



Pathophysiological stress response following surgery & *ERAS*

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ERAS UK conference 2013
Birmingham November 8 2013



Recovery After Surgery

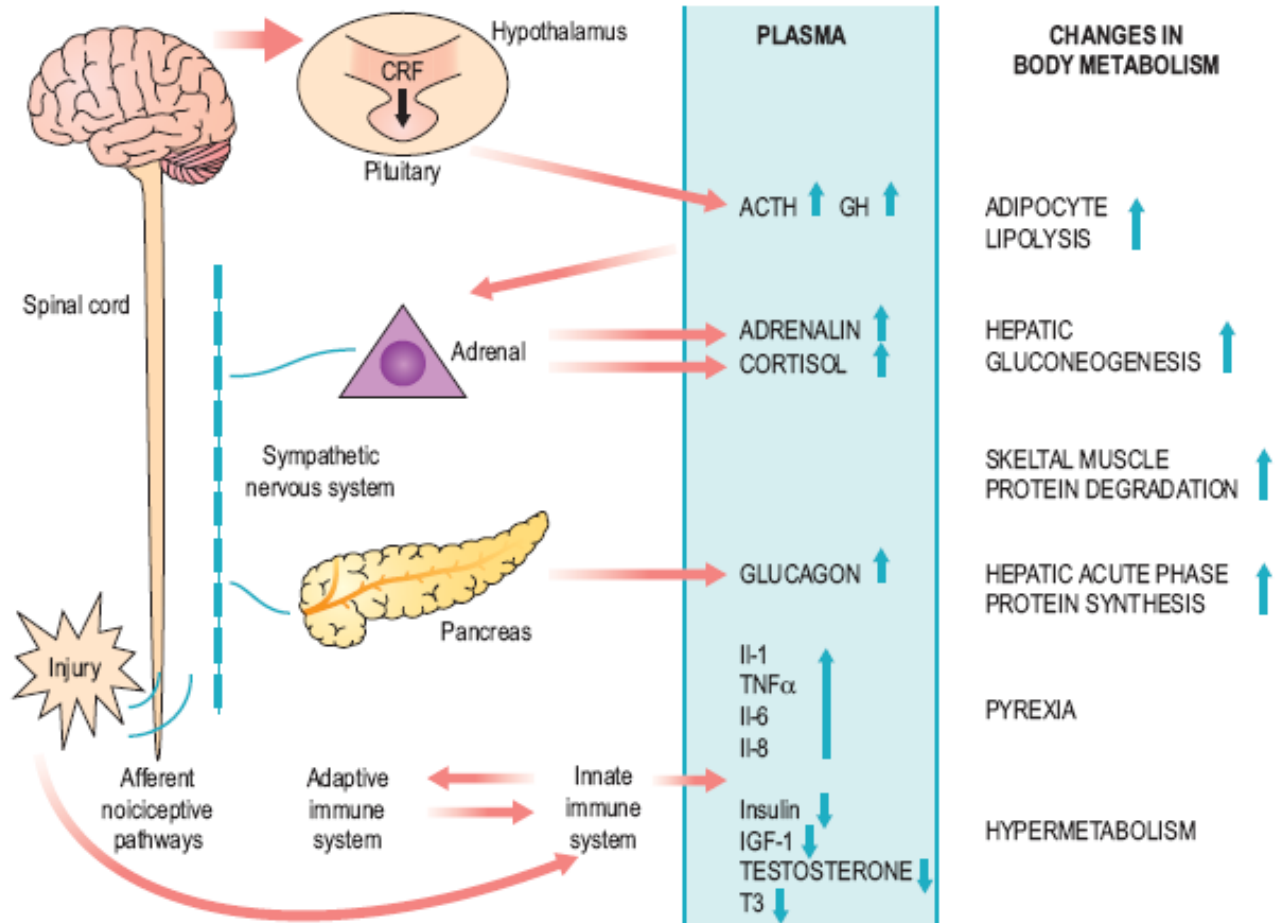
What are we trying to achieve?

Patient back to preoperative function

- **Normal gastrointestinal function**
 - **Normal food intake**
 - **Bowel movement**
- **Pain control**
- **Mobility**

