

# KALP CERRAHİSİ SONRASI YÜKSEK LAKTAT NEDENLERİ; -MEZENTER İSKEMİSİ Mİ?

Dr. Nedim Çekmen

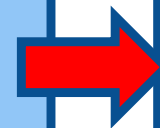
Güven Hastanesi Anesteziyoloji ve Reanimasyon  
Kliniği  
ANKARA

# Kalp cerrahisi sonrası gelişen GIS komplikasyonları

**En sık görülen komplikasyonlar: (% 0.3-1)**

- GIS kanaması(en sık)
- Paralitik ileus
- Divertikülit
- Kolesistit
- Akut Pankreatit
- Kolon perforasyonu
- Mezenter iskemi**
- KC yetmezliği

(Mortalite: % 14.1)  
Postop ölümlerin % 15'i



**-Mezenter iskemi**

- % 10-67 sıklıkta
- En letal komp
- Mortalite %70-100

# **GIS komplikasyonları gelişmesine neden olan risk faktörleri**

## **Hastaya ait faktörler**

- .Yaş
- .EF düşüklüğü veya KKY
- .Renal yetmezlik
- .DM

## **Kalp cerrahisi özellikleri**

- .Acil cerrahi
- .Reoperasyon
- .Kapak cerr/kombine cerr
- .Kalp Transp

## **KPB özellikleri**

- .KPB süresi
- .Kros-klemp süresi
- .Non-pulsatil akım
- .Hipotermi

## **Postoperatif özellikler**

- .Düşük kalp debisi
- .İnotrop/vazopressör kullanımı
- .İABP kullanımı
- .Revizyon
- .Renal yetmezlik
- .Ritm bozukluğu
- .Uzamış MV
- .Uzamış YBÜ'de kalış süresi

# Akut Mezenter İskemi: Tanım

- Primer hastalığın veya, geçirilmiş cerrahi girişimin komplikasyonu

- Düşük kalp debisi

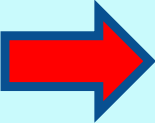
- Splanchnik hipoperfüzyon

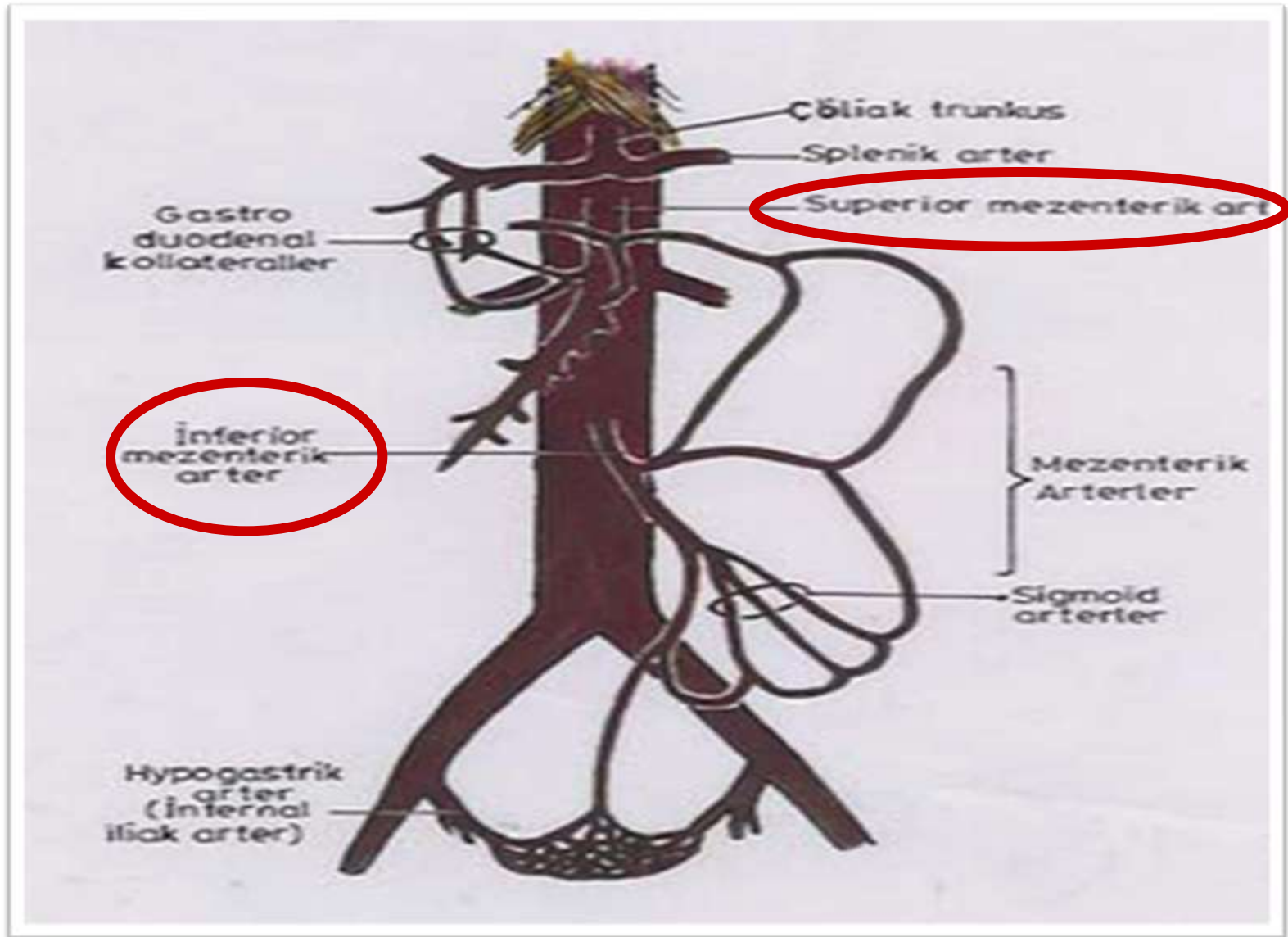


- Gastrointestinal traktusa yeterli kan akımının sağlanamaması

- Oksijen gereksiniminin karşılanamaması

# Akut Mezenter İskemide Etyoloji

- 1-Arteriyel embolizm (% 40-50)
- 2-Arteriyel tromboz (% 18-25)
- 3-Nonokluziv mezenter iskemi (% 20)  Kalp cerrahisi sonrası en sık görülen
- 4-Mezenter ven trombozu (% 5)



# Acute Mesenteric Ischemia: A Diagnostic Challenge in Clinical Practice

by Mamata Ravipati, Srikanth Katragadda

PRACTICAL GASTROENTEROLOGY • AUGUST 2011

**Table 1.**  
**The Four Causes of Abdominal Ischemia**

| <i>Types of Mesenteric Ischemia</i>                                             | <i>Acute mesenteric arterial embolism</i>                                                                   | <i>Acute mesenteric arterial thrombosis</i>                                                                 | <i>Non-occlusive mesenteric ischemia</i>                                                                    | <i>Mesenteric venous thrombosis</i>                                                                         |
|---------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------|
| <b>Pathology</b>                                                                | Atrial fibrillation, MI, valvular disease, left ventricular aneurysm                                        | Atherosclerotic disease, superimposed on trauma, infection                                                  | Systemic hypoperfusion from cardiac failure, sepsis, medications                                            | Hypercoagulable states, blunt trauma, infection, portal hypertension, pancreatitis, portal malignancy       |
| <b>Clinical Manifestation</b>                                                   |                                                                                                             |                                                                                                             |                                                                                                             |                                                                                                             |
| <i>Early</i>                                                                    | Abrupt onset of abdominal pain;                                                                             | Gradual onset of postprandial pain, nausea, bowel changes;                                                  | Gradual onset of malaise and abdominal discomfort;                                                          | Subacute onset of abdominal pain;                                                                           |
|                                                                                 | Minimal physical findings                                                                                   | Minimal physical findings                                                                                   | Minimal physical findings                                                                                   | Minimal physical findings                                                                                   |
| <i>Late</i>                                                                     | Increasing pain, gross distention, absence of bowel sounds, mental status changes, peritoneal signs, sepsis | Increasing pain, gross distention, absence of bowel sounds, mental status changes, peritoneal signs, sepsis | Increasing pain, gross distention, absence of bowel sounds, mental status changes, peritoneal signs, sepsis | Increasing pain, gross distention, absence of bowel sounds, mental status changes, peritoneal signs, sepsis |
| <b>Diagnostic Study</b>                                                         | Angiography                                                                                                 | Angiography                                                                                                 | Angiography                                                                                                 | Angiography                                                                                                 |
| <b>Treatment</b>                                                                |                                                                                                             |                                                                                                             |                                                                                                             |                                                                                                             |
| <i>All types</i>                                                                | Superior mesenteric embolectomy;                                                                            | Surgical revascularization                                                                                  | Vasodilator therapy (Papaverine)                                                                            | Anticoagulant therapy (Heparin)                                                                             |
| Hemodynamic support, correction of acidosis, antibiotics, gastric decompression | Chronic anticoagulation                                                                                     |                                                                                                             |                                                                                                             |                                                                                                             |
| <b>Presence of Bowel Infarct</b>                                                | Surgery                                                                                                     | Surgery                                                                                                     | Surgery                                                                                                     | Surgery                                                                                                     |



# Akut Mezenter İskemide Klinik

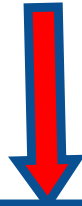
- Şiddetli karın ağrısı (% 94),
- Barsak seslerinin yokluğu,
- Gaz-gaita çıkışının azalması,
- Bulantı-kusma
- Diyare
- Abdominal distansiyon
- Melena
- Hemodinamik instabilite (ateş,hipotermi, taşikardi,takipne, bilinç değişiklikleri)



# Yoğun bakımda Akut Mezenter İskemi

Hastanın prezentasyonu farklı

- Entübe
- MV'ye bağlı
- Sedatize
- Kritik
- İletişimi zor



Tanıyı koymak zordur.

