiency (%)	22	21	.57
Mediastinitis (%)	2.2	1.1	.49
New onset of atrial fibrillation (%)	16	13	.32

\*Patients on preoperative dialysis were excluded.

TABLE 5. Results of multivariate analysis of risk factors for postoperative stroke and acute renal failure

	OR (95% CI)	P value
Stroke		
Metabolic syndrome	2.47 (1.22–4.99)	.012
History of cerebrovascular incidents	9.52 (4.50–20.2)	<.0001
Age	1.08 (1.03–1.13)	.001
Cardiopulmonary bypass time	1.01 (1.00–1.01)	.024
Acute renal failure		
Metabolic syndrome	3.81 (1.42–10.3)	.008
Chronic kidney disease	16.0 (6.45–39.8)	<.0001
Peripheral artery disease	4.85 (1.49–15.8)	.009
Postoperative low output syndrome	5.99 (1.60–22.4)	.008

OR, Odds ratio; CI, confidence interval.

## Preoperatif KH'lı sıvı almanın klinik metabolik sonuçları

- ❑ Cerrahi öncesi 6. saat 400 ml ve 2. saat 200 ml, 12.5% maltodextrin
- ❑ Kan glukozu hedefi  $<150$  mg/dL : OP ve YB da ilk 6 saatte.
- ❑ İnsülin direnci Homa-IR yöntemle değerlendiriliyor.

# Preoperatif KH'lı sıvı almanın klinik metabolik sonuçları

- YB ilk 6 saate glisemik kontrolde düzelme
- Hastane ve YB kalış süresinde kısalma
- Daha kısa süre dobutamin kullanımı
- İnsülin direnci üzerine etkili değil
- Hastanede morbidite ve mortaliteye etkisi yok.

Clinical and metabolic results of fasting  
abbreviation | with carbohydrates in coronary artery  
bypass graft surgery

Rev Bras Cir Cardiovasc 2012

# Sonuç

1. İntrooperatif glisemik kontrolün sağlanabilmesi için preoperatif glisemik kontrol sağlanmalıdır.
2. Kardiyak cerrahi olgularında glisemik takip kliniklerin belirledikleri intraoperatif ve yoğun bakım protokollerine uygun olarak yapılmalıdır.
3. Hipoglisemiden kaçınılmalıdır.
4. Postoperatif sonuçları işaret eden intraoperatif eşik insülin direnci seviyesi net değildir.

# TEŞEKKÜRLER ...