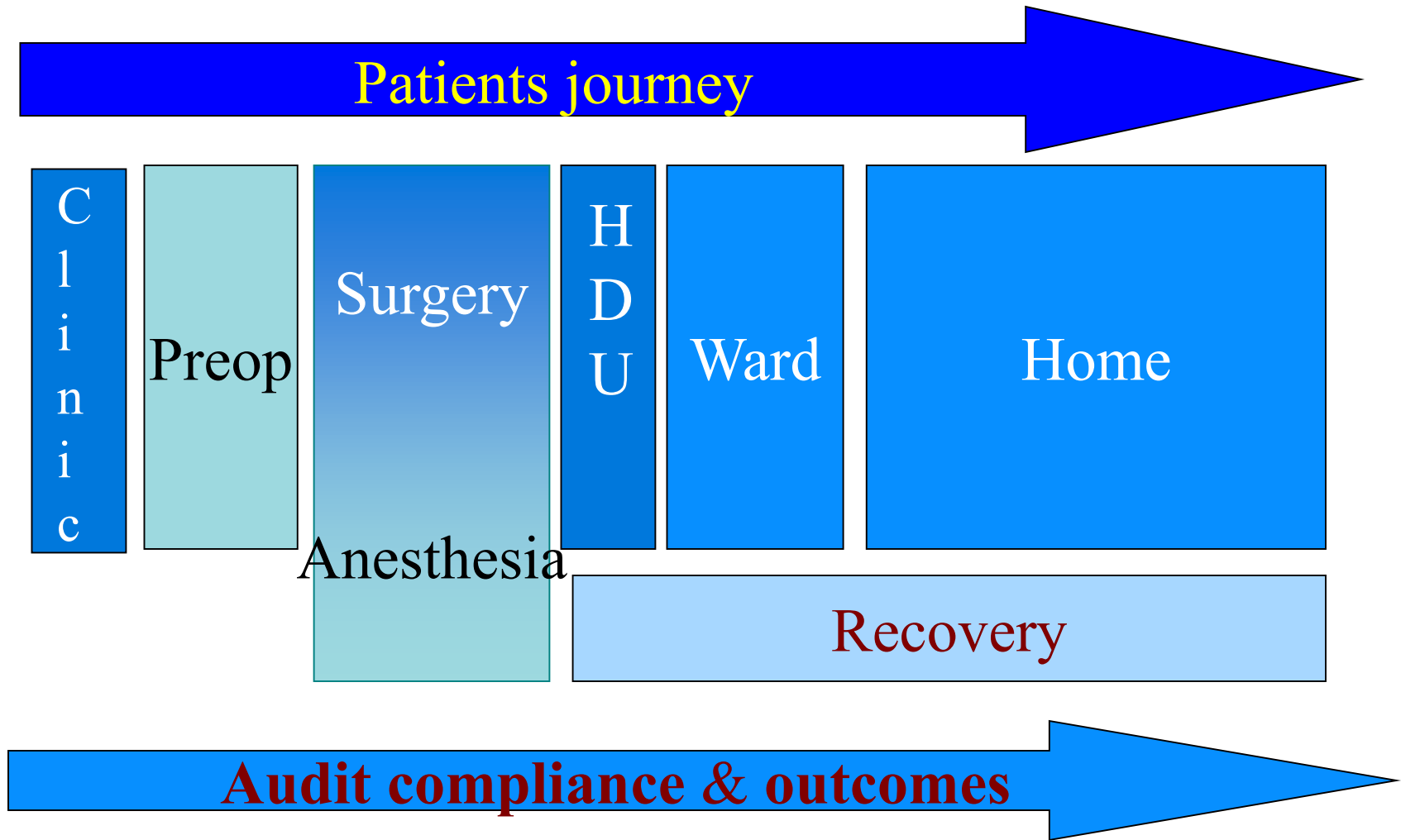
- **No complication**

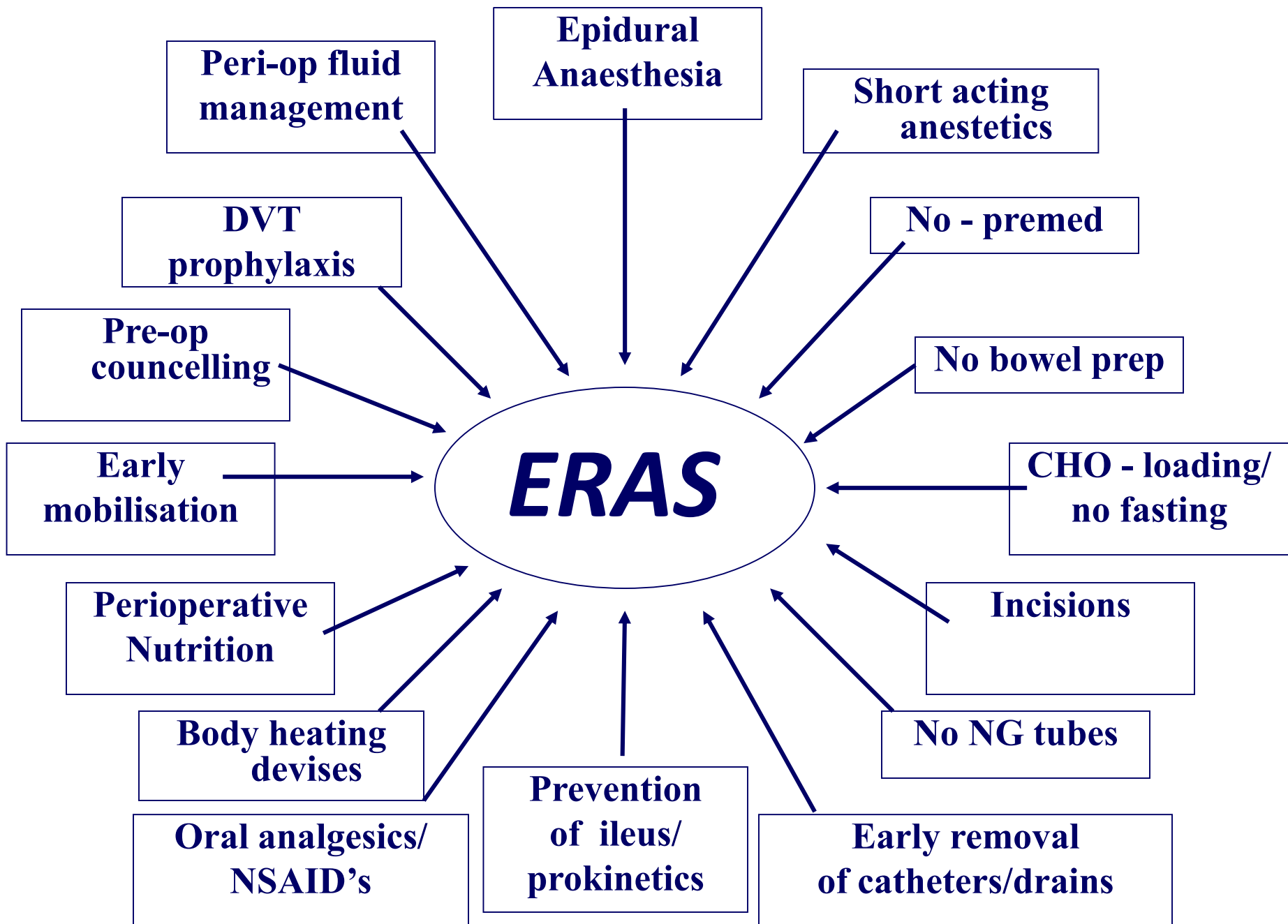
The Metabolic Stress Response to Surgery and Trauma



Philosophy

ERAS philosophy: The Patients journey





ERAS

Securing modern care

Surgeon:

No bowel prep

Food after surgery

No drains

Early removal u-catheter

No iv fluids, no lines

Early discharge

All evidence based!

Anesthetist:

Carbohydrates no fasting

No premedication

Thoracic Epidural

Anesthesia (open)

Balanced fluids

Vasopressors

No or short acting

opioids



ERAS team approach

- **Surgeon**
- **Anesthetist**
- **HDU specialist**
- **Ward nurses**
- **Anesthesia nurses**
- **Physiotherapist**
- **Dietitian**

- **Management**

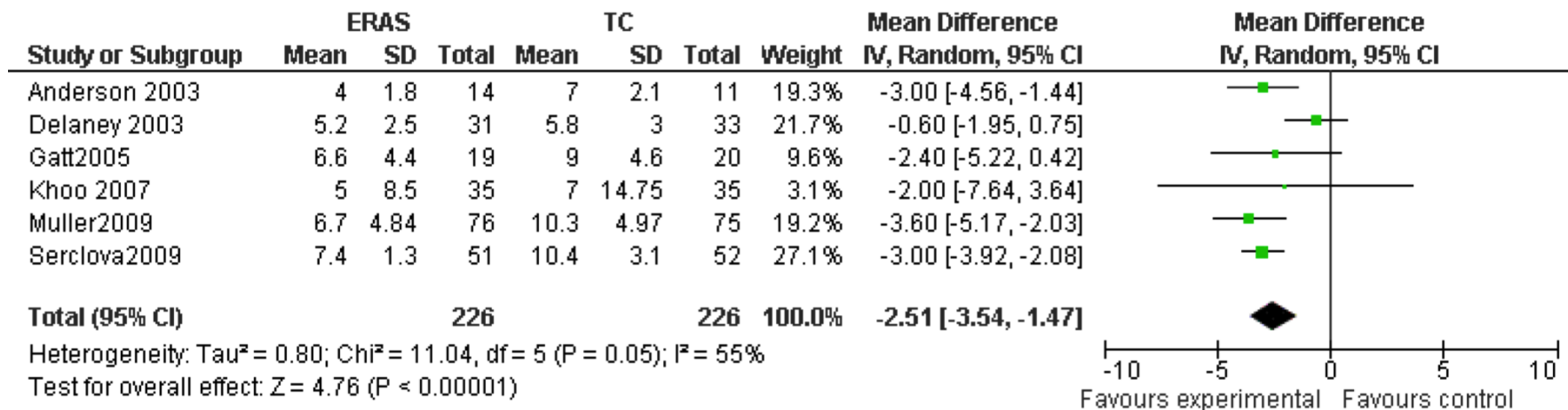
Team work:

- **Training**
- **Implementing**
- **Planning**
- **Auditing**
- **Updating**
- **Reporting**
- **Research**

ERAS works!

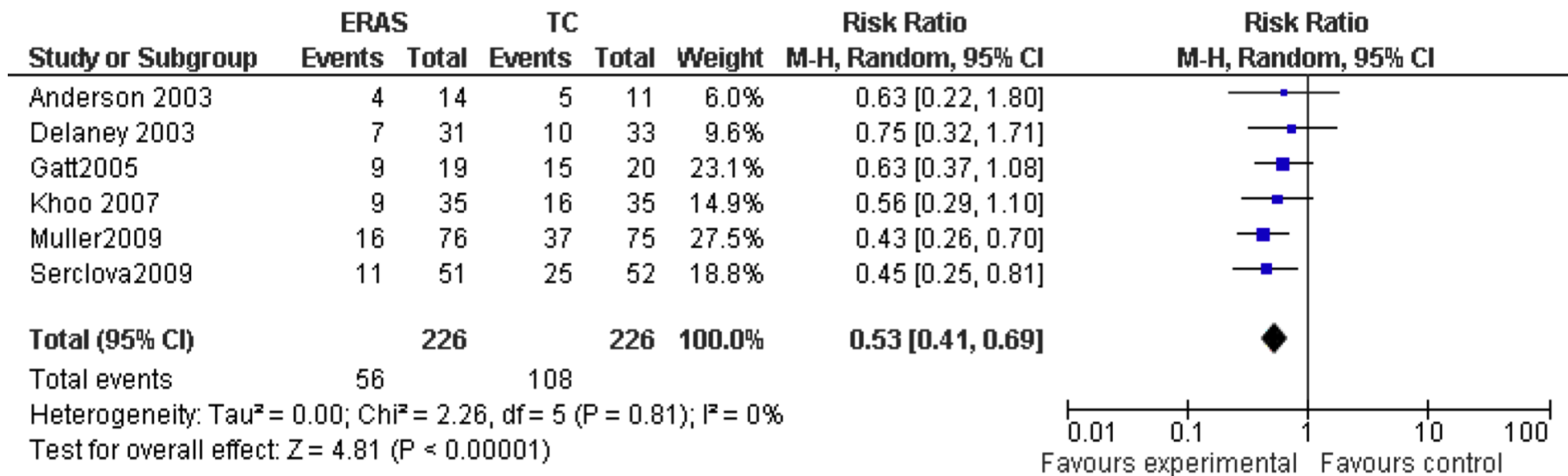
ERAS Meta analys

ERAS: shorter length of stay by 2.5 days



ERAS Meta analysis

ERAS: Reduce complications by 50%



How does ERAS work?