# Kalp cerrahi sonrası Yoğun bakımda

- Karın ağrısı veya hassasiyet
- Batın distansiyonu (obstrüksiyon dışı)
- Diyare/GİS kanama
- Laktat yüksekliği
- Ateş ve lökositoz
- CRP yüksekliği
- Metabolik asidoz
- Açıklanamayan sepsis veya MOF



**Akut Mezenter İskemi**

# Kalp cerrahi sonrası Yoğun bakımda AMİ Tanısı

## Labaratuvar testleri

- Hiperlaktatemi
- D-dimer,
- $\alpha$ -GST,
- I-FABP
- Lökositosiz
- CRP yüksekliği
- Amilaz yüksekliği
- Metabolik Asidoz
- Hiperosmolarite
- Hiperkalemi
- Kreatinin yüksekliği
- CK,CPK,LDH,AST/ALT,ALP

## Radyolojik testler

- Direkt Batın Grafisi
- USG
- Bilgisayarlı Tomografi
- Selektif Anjiyografi

# Kalp cerrahi sonrası Yoğun bakımda AMİ

## Direkt Batın Grafisi



- Hava-sıvı seviyeleri
- Barsak duvarında kalınlaşma-ödem



## Bilgisayarlı Tomografi



- Barsak duvarında kalınlaşma-Dilatasyon
- Barsak duvarında kontrast tutulumunun az olması-hiç olmaması
- Pneumatisis intestinalis (%6-%30)
- Portomezenterik hava (%3-14)

# Kalp cerrahi sonrası Akut Mezenter İskemide

Tanıda en önemli basamak



**Şüphelenmektir**

# Kalp cerrahi sonrası Akut Mezenter İskemide tedavi

- Monitorizasyon ve hemodinamik stabilite
- Agresif sıvı tedavisi
- NG dekompresyon
- Genis spektrumlu antibiyotik
- Alfa adrenerjik ajanların kesilmesi
- Kardiyak destek (İnotrop)
- Kan akımının restorasyonu (Papaverine, trombolitik/cerr embolektomi)
- Laparotomi

# Laktat neden yükselir?

-Laktat global doku perfüzyonunun değerlendirilmesinde sıklıkla kullanılan bir markerdir.

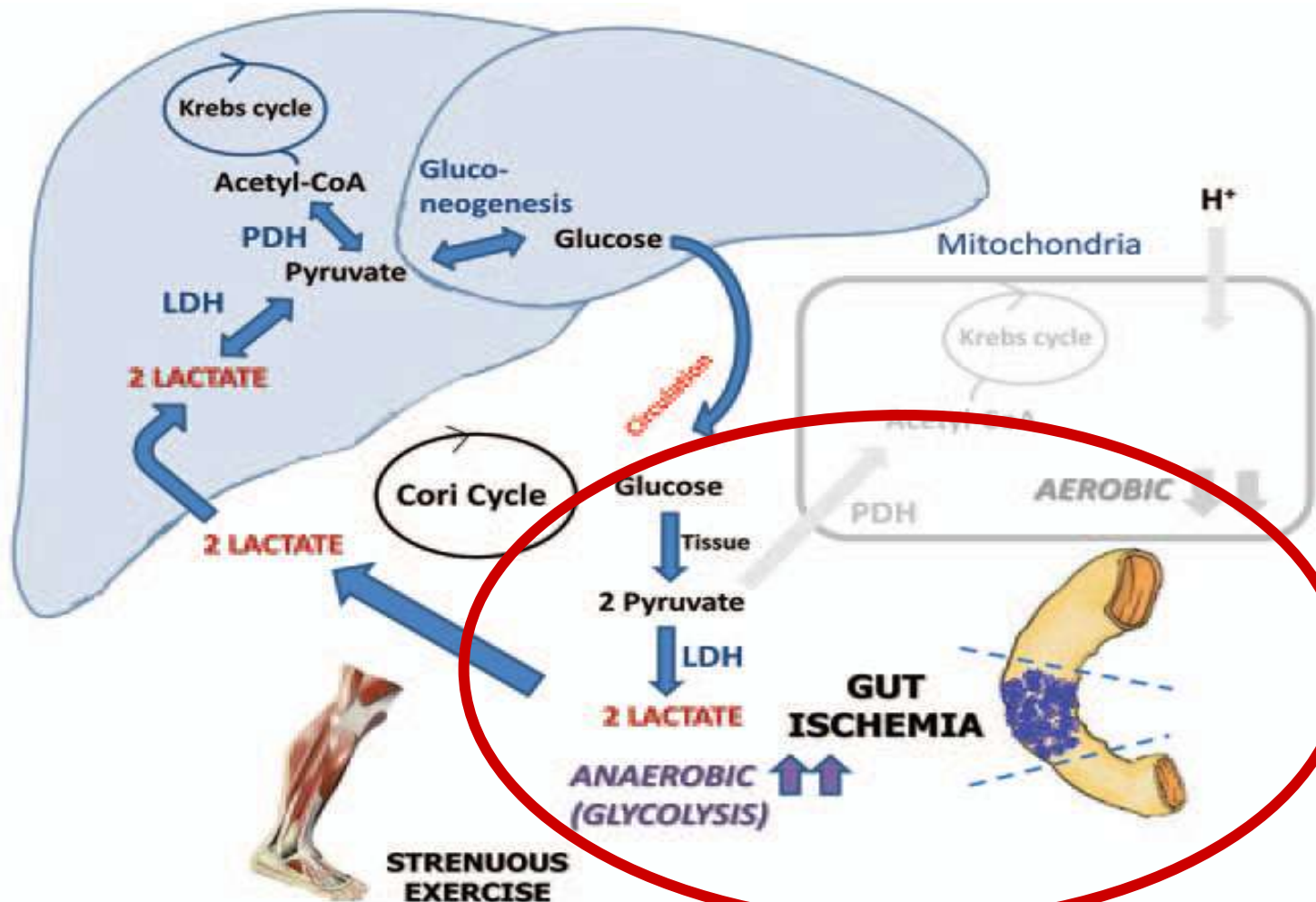
-Laktat yüksekliği sıklıkla yetersiz oksijen taşınması veya bozulmuş doku oksijenizasyonunun görüldüğü anaerobik metabolizmanın bir sonucu olarak gelişir.



# Beyond Lactate: Is There a Role for Serum Lactate Measurement in Diagnosing Acute Mesenteric Ischemia?

Ihsan Ekin Demir   Güralp O. Ceyhan   Helmut Friess

Dig Surg 2012;29:226–235



# Kalp cerrahi sonrası;laktat yüksekliği

- **Laktat yüksekliği** → Gelişebilecek komplikasyonların saptanmasında erken uyarıcı ve yararlı olabilir.
- **Laktat yüksekliğinin nedeni** → Mezenter iskemi olabilir.
- Mezenter iskemi için → laktat düzeyi bir tanısal test olarak kullanılmaktadır.
- **Laktat yüksekliği** → Uzun süreli yoğun bakım ve hastane kalış süresi ile ilişkili olup, postoperatif artmış morbidite ve mortaliteyle de ilişkilidir.