Mechanisms

3 new guidelines 2012

World J Surg
DOI 10.1007/s00268-012-1772-0

Multimodal

**Guidelines for Perioperative
Enhanced Recovery After
Surgery (ERAS®) Society
Recommendations**

U. O. Gustafsson · M. J. Scott
N. Francis · C. E. McNaughton
A. Hill · R. H. Kennedy · I.

World Journal
of Surgery

Reduce stress

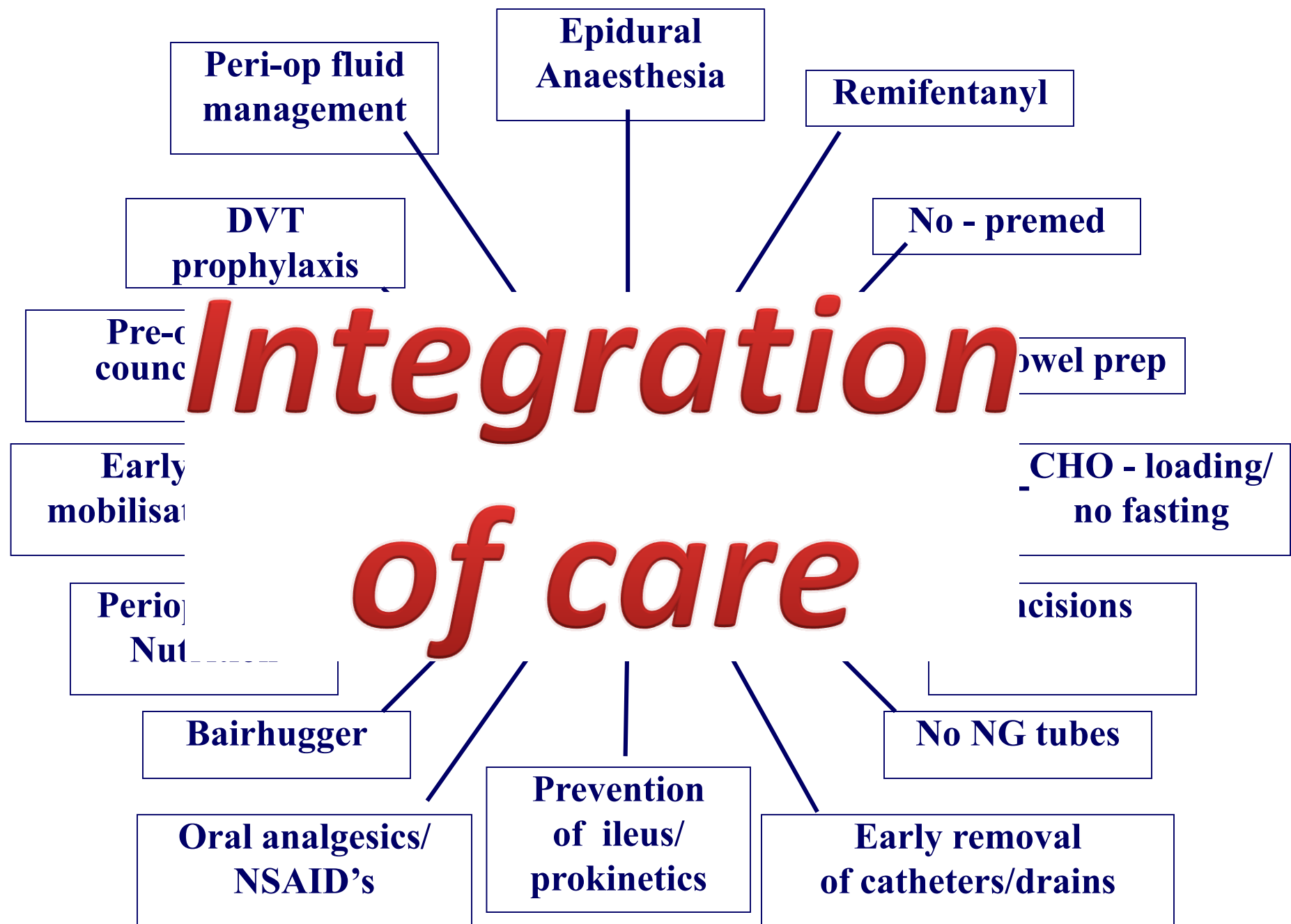
nectomy:

World J Surg
DOI 10.1007/s00268-012-1772-0

Support function

**Guidelines for Perioperative Care in Elective Rectal/Perineal
Surgery: Enhanced Recovery After Surgery (ERAS®) Society
Recommendations**

J. Nygren · J. Thacker · F. Carli · K. C. H. Fearon ·
S. Norderval · D. N. Lobo · O. Ljungqvist ·
M. Soop · J. Ramirez



How does ERAS work?

Mechanisms

Insulin

Insulin & Recovery

Insulin: main anabolic hormone involved in

- **All parts of metabolism**
 - Glucose control
 - Fat metabolism
 - Protein
- **Regulator of return of key functions**
- **Central to development of complications**
- **Affected by many perioperative treatments**

Insulin & Recovery

Insulin: main anabolic hormone involved in

- All parts of metabolism
 - Glucose control
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- Regulator of return of key functions
- Central to development of complications
- Affected by many perioperative treatments
- **Insulin resistance: a key for understanding and enhancing recovery**

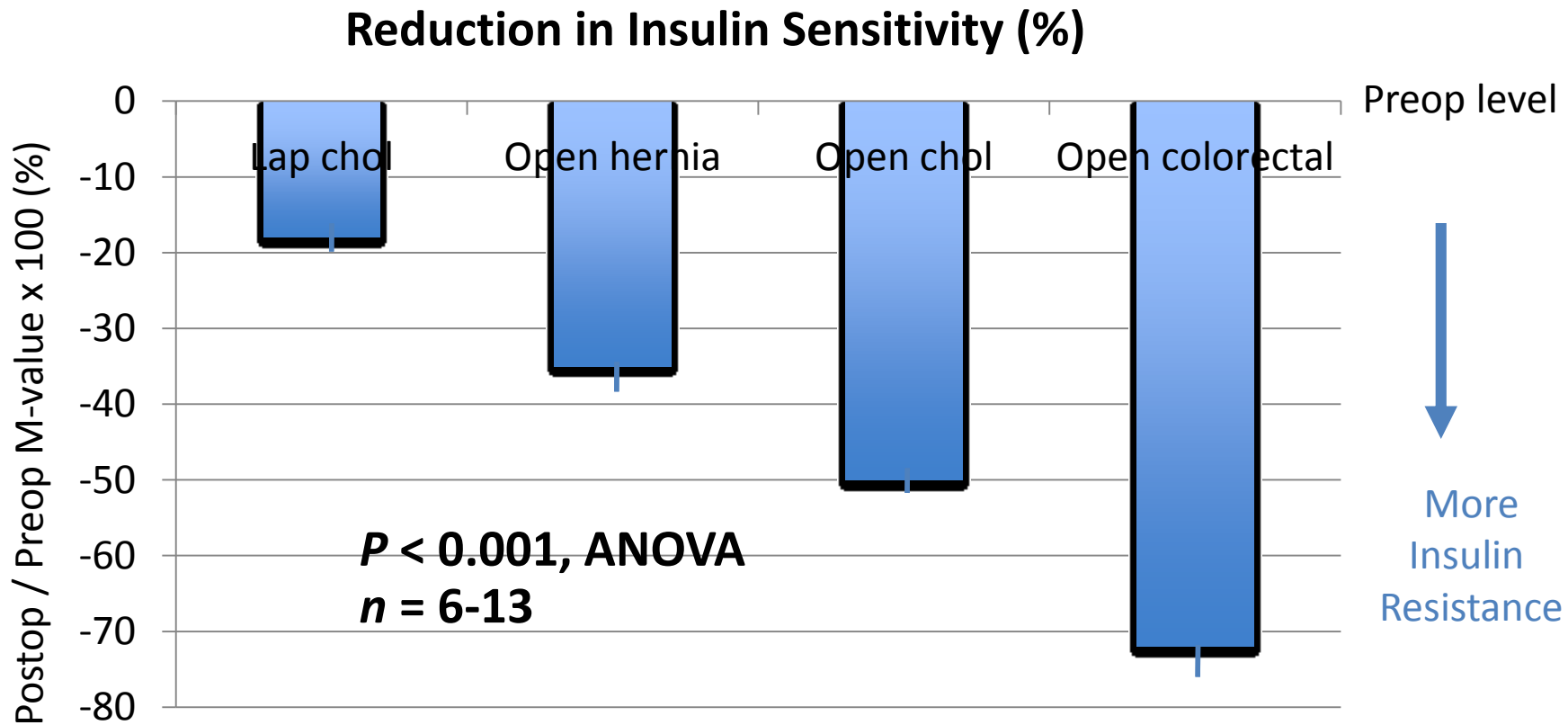
Postoperative Insulin resistance

Defintion:

Below normal metabolic effect of insulin

- **Glucose uptake**
- **Reduction in glucose production**
- **Lipolysis**
- **Protein breakdown / balance**

Insulin sensitivity falls with the magnitude of surgery



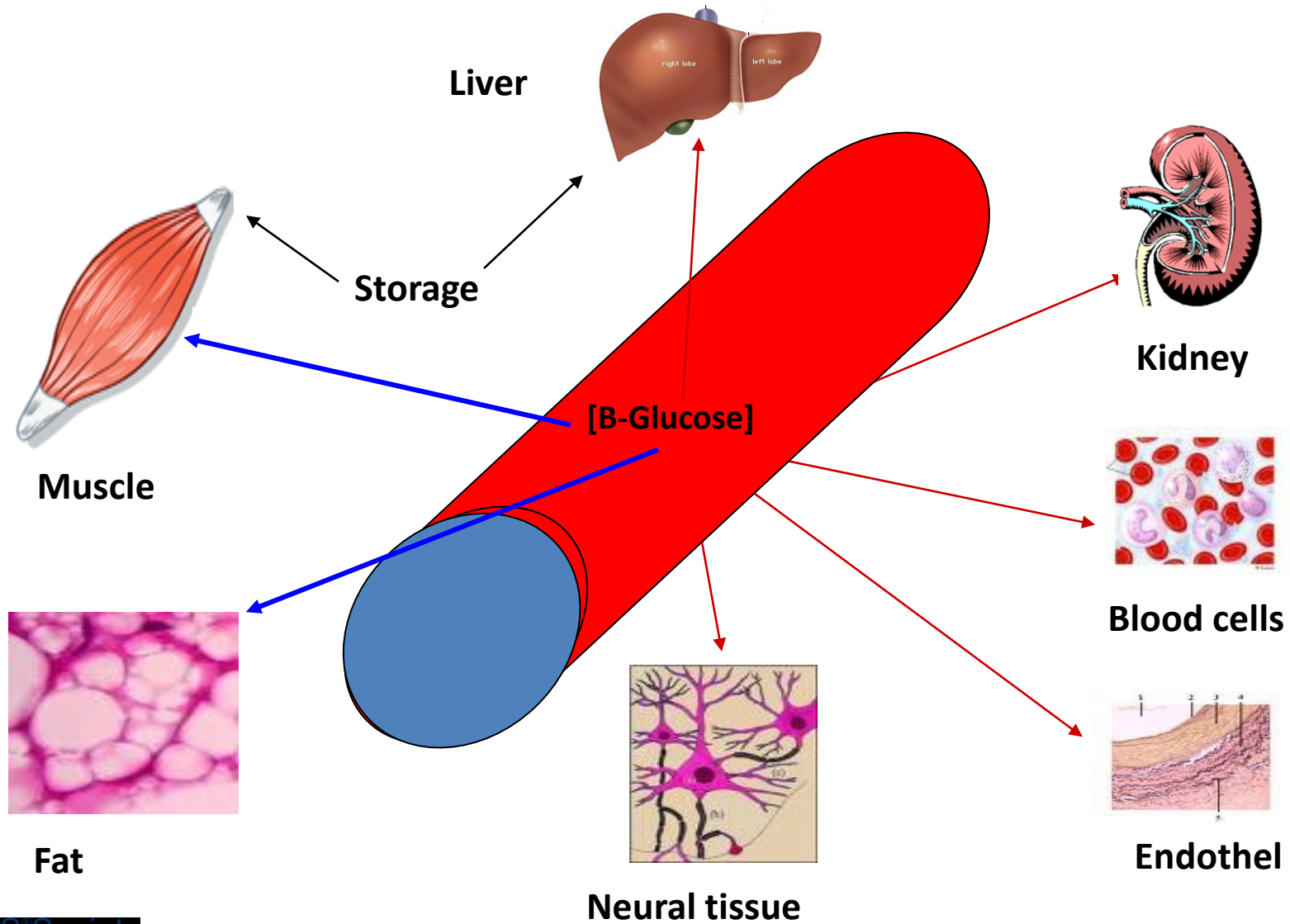
Independent factors predicting length of stay

- **Type of surgery**
- **Perioperative blood loss**
- **Postoperative insulin resistance**