# Kalp cerrahi sonrası laktat yüksekliğinde risk faktörleri

Kalp cerrahisi sonrası;

- Aterosklerotik hastalar (%100)
- Yaş>70 (%91.7)
- Hiperosmotik dehidratasyon (%100)
- Kardiyak iskemi (%25)
- DM
- Renal yetmezlik
- Konjesif kalp yetmezliği

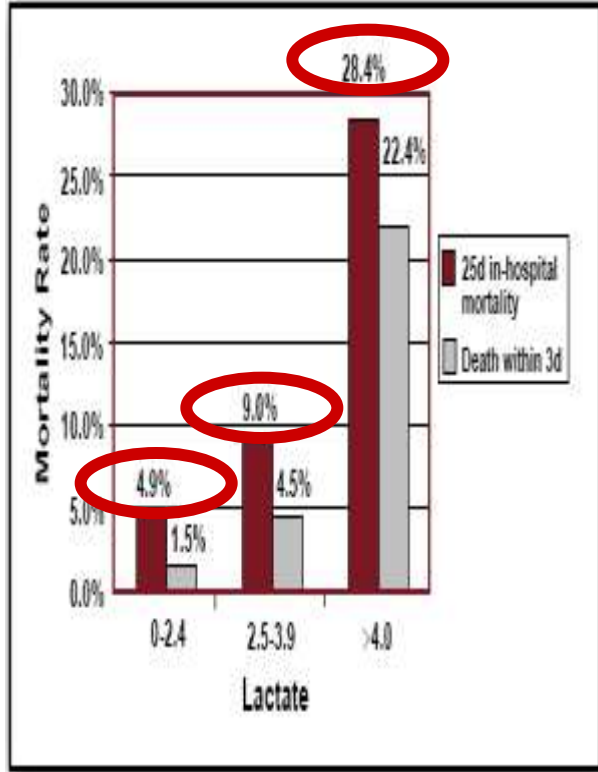


Figure 4. Lactate as a predictor of mortality.<sup>12</sup> Reprinted with permission from Shapiro et al. Ann Emerg Med. 2005; 45:524-28.

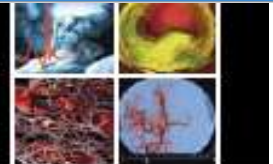
## Hiperlaktatemi

↑ Lactate > 2.0 mmol/L

Hafif  
Laktat 2.0-4.0

Şiddetli  
Laktat > 4.0

# LACTATE – A MARKER FOR SEPSIS AND TRAUMA



**Andra L. Blomkalns, MD**

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[www.emcreg.org](http://www.emcreg.org)

**Table 1. Causes of Lactic Acidosis**

| <b>Inadequate oxygen delivery</b>        | <b>Disproportionate oxygen demands</b> | <b>Inadequate oxygen utilization</b>                                                     |
|------------------------------------------|----------------------------------------|------------------------------------------------------------------------------------------|
| Volume depletion or profound dehydration | Hyperthermia                           | Systemic inflammatory response syndrome                                                  |
| Significant blood loss                   | Shivering                              | Diabetes mellitus                                                                        |
| Septic shock                             | Seizures                               | Total parenteral nutrition                                                               |
| Profound anemia                          | Strenuous exercise                     | Thiamine deficiency                                                                      |
| Severe hypoxemia                         |                                        | HIV infection                                                                            |
| Prolonged carbon monoxide exposure       |                                        | Drugs such as metformin, salicylate, antiretroviral agents, isoniazid, propofol, cyanide |
| Trauma                                   |                                        |                                                                                          |

# OLGU

**63 yaşında erkek hasta**

- EF %40, PAB=20 mmHg
- SFT, labaratuar tetkikleri ve FM normal
- PA Akciğer grafisi normal
- Euroscore:2 (Düşük Risk)

**Hastaya üçlü KABG planlandı(Standart anestezi altında)**

- Total Bypass zamanı 150 dk,
- Kros klemp zamanı ise 86 dk idi
- İntraoperatif inotrop kullanımı vardı

Hasta postop 12. saatinde ekstübe edildi.

Hastanın AKG, vital bulguları ve idrar çıkışı normaldi.

Postop 2. gün

HİPOTANSİYON

SIVI REPLASMANI

DOPAMİN

DOBUTAMİN

İABP 1:1

-Laktat 8.4 mmol/L

-Metabolik asidoz,

-Lökositoz,

-CRP yüksekliği,

-pH 7.20, pO<sub>2</sub> 53 mmHg

PA AKC GRAFİSİ

Minimal Plevral Effüzyon

EKO → Minimal  
Perikardiyal Effüzyon,  
Tamponad Ve Trombus Yok

Postop 3. gün

DİSTANSİYON

BARSAK SESLERİNDE  
AZALMA

GAZ-GAİTA ÇIKIŞI  
MİNİMAL

EPIGASTRİK AĞRI

GAİTADA GİZLİ  
KAN(+++)

- NG DEKOMPRESYON
- MEDİKAL TEDAVİ
- REKTAL TUŞE
- LAVMAN
- GENEL CERR KONS.

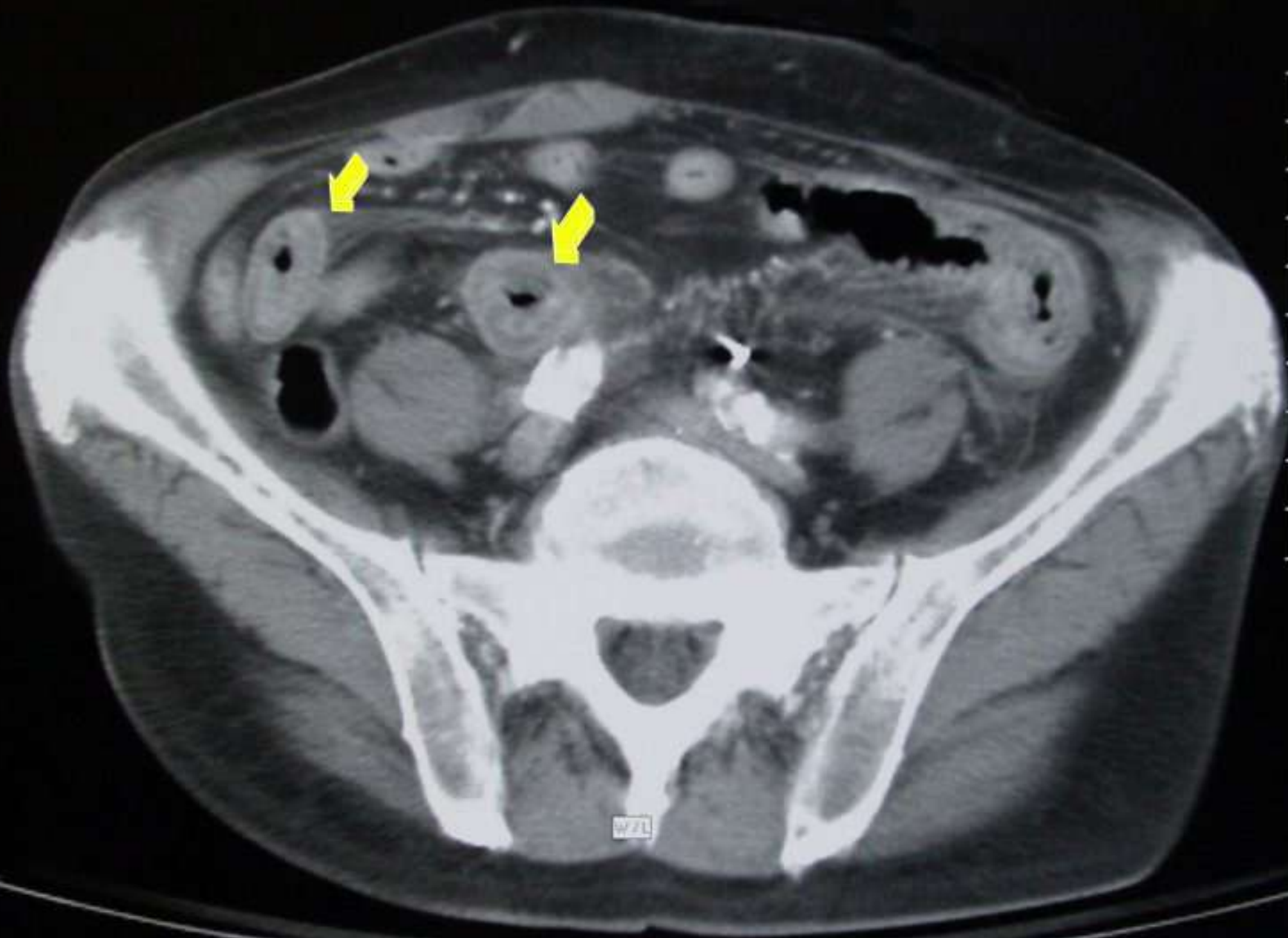
**BATIN BT**

- BARSAK DUVARINDA  
KALINLASMA
- DİLATASYON
- BARSAK DUVARINDA  
KONTRAST TUTULUMUNUN  
AZ OLMASI-HİÇ OLMAMASI

MEZENTER İSKEMİ

LAPARATOMİ





# TEDAVİ

MEZENTER İSKEMİ



Laparotomi

ARDS



Koruyucu MV

MOY



Destekleyici ted



Hasta postoperatif 25. gününde septik şok ve multipl organ yetmezliğinden kaybedildi.

GLASKOW: 6

APACHE II: 46

MODS: 16

Hastamızda  
mezenter  
iskeminin  
esas nedeni



Düşük kalp  
debisi



Splanknik  
hipoperfüzyon



RESEARCH ARTICLE

Open Access

## Postoperative abdominal complications after cardiopulmonary bypass

Guohua Dong, Canhui Liu, Biao Xu, Hua Jing, Demin Li and Haiwei Wu\*

**Table 2** The incidence and the mortality of various abdominal complications

| Complications              | Patients | Incidence (%) | Laparotomies | Deaths | Mortality (%) |
|----------------------------|----------|---------------|--------------|--------|---------------|
| Paralytic ileus            | 11       | 33.3          | 0            | 0      | 0             |
| Gastrointestinal bleeding  | 9        | 27.3          | 1            | 1      | 11.1          |
| Gastroduodenal perforation | 2        | 6.1           | 2            | 0      | 0             |
| Calculus cholecystitis     | 2        | 6.1           | 2            | 0      | 0             |
| Acalculus cholecystitis    | 3        | 9.1           | 0            | 0      | 0             |
| Hepatic dysfunction        | 4        | 12.1          | 0            | 2      | 50            |
| Ischemic bowel disease     | 2        | 6.1           | 2            | 2      | 100           |
| TOTAL                      | 33       | 1.4           | 7            | 5      | 15.2          |

*Clinical  
Investigation*

Giuseppe D'Ancona, MD  
Richard Baillot, MD  
Brigitte Poirier, MD  
Francois Dagenais, MD  
José Ignacio Saez de  
Ibarra, MD  
Richard Bauset, MD  
Patrick Mathieu, MD  
Daniel Doyle, MD

# Determinants of Gastrointestinal Complications in Cardiac Surgery

*Texas Heart Institute Journal* 2003;30:280-5)

Distribution of 147 GI Complications in 129 Cardiac Surgery Patients

| Type of GI Complication | No. (%)   |
|-------------------------|-----------|
| Upper GI bleeding       | 42 (28.6) |
| Gastroesophagitis       | 18 (12.2) |
| Colitis                 | 18 (12.2) |
| Intestinal ischemia     | 17 (11.5) |
| Pancreatitis            | 13 (8.8)  |
| Cholecystitis           | 10 (6.8)  |
| Perforated peptic ulcer | 7 (4.7)   |
| Diverticulitis          | 5 (3.4)   |
| Intestinal occlusion    | 2 (1.1)   |
| Lower GI bleeding       | 1 (0.7)   |
| Mixed complications     | 14 (9.5)  |
| Total                   | 147       |

GI = gastrointestinal

*Clinical  
Investigation*

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# Determinants of Gastrointestinal Complications in Cardiac Surgery

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**TABLE II.** Intra- and Postoperative Variables, Including Morbidity and Mortality

| Intra- and Postoperative Variables | GI Complications    |                           | P Value |
|------------------------------------|---------------------|---------------------------|---------|
|                                    | With (%)<br>(n=129) | Without (%)<br>(n=10,929) |         |
| Postoperative IABP                 | 6 (4.6)             | 163 (1.5)                 | <0.005  |
| Reoperation for bleeding           | 15 (11.6)           | 635 (5.8)                 | <0.01   |
| Perioperative AMI                  | 6 (4.6)             | 327 (2.9)                 | <0.05   |
| Acute renal failure                | 36 (27.9)           | 656 (6.0)                 | <0.0001 |
| Prolonged ventilation              | 53 (41.1)           | 624 (5.7)                 | <0.0001 |
| Deep sternal infection             | 8 (6.2)             | 110 (1.0)                 | <0.0001 |
| Sepsis                             | 18 (14)             | 92 (0.8)                  | <0.0001 |
| Cerebrovascular accident           | 18 (13.9)           | 296 (2.7)                 | <0.0001 |
| Valve surgery                      | 30 (23.2)           | 1,768 (16.1)              | <0.0001 |
| CABG plus valve surgery            | 21 (16.3)           | 930 (8.5)                 | <0.0001 |
| Perfusion time                     | 106.9 ± 41.3        | 90.7 ± 39.3               | <0.0001 |
| Cross-clamp time                   | 69.3 ± 76.0         | 60.4 ± 61.0               | <0.0001 |
| Mortality rate                     | 29 (22.5)           | 431 (4)                   | <0.0001 |

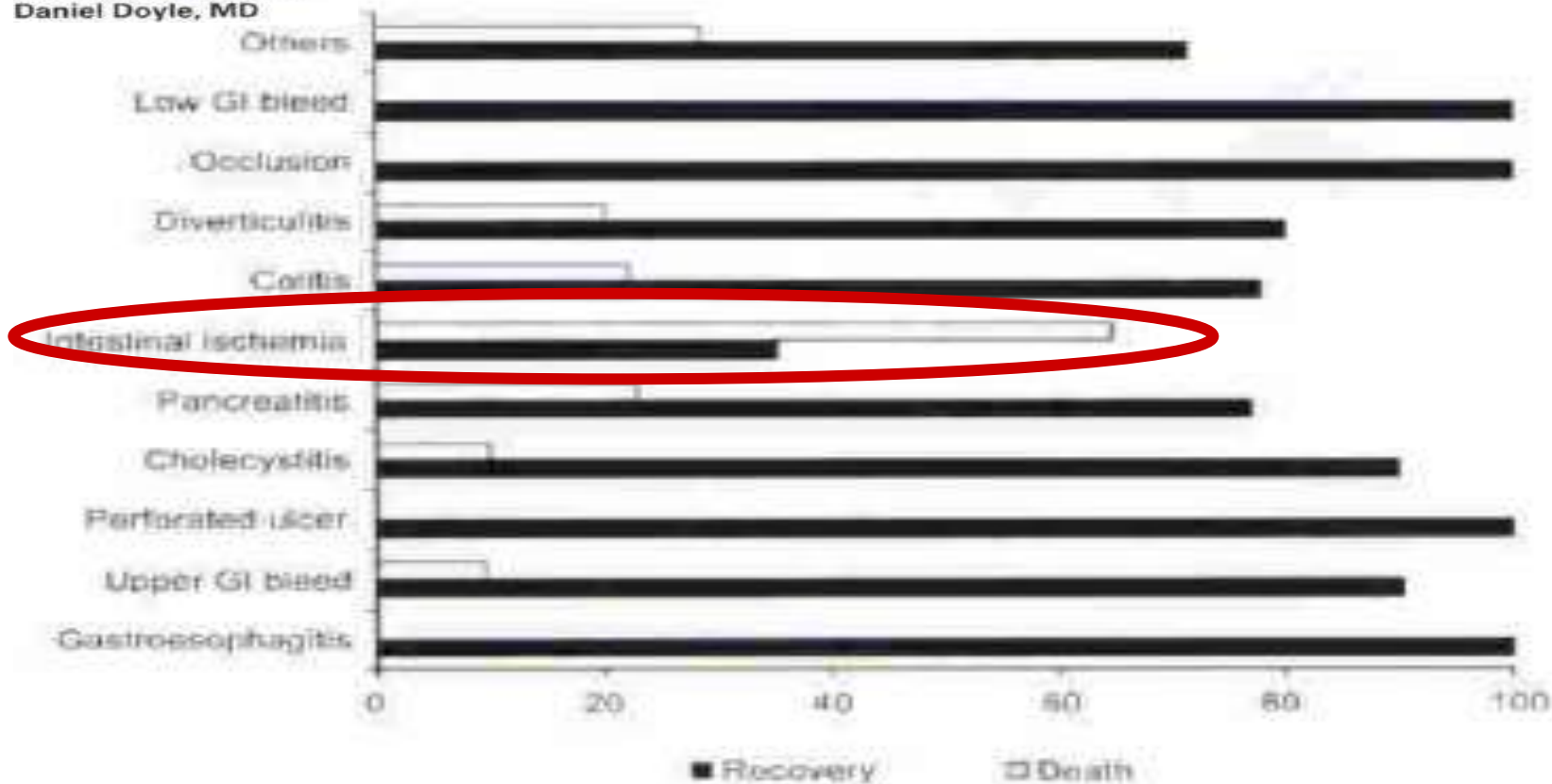
AMI = acute myocardial infarction; CABG = coronary artery bypass grafting; GI = gastrointestinal; IABP = intra-aortic balloon pump

*Clinical  
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# Determinants of Gastrointestinal Complications in Cardiac Surgery

*Texas Heart Institute Journal* 2003;30:280-5)



**Fig. 1** Mortality rate by gastrointestinal (GI) complication.



# Institutional report - Cardiopulmonary bypass

## Incidence and outcome of gastrointestinal complications after cardiopulmonary bypass

Hans J. Geissler<sup>a,\*</sup>, Uwe M. Fischer<sup>a</sup>, Stephanie Grunert<sup>a</sup>, Ferdinand Kuhn-Régnier<sup>a</sup>, Arnulf Hoelscher<sup>b</sup>, Robert H.G. Schwinger<sup>c</sup>, Uwe Mehlhorn<sup>a</sup>, Khosro Hekmat<sup>a</sup>