$R^2 = 0.71, p < 0.01$

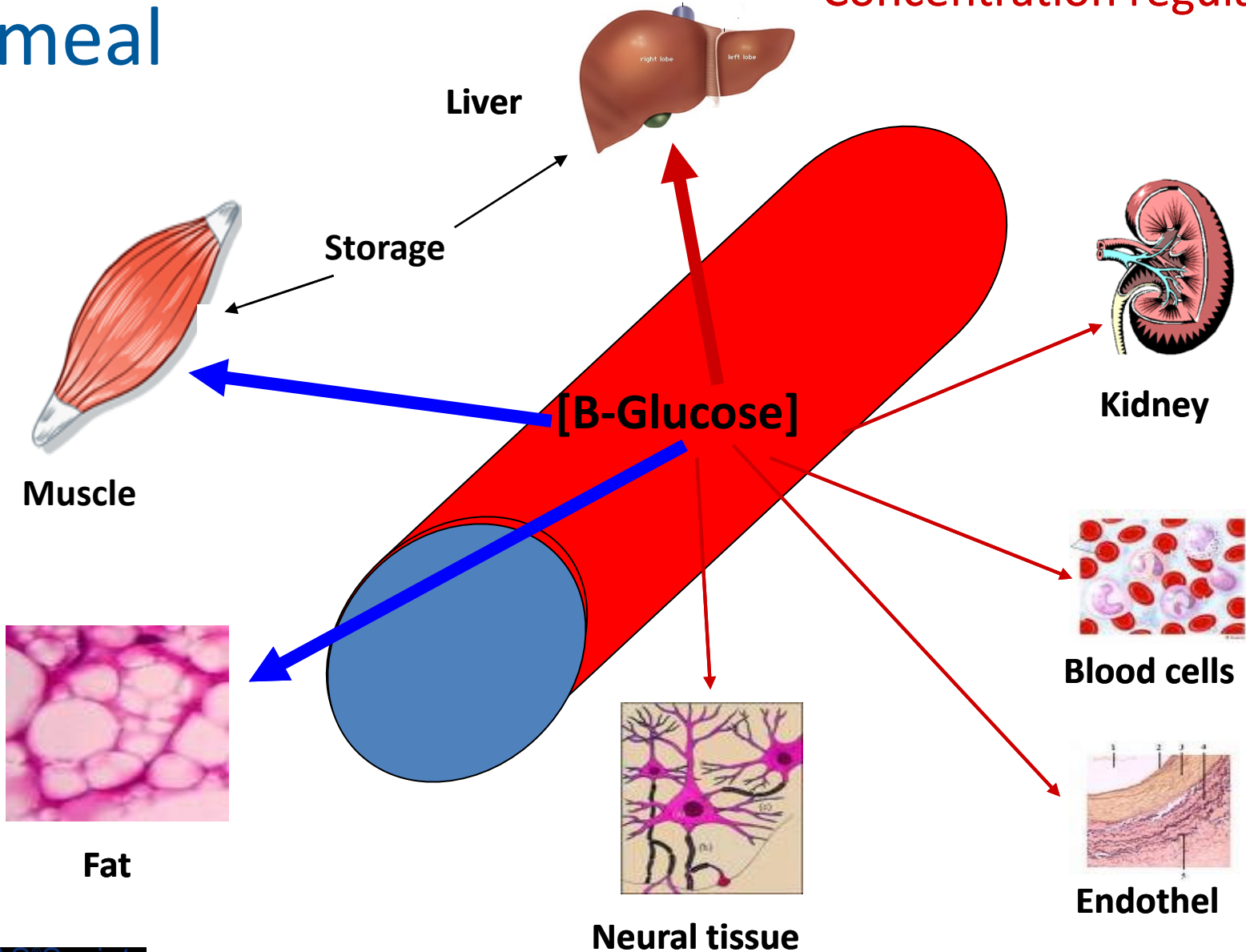
Glucose uptake

Insulin regulated
Concentration regulated



Glucose uptake - meal

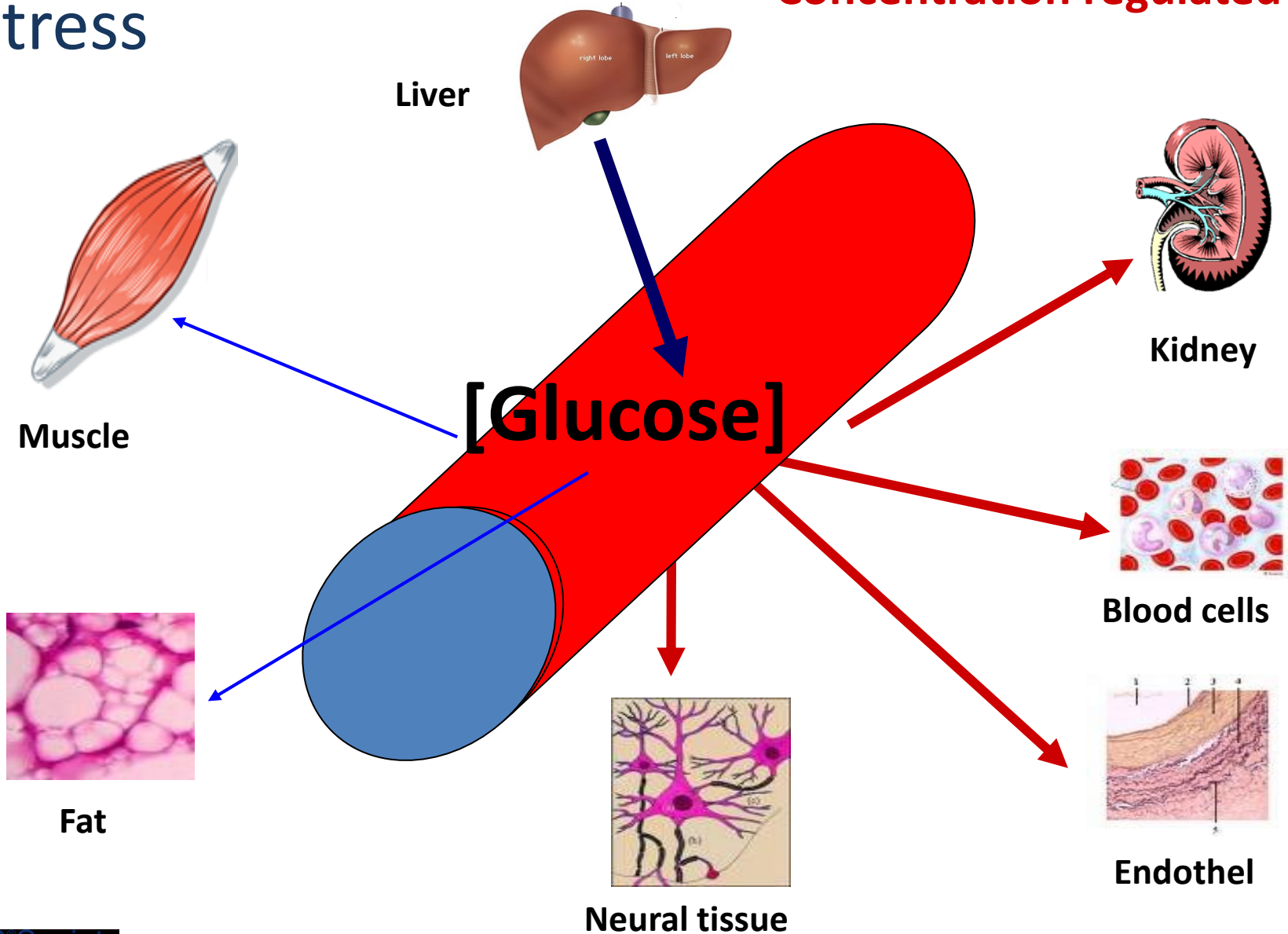
Insulin regulated
Concentration regulated



Glucose uptake - stress

Insulin regulated

Concentration regulated



Driving forces for hyperglycemia after surgery

	Postop
Hyperglycemia	+
Insulin sensitivity	-
Glucose production	+
Peripheral glucose uptake	-
GLUT4 translocation	-
Glycogen formation	-

Driving forces for hyperglycemia after surgery similar to diabetes

	Postop	Type 2 DM
Hyperglycemia	+	+
Insulin sensitivity	-	-
Glucose production	+	+
Peripheral glucose uptake	-	-
GLUT4 translocation	-	-
Glycogen formation	-	-

Normalizing insulin action normalizes metabolism

Insulin infusion to normalize:

- **Blood glucose**

Also controlled:

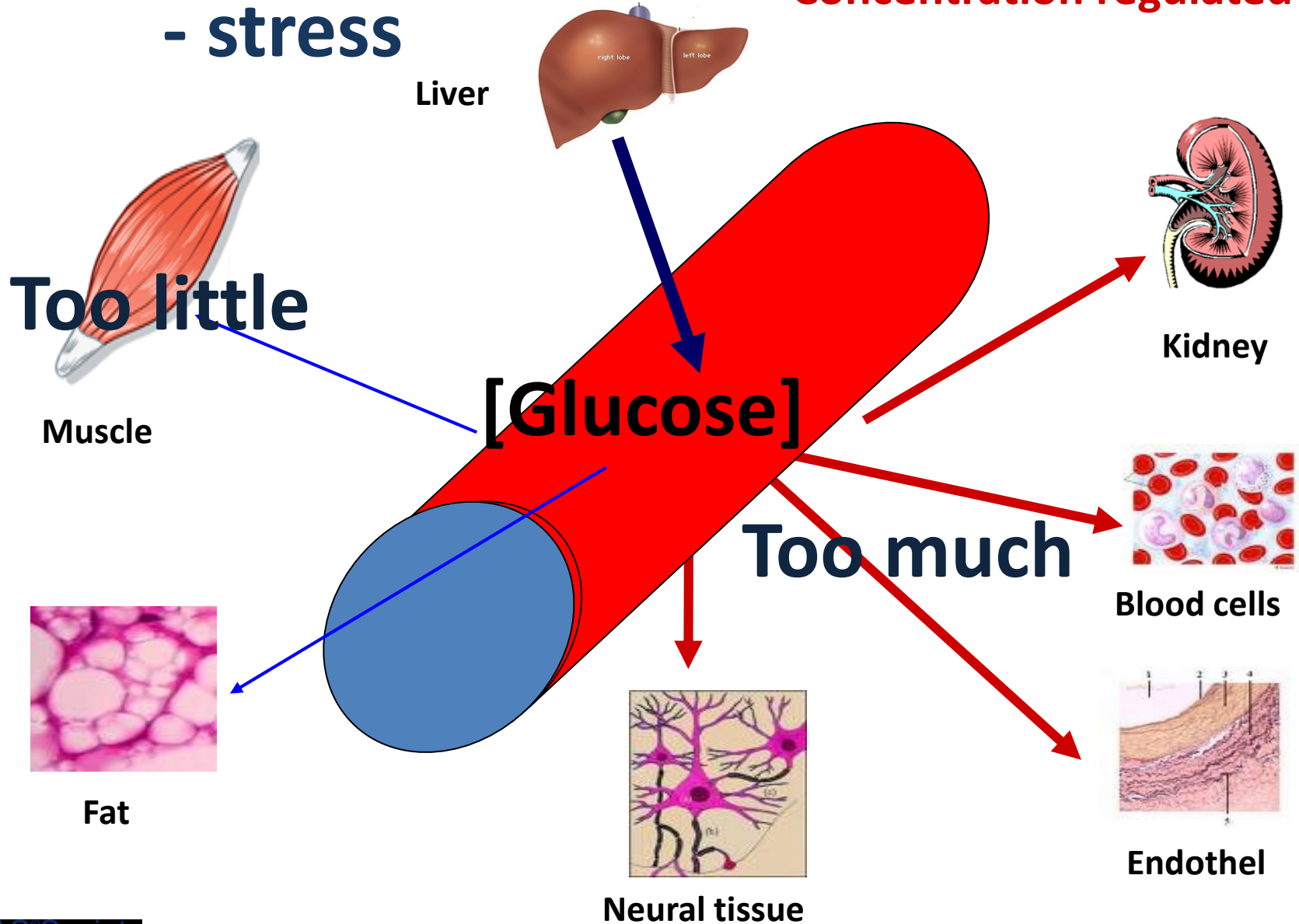
- **FFA**
- **Urea excretion**
- **Substrate utilization after major surgery**