Interactive CardioVascular and Thoracic Surgery 5 (2006) 239-242

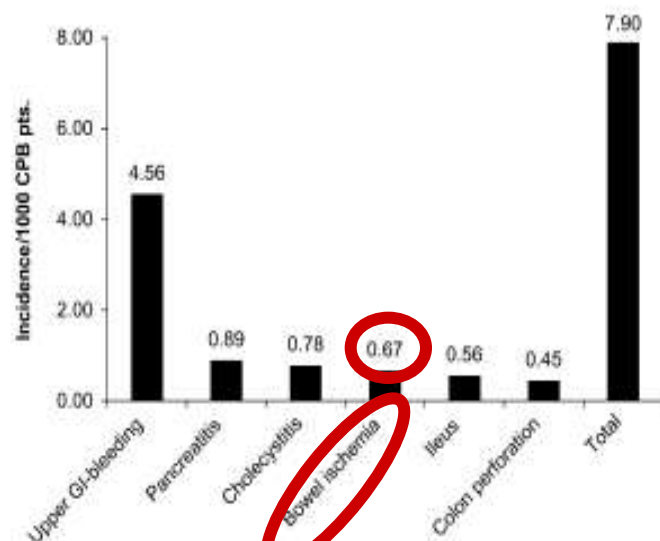


Fig. 1. Incidence of gastrointestinal (GI-) complications per 1000 CPB patients.

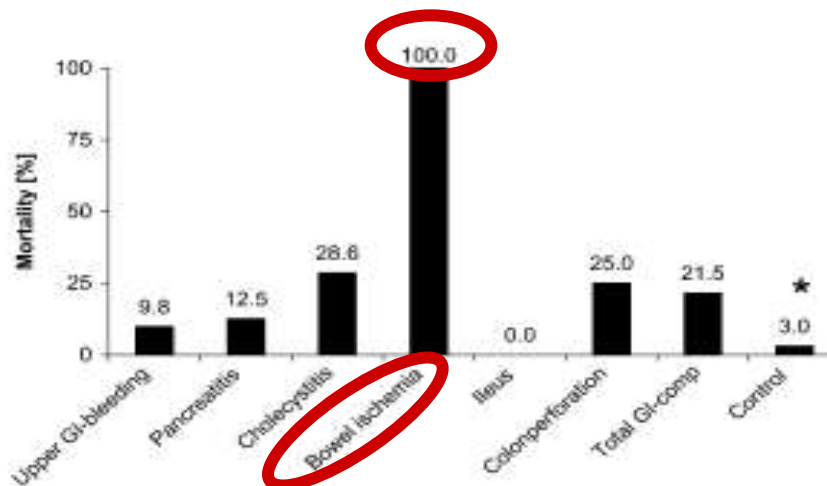


Fig. 2. Mortality of different GI-complications and control in comparison. Total mortality of patients with GI-complications after CPB was 21.5% in comparison to 3.0% in controls (\* $P < 0.05$ ).



# Current status on plasma biomarkers for acute mesenteric ischemia

Stefan Acosta • Torbjörn Nilsson

J Thromb Thrombolysis (2012) 33:355–361

**Table 2** Overview of studied plasma biomarkers for acute mesenteric ischemia in humans

| First author   | Publication year | Studied marker(s)                   | Patients in study | Control group                                   | Study design | Sensitivity (%) | Specificity (%) |
|----------------|------------------|-------------------------------------|-------------------|-------------------------------------------------|--------------|-----------------|-----------------|
| Lange [11]     | 1994             | L-lactate                           | 85                | Acute abdomen                                   | Prospective  | 100             | 42              |
| Murray [28]    | 1994             | D-lactate                           | 31                | Emergency laparotomy                            | Prospective  | 90              | 87              |
| Kanda [30]     | 1996             | I-FABP                              | 61                | Hospitalized patients with acute abdominal pain | Prospective  | 100             | 96              |
| Delaney [26]   | 1999             | $\alpha$ -Glutathione S-transferase | 26                | Suspected AMI                                   | Prospective  | 100             | 86              |
| Lieberman [31] | 1997             | I-FABP                              | 22                | SIRS                                            | Prospective  | 92              | 0               |
| Acosta [17]    | 2001             | D-dimer                             | 14                | Suspected AMI                                   | Prospective  | 100             | 38              |
| Gearhart [27]  | 2003             | $\alpha$ -Glutathione S-transferase | 58                | Suspected AMI                                   | Prospective  | 72              | 77              |
|                |                  | L-lactate                           |                   |                                                 |              | 78              | 53              |
| Acosta [10]    | 2004             | D-dimer                             | 101               | Suspected AMI                                   | Prospective  | 100             | 36              |
| Block [18]     | 2008             | D-dimer                             | 71                | Suspected AMI                                   | Prospective  | 100             | 44              |
|                |                  | LD isoenzymes                       |                   |                                                 |              | 80 (LD2)        | 67 (LD2)        |
|                |                  | ALP isoenzymes                      |                   |                                                 |              | 80 (ALP liver)  | 64 (ALP liver)  |
| Polk [60]      | 2008             | Cobalt-albumin                      | 26                | Need of explorative laparotomy                  | Prospective  | 100             | 86              |
| Chiu [19]      | 2009             | D-dimer                             | 67                | Suspected AMI                                   | Prospective  | 96              | 18              |
| Thuijls [29]   | 2011             | U-FABP                              | 46                | Suspected AMI                                   | Prospective  | 90              | 89              |
|                |                  | I-FABP                              |                   |                                                 |              | 68              | 71              |

# Beyond Lactate: Is There a Role for Serum Lactate Measurement in Diagnosing Acute Mesenteric Ischemia?

Dig Surg 2012;29:226–235

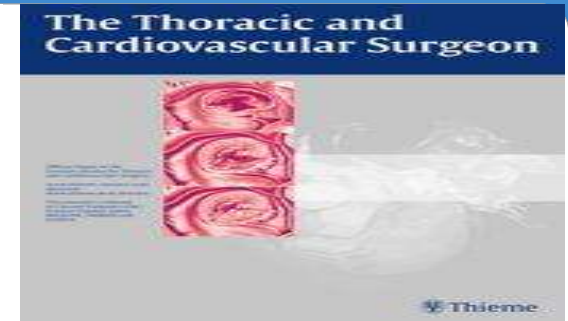
Ihsan Ekin Demir   Güralp O. Ceyhan   Helmut Friess

**Table 1.** Clinical studies on the sensitivity, specificity and accuracy of L-lactate, the commonly used lactate isoform in diagnosing mesenteric ischemia

| Investigators               | Study design                                                                                               | Lactate in mesenteric ischemia                                     | Limitations                                                                                                                        | Evaluation                                                                                                                       |
|-----------------------------|------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------|
| Lange and Jackel 1994 [4]   | prospective study patients with acute abdomen<br>n = 85<br>blood sampling before operation/final diagnosis | elevated lactate in all cases of mesenteric ischemia (n = 20)      | elevated lactate in: all cases of bacterial peritonitis; some cases of intestinal obstruction (10 out of 20)                       | very low specificity (42%)<br>no remark on the elevation time course of lactate                                                  |
| Meyer et al. 1998 [17]      | retrospective study patients with clinically suspected mesenteric ischemia<br>n = 46                       | elevated lactate in over 90% of mesenteric ischemia cases          | 16 out of a total of 22 patients with mesenteric ischemia were diagnosed via clinical suspicion and angiography                    | elevated serum lactate does not prove mesenteric ischemia                                                                        |
| Lange and Toivola 1997 [20] | prospective study patients with abdominal complaints<br>n = 120                                            | elevated lactate in 24 out of 25 patients with mesenteric ischemia | elevated lactate in: 20 out of 20 general bacterial peritonitis patients; 6 out of 20 acute pancreatitis patients                  | very low specificity (36%)<br>no remark on the elevation time course of lactate                                                  |
| Gearhart et al. 2003 [56]   | prospective study patients with clinically suspected mesenteric ischemia<br>n = 58                         | elevated lactate in 24 out of 31 patients with intestinal necrosis | significant elevation not present when subanalysis performed with small bowel and colonic necrosis                                 | 78% sensitivity<br>53% specificity<br>accuracy of mere 47–69%<br>only significant in necrotic, but not ischemic bowel            |
| Cronk et al. 2006 [65]      | prospective study validation cohort of patients admitted for mechanical small bowel obstruction<br>n = 21  | comparison of serum L-lactate with i-FABP levels                   | elevated lactate in 1 out of 3 patients with gut necrosis<br>false negative elevation in 5 out of 18 patients without gut necrosis | 33% sensitivity<br>72% specificity<br>small cohort for evaluating serum lactate in bowel necrosis                                |
| Acosta et al. 2011 [26]     | retrospective study patients with acute mesenteric artery occlusion<br>n = 55                              | elevated lactate and troponin I in mesenteric ischemia             | elevated lactate in 12 out of 27 patients                                                                                          | normal lactate may not be infrequent after mesenteric artery occlusion                                                           |
| Akutsu et al. 2007 [25]     | case report type B aortic dissection                                                                       | near-normal serum lactate upon admission                           | single case in contradiction to another case report in which increased serum lactate was detected during type A aortic dissection  | aortic dissection may not be associated with serum lactate elevation despite intraoperatively observed overt mesenteric ischemia |

## Early detection of Mesenteric Ischemia by serum markers in cardiac surgery patients

DS Dohle et al.



**Objective:** Mesenteric ischemia (MESI) is a rare but often fatal complication for patients after cardiac surgery. Non-specific clinical symptoms and a lack of specific laboratory parameters complicate diagnosis. We evaluated potential serum markers for MESI in cardiac surgery patients.

**Methods:** Between 05/2011 and 01/2012 serum samples of 29 cardiothoracic patients suspicious for MESI were collected. Serum concentration of potential markers for MESI (alpha-glutathione-S-transferase:  $\alpha$ GST; intestinal-fatty-acid-binding-protein-2: iFABP2; D-lactate) were measured in samples taken within 24h around confirmation or exclusion of a MESI using ELISA-kits. Confirmation of MESI was achieved in 14/29 -, exclusion of MESI in 15/29 patients by laparotomy, endoscopy, angiography, or autopsy. A subgroup of early, not necrotizing MESI in 6/14 patients, in whom diagnosis was achieved early by angiography (4/6) or autopsy, showed segmental ischemia but no necrosis (2/6), and was analysed separately.

**Results:** Serum concentrations of  $\alpha$ GST [ng/ml], iFABP2 [ng/ml] and D-Lactat [nmol/ $\mu$ l] in patients with confirmed versus excluded MESI were significantly elevated only for  $\alpha$ GST ( $410 \pm 478$  vs.  $92 \pm 254$ ,  $p = 0.032$ ). In the subgroup analysis of patients with early MESI in comparison to excluded MESI, serum concentrations of  $\alpha$ GST were highly significantly elevated ( $927 \pm 176$  vs.  $92 \pm 254$ ,  $p < 0.0001$ ). Serum concentrations of iFABP2 ( $8.8 \pm 3.8$  vs.  $3.5 \pm 5.4$ ,  $p = 0.04$ ) and D-Lactat ( $144.5 \pm 163.1$  vs.  $33.7 \pm 25.6$ ,  $p = 0.016$ ) were significantly increased.

**Conclusions:** D-Lactat,  $\alpha$ GST and iFABP2 enable early detection of non necrotizing MESI. Thus, these markers will be used systematically in an ensuing study for early detection of MESI to hopefully enable early surgical therapy and avoidance of necrotizing MESI.

# Systematic Review and Pooled Estimates for the Diagnostic Accuracy of Serological Markers for Intestinal Ischemia

Nicholas J. Evennett · Maxim S. Petrov ·  
Anubhav Mittal · John A. Windsor

World J Surg (2009) 33:1374–1383

**Table 3** Pooled diagnostic accuracy of the studied tests

| Index test      | No. of studies | Se               | P Value | I <sup>2</sup> , % | Sp               | P Value | I <sup>2</sup> , % | LR+               | P Value | I <sup>2</sup> , % | LR–               | P Value | I <sup>2</sup> , % |
|-----------------|----------------|------------------|---------|--------------------|------------------|---------|--------------------|-------------------|---------|--------------------|-------------------|---------|--------------------|
| D-lactate       | 4              | 0.82 (0.65–0.93) | 0.40    | 0                  | 0.48 (0.38–0.58) | <0.001  | 93                 | 3.04 (0.73–12.59) | <0.001  | 89                 | 0.35 (0.18–0.70)  | 0.41    | 0                  |
| i-FABP          | 3              | 0.72 (0.51–0.88) | 0.08    | 60                 | 0.73 (0.62–0.83) | <0.001  | 93                 | 2.44 (0.41–14.58) | <0.001  | 95                 | 0.51 (0.29–0.91)  | 0.58    | 0                  |
| GST             | 3              | 0.68 (0.54–0.80) | <0.001  | 88                 | 0.85 (0.76–0.92) | 0.71    | 0                  | 3.38 (1.64–6.97)  | 0.31    | 16                 | 0.40 (0.11–1.47)  | <0.001  | 90                 |
| D-dimer         | 3              | 0.89 (0.77–0.96) | 0.46    | 0                  | 0.40 (0.33–0.47) | 0.28    | 21                 | 1.48 (1.28–1.71)  | 0.46    | 0                  | 0.30 (0.14–0.64)  | 0.42    | 0                  |
| Serum phosphate | 2              | 0.56 (0.40–0.72) | <0.001  | 95                 | 0.91 (0.80–0.97) | 0.08    | 67                 | 7.64 (0.16–371.5) | 0.009   | 86                 | 0.24 (0.01–21.42) | <0.001  | 95                 |
| CK-BB           | 2              | 0.76 (0.47–0.94) | 0.17    | 48                 | 0.85 (0.72–0.94) | 0.002   | 90                 | 8.31 (0.20–345.2) | 0.009   | 85                 | 0.27 (0.03–2.64)  | 0.09    | 64                 |
| Amylase         | 2              | 0.42 (0.26–0.69) | 0.14    | 53                 | 0.68 (0.45–0.86) | 0.67    | 0                  | 1.22 (0.49–3.05)  | 0.24    | 27                 | 0.89 (0.53–1.50)  | 0.19    | 41                 |
| WBC             | 2              | 0.80 (0.66–0.91) | 0.89    | 0                  | 0.50 (0.31–0.69) | 0.46    | 0                  | 1.57 (1.07–2.29)  | 0.47    | 0                  | 0.41 (0.20–0.83)  | 0.65    | 0                  |
| pH              | 2              | 0.38 (0.24–0.54) | 0.11    | 62                 | 0.84 (0.60–0.97) | 0.94    | 0                  | 2.49 (0.82–7.51)  | 0.63    | 0                  | 0.71 (0.45–1.14)  | 0.23    | 30                 |
| Base excess     | 2              | 0.74 (0.58–0.86) | 0.60    | 0                  | 0.42 (0.20–0.67) | 0.64    | 0                  | 1.26 (0.83–1.92)  | 0.53    | 0                  | 0.62 (0.29–1.33)  | 0.49    | 0                  |



# Systematic Review and Pooled Estimates for the Diagnostic Accuracy of Serological Markers for Intestinal Ischemia

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Table 4 Pooled global measures of tests performance

| Characteristic | Diagnostic test    |                   |                   |                   |
|----------------|--------------------|-------------------|-------------------|-------------------|
|                | D-lactate          | GST               | i-FABP            | D-dimer           |
| DOR            | 10.75 (3.15–36.74) | 8.82 (1.24–62.86) | 7.62 (2.27–25.54) | 5.77 (1.93–17.23) |
| P Value        | 0.33               | 0.04              | 0.41              | 0.34              |
| $I^2$          | 12%                | 68%               | 0%                | 9%                |
| AUC            | 0.86               | 0.87              | 0.78              | 0.53              |
| SE for AUC     | 0.06               | 0.05              | 0.08              | 0.41              |
| Q index        | 0.79               | 0.80              | 0.72              | 0.52              |
| SE for Q index | 0.05               | 0.05              | 0.07              | 0.31              |

DOR diagnostic odds ratio, AUC area under the summary receiver operating characteristic curve, SE standard error

# Acute mesenteric ischemia after open heart surgery

Schutz, A;Eichinger, W;Breuer, M;Gansera, B;Kemkes, B M  
*Angiology*; Apr 1998; 49, 4; ProQuest Health & Medical Complete  
pg. 267

**Table I**

*Summary of 4640 Operations  
with Extracorporeal Circulation*

- Mesenteric ischemia: 12 (0.25%)
- 10 CABG
- 1 CABG + AVR bioprosthesis
- 1 CABG + mitral reconstruction
- 1 CABG + carotid endarterectomy
- Mortality rate: 83.3%
- Male/female ratio: 5/7

**Table III**

*Laboratory Findings*

- |                               |                           |
|-------------------------------|---------------------------|
| • Leukocytosis                | 91.7% (18.8 ±5.4/nL)      |
| • Metabolic acidosis (pH<7.3) | 83.3% (pH 7.27 ±0.07)     |
| • Serum lactate ↑             | 100% (14.2 ±13.8 mmol/L)  |
| • Renal parameters (Crea) ↑   | 100% (2.6 ±0.8 mg/dL)     |
| • Serum osmolality ↑          | 100% (335.4 ±8.4 mosm/kg) |
| • Serum sodium ↑              | 75% (150.4 ±6.4 mmol/L)   |

# What is a normal lactate level during cardiopulmonary bypass?

*Scandinavian Cardiovascular Journal*. 2006; 40: 305–311

STAFFAN SVENMARKER<sup>1</sup>, SÖREN HÄGGMARK<sup>1</sup> & MARGARETA ÖSTMAN<sup>1</sup>