Insulin resistance the key to catabolism

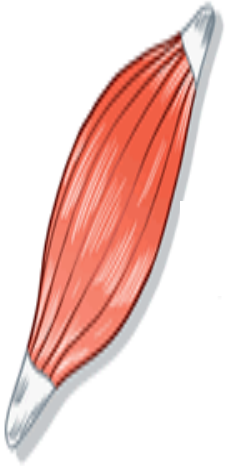
Glucose uptake - stress

Insulin regulated

Concentration regulated

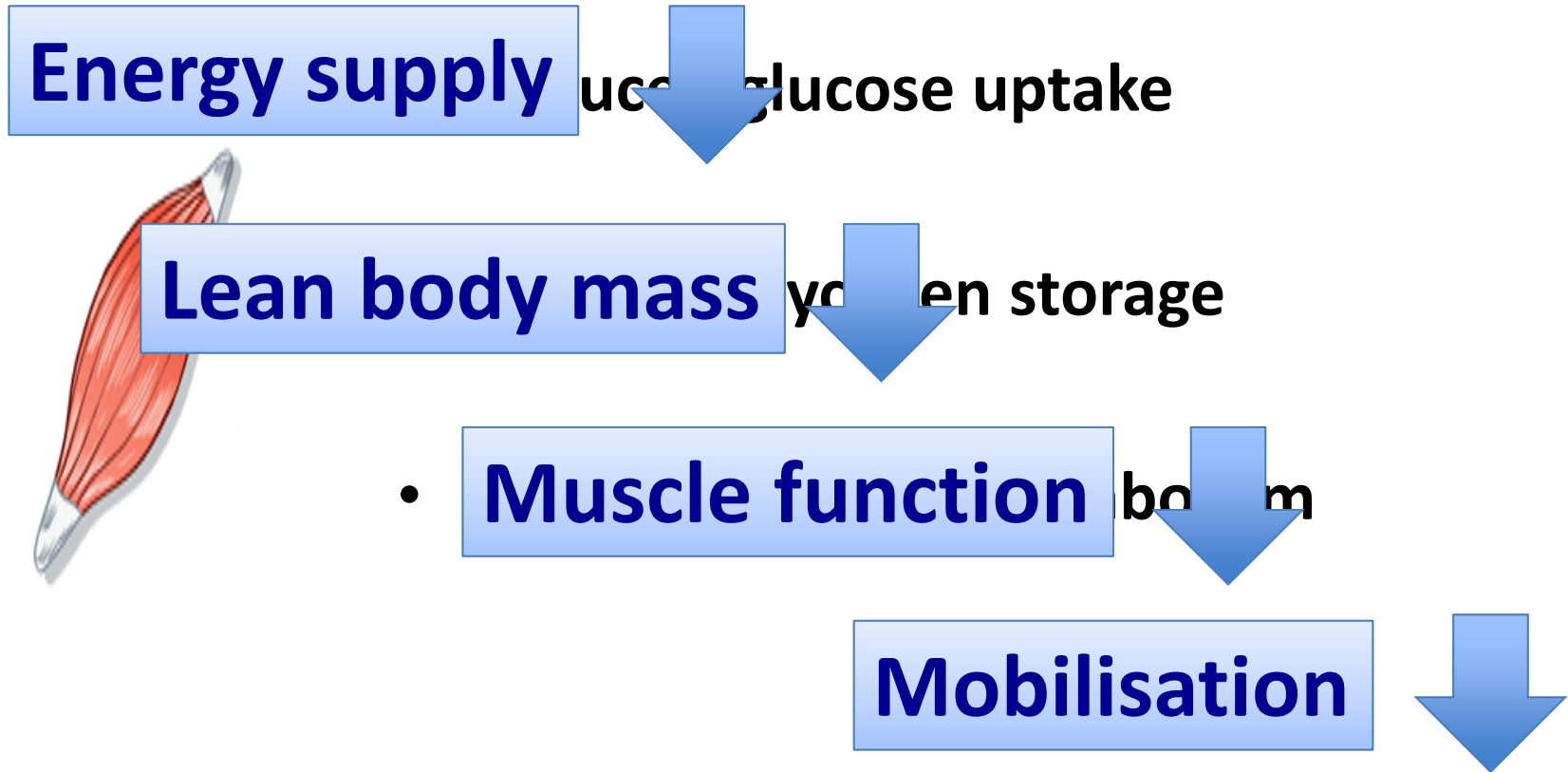


Insulin resistance muscle



- **Reduced glucose uptake**
- **Reduced glycogen storage**
- **Increased protein catabolism**

Insulin resistance muscle



Impaired Recovery

Postop (days)

Muscle weakness

Infections

Cardiovascular

Renal failure

Polyneuropathy

Tissues/cells

muscle

leukocytes

blood vessels

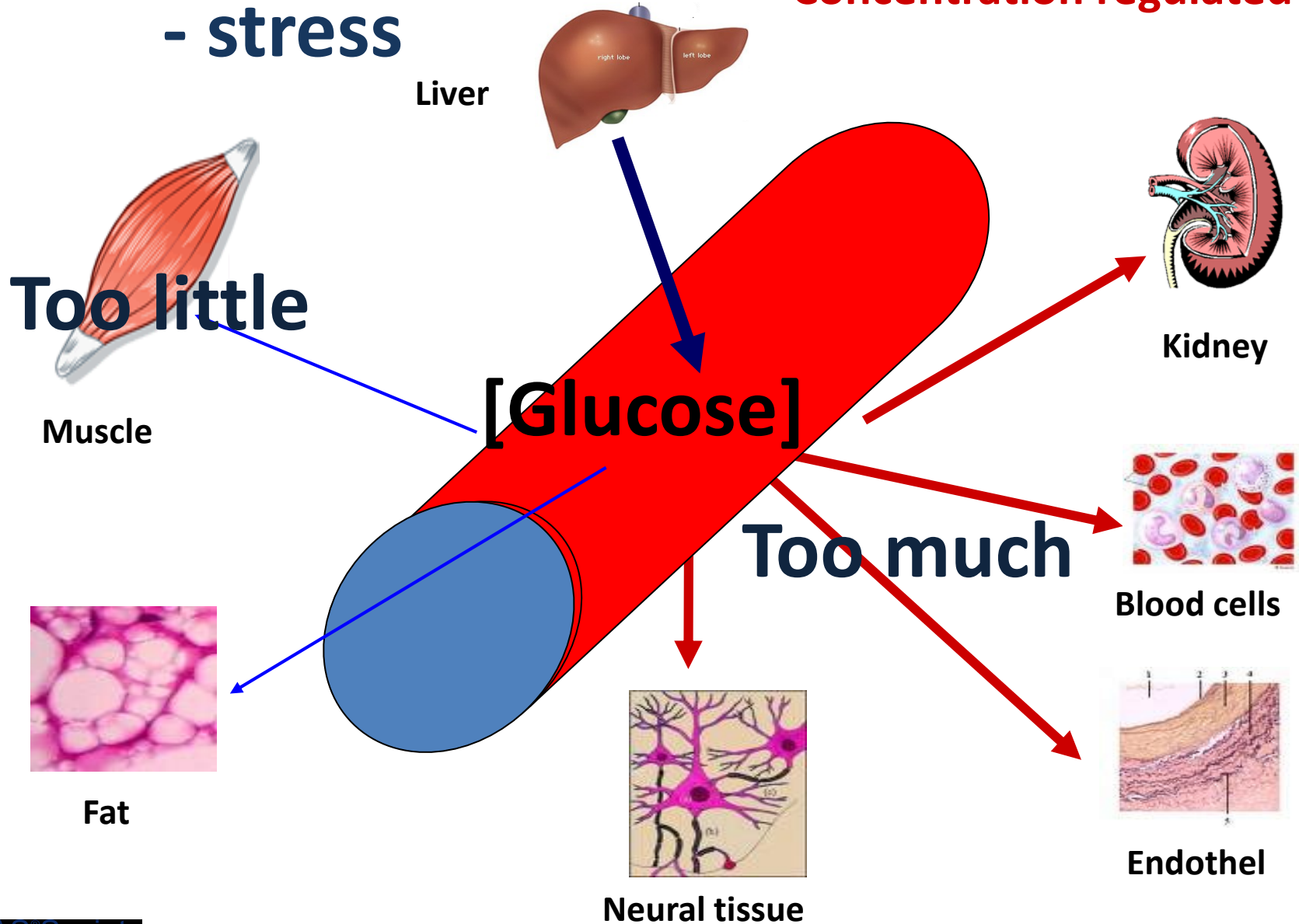
kidney

nerve tissue

Glucose uptake - stress

Insulin regulated

Concentration regulated



Complications

Postop (days)

Infections

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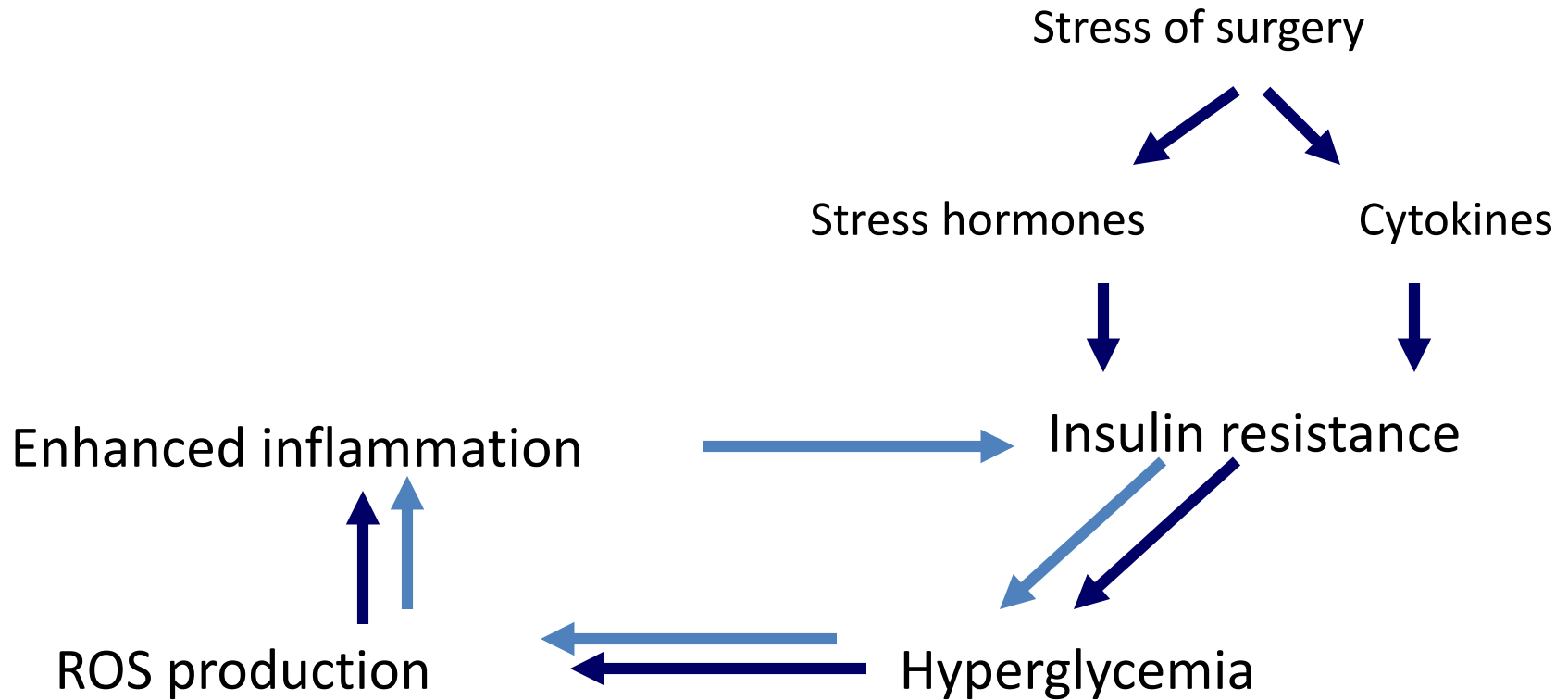
muscle