Table 1. The predictive value of hyperlactatemia at termination of cardiopulmonary bypass with reference to postoperative complications.

| Type of complication | Sensitivity [%] | OR [95% CI]    | Positive Predictive Value [%] | OR [95% CI]    |
|----------------------|-----------------|----------------|-------------------------------|----------------|
| Renal failure        | 35.4            | 5.3 [4.0–7.0]  | 13.3                          | 5.9 [4.3–8.2]  |
| CAVH                 | 42.3            | 7.1 [4.1–12.2] | 4.6                           | 7.4 [4.2–12.9] |
| Haemodialysis        | 30.0            | 4.1 [1.1–16.0] | 0.6                           | 4.2 [1.1–16.2] |
| Infection            | 31.2            | 4.4 [3.0–6.3]  | 8.1                           | 4.7 [3.2–6.9]  |
| Within thorax        | 27.3            | 3.6 [1.4–9.2]  | 1.3                           | 3.7 [1.4–9.2]  |
| Respiratory tract    | 32.4            | 4.6 [2.3–9.2]  | 4.7                           | 4.7 [2.4–9.5]  |
| Sepsis               | 34.1            | 5.0 [2.6–9.5]  | 2.9                           | 5.1 [2.6–9.9]  |
| Respiration          | 24.1            | 3.0 [2.7–3.5]  | 42.3                          | 4.6 [3.7–5.6]  |
| Ventilator > 16 h    | 36.0            | 5.4 [4.5–6.5]  | 30.4                          | 7.4 [5.8–9.3]  |
| Tracheotomy          | 14.0            | 1.5 [0.9–2.8]  | 2.7                           | 1.6 [0.9–2.9]  |
| Re-intubation        | 40.2            | 6.5 [4.3–9.9]  | 7.3                           | 6.9 [4.4–10.8] |
| Advanced therapy     | 28.7            | 3.9 [2.9–5.3]  | 10.8                          | 4.3 [3.0–6.0]  |
| Circulation          | 20.0            | 2.4 [2.2–2.7]  | 47.3                          | 3.7 [3.0–4.5]  |
| Gastrointestinal     | 24.5            | 3.1 [2.0–5.0]  | 4.8                           | 3.2 [2.0–5.2]  |
| Neurology            | 19.4            | 2.3 [1.8–3.0]  | 14.8                          | 2.6 [1.9–3.4]  |
| Surgery              | 16.4            | 1.9 [1.6–2.3]  | 23.1                          | 2.2 [1.7–2.7]  |
| Miscellaneous        | 17.4            | 2.0 [1.5–2.7]  | 10.6                          | 2.2 [1.6–3.0]  |
| Anaesthesia          | 1.9             | 1.7 [0.8–3.3]  | 14.8                          | 1.7 [0.8–3.4]  |
| Pain                 | 11.1            | 1.2 [0.4–4.0]  | 0.6                           | 1.2 [0.4–4.0]  |

# What is a normal lactate level during cardiopulmonary bypass?

*Scandinavian Cardiovascular Journal.* 2006; 40: 305–311

STAFFAN SVENMARKER<sup>1</sup>, SÖREN HÄGGMARK<sup>1</sup> & MARGARETA ÖSTMAN<sup>1</sup>

Table II. Univariate risk stratification of hyperlactatemia during cardiopulmonary bypass: continuous variables.

| Risk Strata                    | Lactate <2 mmol/L | Lactate ≥ 2 mmol/L | p-value |
|--------------------------------|-------------------|--------------------|---------|
| Age (years)                    | 66.6±10.0         | 64.7±12.0          | 0.00    |
| Body Mass Index                | 26.8±3.0          | 27.2±4.3           | 0.05    |
| CPB Duration (min)             | 83.0±39.3         | 159.6±87.1         | 0.00    |
| Cross Clamp of Aorta (min)     | 48.8±29.1         | 93.9±60.2          | 0.00    |
| Temperature CPB (°C)           | 33.6±1.9          | 30.3±5.6           | 0.00    |
| Blood Transfusion CPB (ml)     | 66.3±202.7        | 348.3±521.5        | 0.00    |
| Volume Load CPB (ml/min)       | 9.6±8.7           | 12±4               | 0.00    |
| Urine Output CPB (ml/min)      | 6.5±3.8           | 5.2±3.6            | 0.00    |
| Haemoglobin at CPB start (g/l) | 82.6±12.6         | 80.4±14.7          | 0.02    |
| Phenylephrine dose CPB (mg)    | 0.57±1.36         | 0.71±0.85          | 0.04    |
| Higgins Score                  | 2.4±2.3           | 4.3±3.5            | 0.00    |
| pH at CPB start                | 7.37±0.04         | 7.34±0.06          | 0.00    |

Volume load and urine output during CPB were calculated and based on the duration of CPB.



# The impact of hyperlactatemia on postoperative outcome after adult cardiac surgery

Alexander Kogan • Sergey Preisman • Alex Bar •  
Leonid Sternik • Jacob Lavee • Ateret Malachy •  
Dan Spiegelstein • Haim Berkenstadt • Ehud Raanani

J Anesth (2012) 26:174–178

**Table 2** Postoperative data for normolactatemia (groups I), mild hyperlactatemia (group II), and severe hyperlactatemia (group III)

|                                           | Group I<br>Lactate $\leq 2.2$ mmol/l,<br><i>n</i> = 332 | Group II<br>Lactate 2.21–4.4 mmol/l,<br><i>n</i> = 1,054 | Group III<br>Lactate $\geq 4.4$ mmol/l,<br><i>n</i> = 434 | <i>P</i> value |
|-------------------------------------------|---------------------------------------------------------|----------------------------------------------------------|-----------------------------------------------------------|----------------|
| Bypass time (min)                         | 76 $\pm$ 38                                             | 91 $\pm$ 38                                              | 109 $\pm$ 53                                              | $<0.01^*$      |
| Cross-clamp time (min)                    | 55 $\pm$ 29                                             | 66 $\pm$ 32                                              | 74 $\pm$ 63                                               | $<0.01^*$      |
| Bleeding during first 24 h (ml)           | 385 $\pm$ 479                                           | 389 $\pm$ 295                                            | 576 $\pm$ 708                                             | $<0.01^*$      |
| Postoperative renal failure, <i>n</i> (%) | 12 (3.61)                                               | 49 (4.65)                                                | 40 (9.22)                                                 | $<0.05^*$      |
| Using of $\beta$ -agonists, <i>n</i> (%)  | 26 (7.83)                                               | 218 (20.68)                                              | 123 (28.34)                                               | $<0.01^{**}$   |
| Ventilation time (h)                      | 12 $\pm$ 7                                              | 20 $\pm$ 50                                              | 45 $\pm$ 109                                              | $<0.01^*$      |
| ICU length of stay (h)                    | 38 $\pm$ 29                                             | 59 $\pm$ 123                                             | 107 $\pm$ 210                                             | $<0.01^*$      |
| Postoperative hospital stay (days)        | 7 $\pm$ 4                                               | 8 $\pm$ 9                                                | 11 $\pm$ 13                                               | 0.067          |
| Hospital mortality, <i>n</i> (%)          | 3 (0.9)                                                 | 8 (0.76)                                                 | 32 (7.37)                                                 | $<0.01^*$      |