Why these organs/cells?

Tissues unprotected to glucose uptake:

- **Uncontrolled inflow of glucose**
- **No storage**
- **Overflow of glycolysis**
- **ROS production**
- **Block of glycolysis & Krebs cycle**
- **Altered gene expression**
- **Enhanced inflammatory response**
- **Vicious circle**

Vicious circle



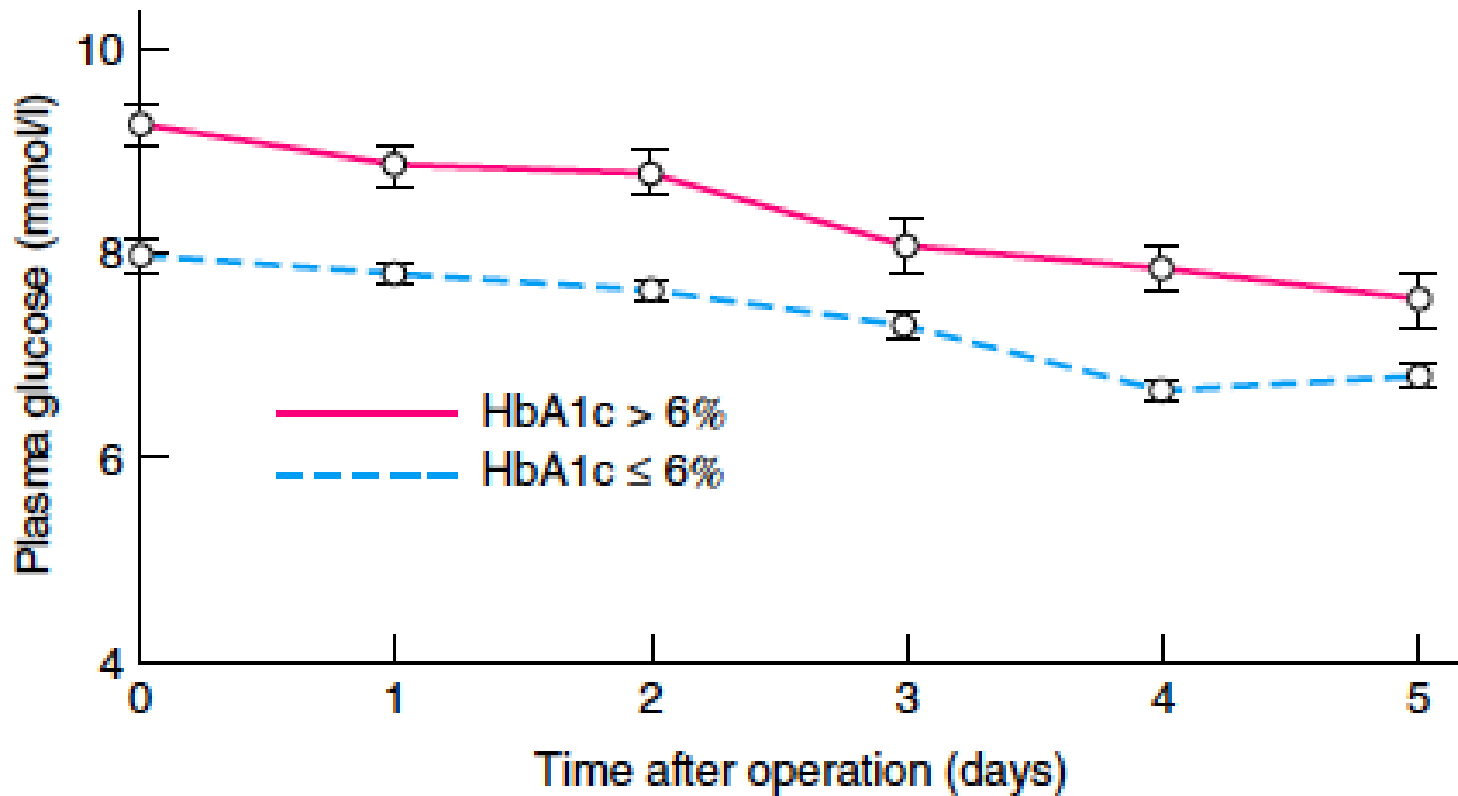
Insulin important for wound healing

- 6 patients studied twice, >40% burn injury
- Placebo – randomised - cross over design
- Hyperinsulinemia
 - 400-900 microunits/ml for 7 days or placebo
- Glucose infusion to normoglycemia
- Donor-site healing time reduced
 - from 6.5 to 4.7 days, $p < 0.05$

Glucose levels in ERAS & outcomes after surgery

- **120 Consecutive patients**
- **Colorectal surgery**
- **No history of diabetes**
- **Preop HbA1c – above or below 6.1**
- **26% pathologically high (≥ 6.1 mM)**
- **Glucose 5 times daily postop**
- **CRP and complications (30 day follow up)**