Results are presented as average  $\pm$  SD or percentage

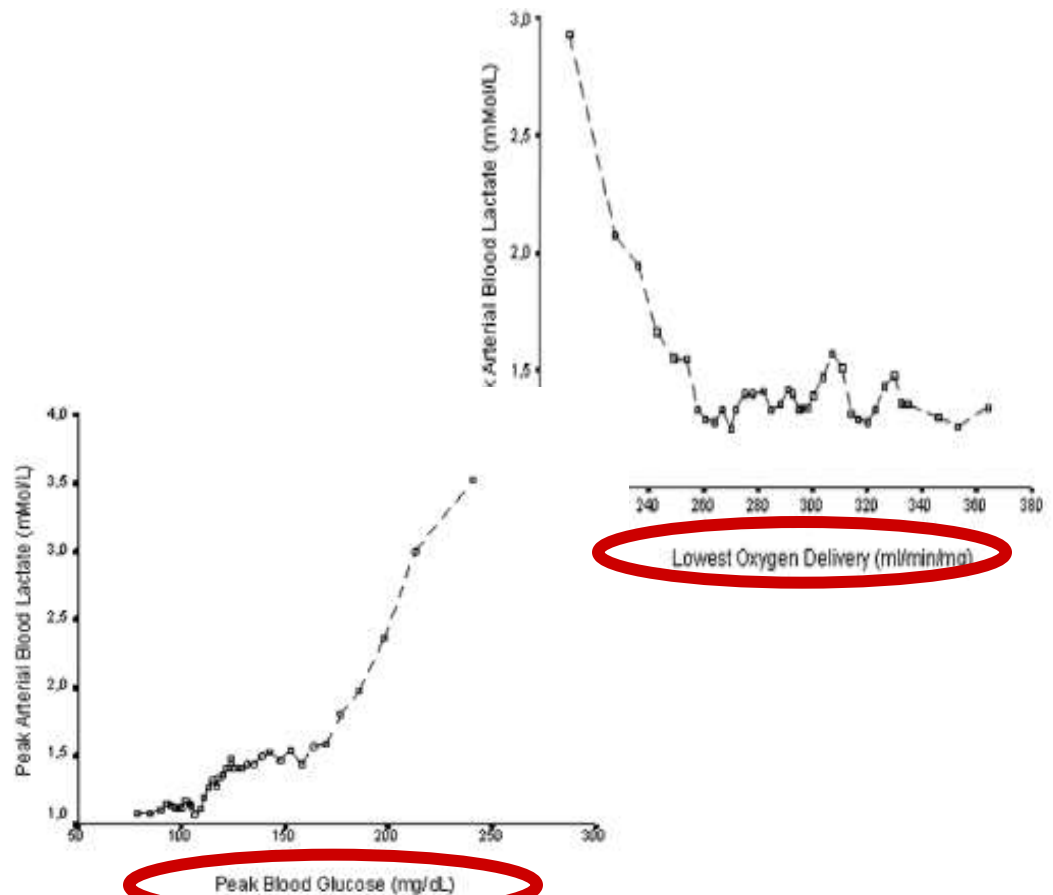
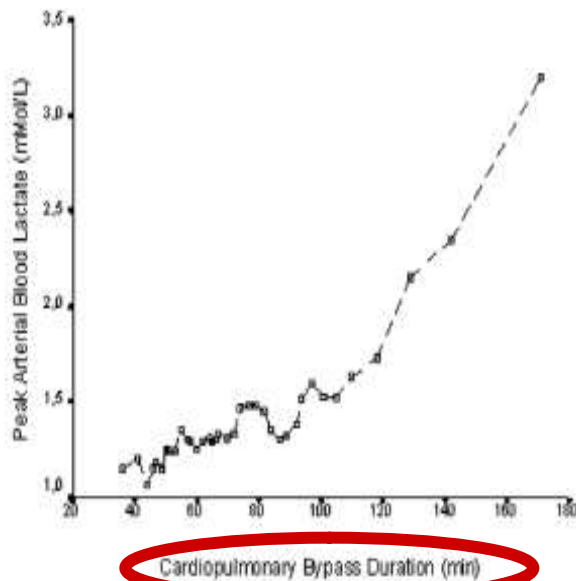
\* Groups I and II compared with group III; \*\* group I compared with groups II and III

Research

# Hyperlactatemia during cardiopulmonary bypass: determinants and impact on postoperative outcome

Marco Ranucci, Barbara De Toffol, Giuseppe Isgrò, Federica Romitti, Daniela Conti and Maira Vicentini

Critical Care Vol 10 No 6 Ranucci *et al.*



# Diagnosis and Treatment of Nonocclusive Mesenteric Ischemia After Open Heart Surgery

Stefan Klotz, MD, Thomas Vestring, MD, Jürgen Rötger, MD, Christoph Schmidt, MD, Hans H. Scheld, MD, and Christof Schmid, MD

Ann Thorac Surg  
2001;72:1583-6

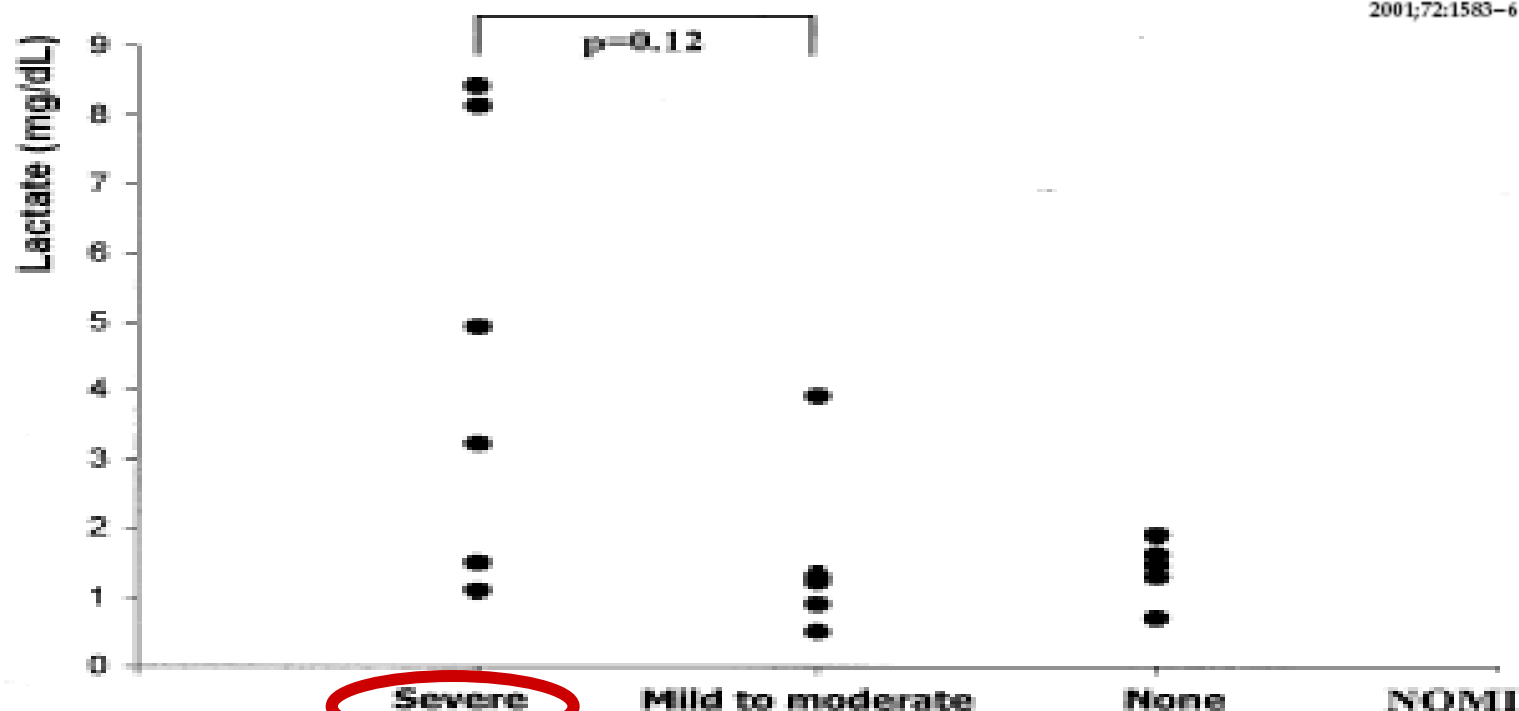


Fig 1. Serum lactate levels in patients with radiologically proven mild to moderate and severe nonocclusive mesenteric hypoperfusion ( $p = 0.12$ ). (NOMI = nonocclusive mesenteric ischemia.)

# Cardiopulmonar Bypass

## Function

Allow adequate systemic oxygenation and perfusion during cardiac surgical procedure.

## Challenge

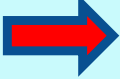
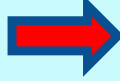
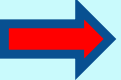
Periods of acute tissue hypoperfusion:

- Poor venous return
- Low volumes/flows
- Patient anatomy
- Surgical technique
- Circulatory arrest
- Hemodilution

## Solution

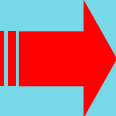
Monitoring of intraoperative ve postoperative lactate levels leading to therapeutic intervention to improve post-operative course.

# Sonuç

- Akut karın kuşkusu olan tüm olgular  **G.Cerrah** tarafından değerlendirilmelidir.
- Klinik değerlendirme ve FM  ayrıntılı yapılmalıdır.
- Tipik semptomların varlığında tanısal ve tedavi edici prosedürler  çok acil yapılmalıdır.

# Sonuç

-İnatçı **laktat yüksekliği**, met asidoz, lökositoz ve CRP yüksekliğinde  Mezenter iskemi mutlaka akla getirilmelidir.

-Mezenter iskeminin gelişmesinde ana sebep  splanknik hipoperfüzyondur.

-Tedavi de amaç geri dönüşümsüz barsak iskemisi gelişmeden  barsak kan akımını yeniden sağlamaktır.

-Laktat yüksekliği tek başına AMİ tanısının konmasında yeterli değildir, fakat yüksekliği tanının konmasında klinikle beraber anlamlıdır.

# Sonuç

Mutlaka monitörize edilmeli

Mezenter iskemi tanısında yardımcıdır

Maliyeti artırır

**Laktat**

YBÜ kalış süresini uzatır

Mortaliteyi artırır

Morbiditeyi artırır