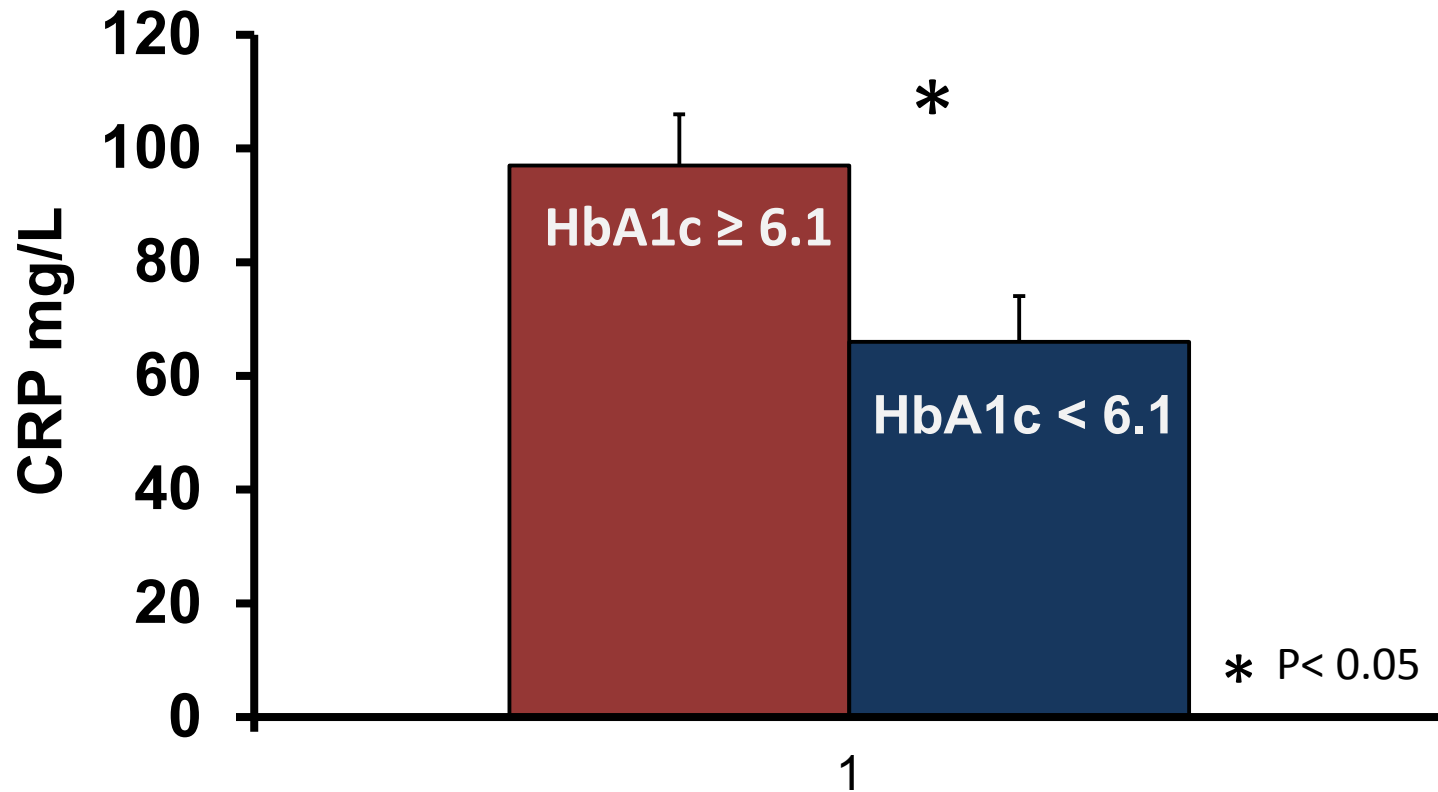
Glucose after major elective surgery



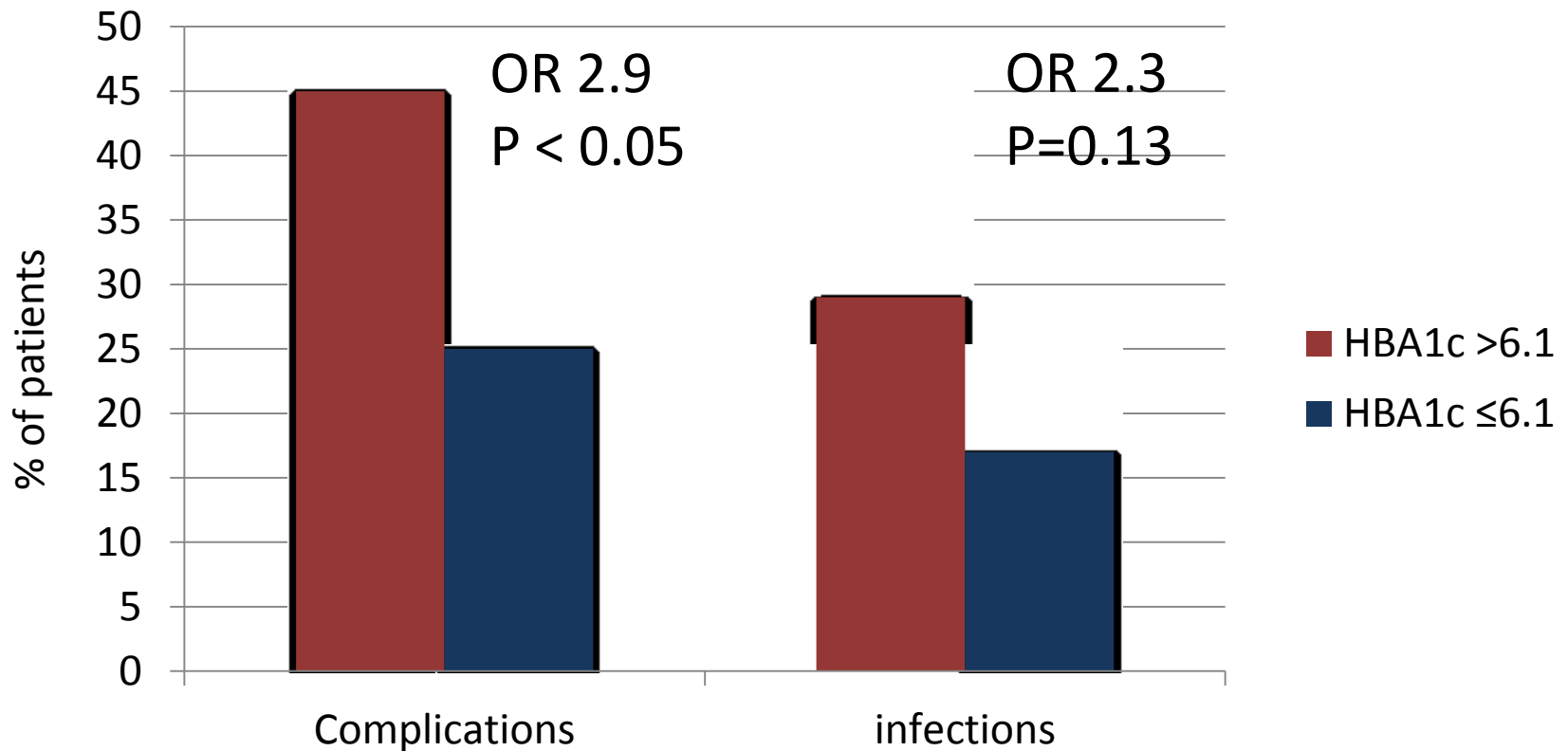
N = 120

1500 kcal/d

CRP postop day 1



HbA1c, Glucose control and postop complications and postop complications

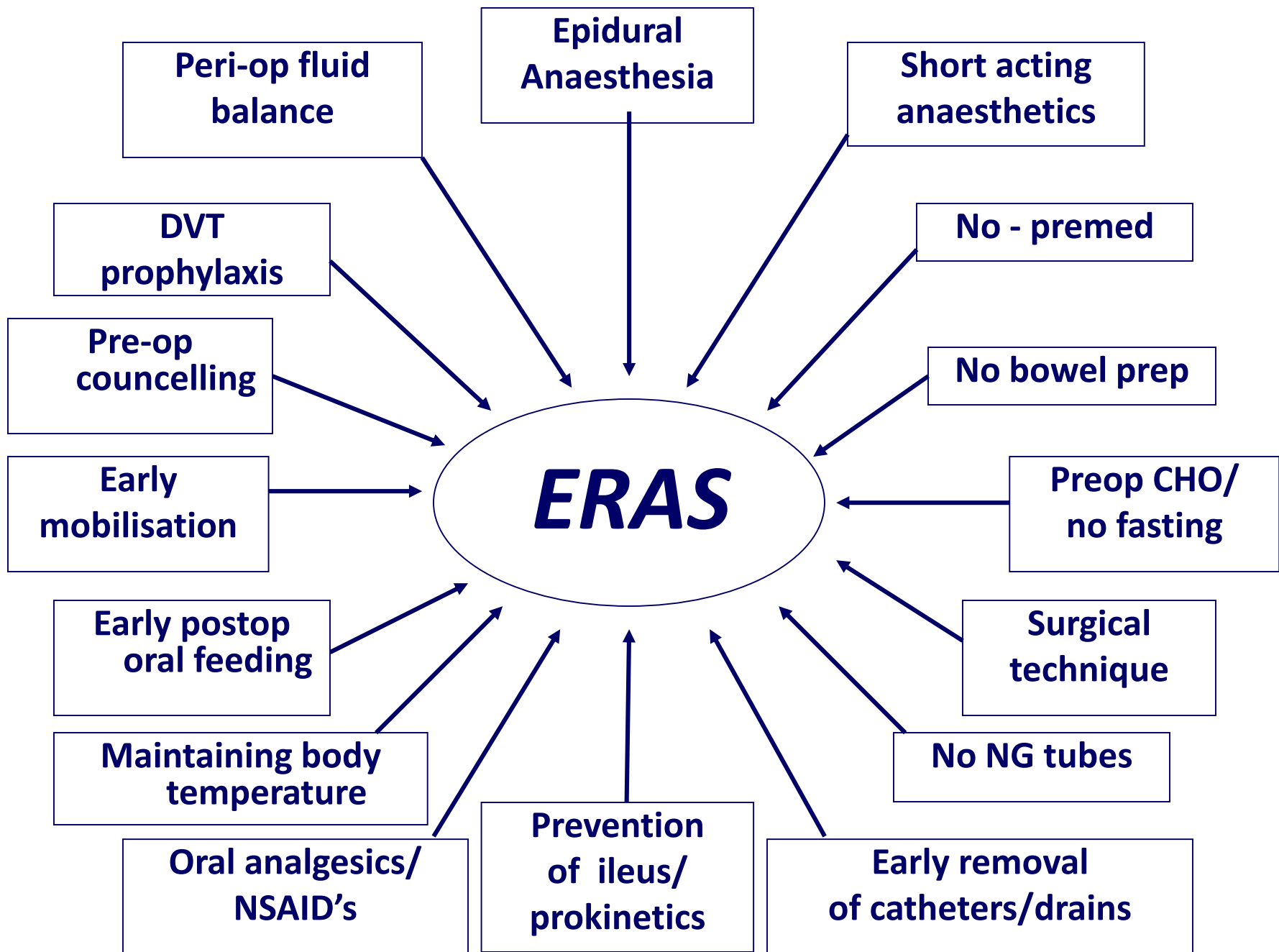


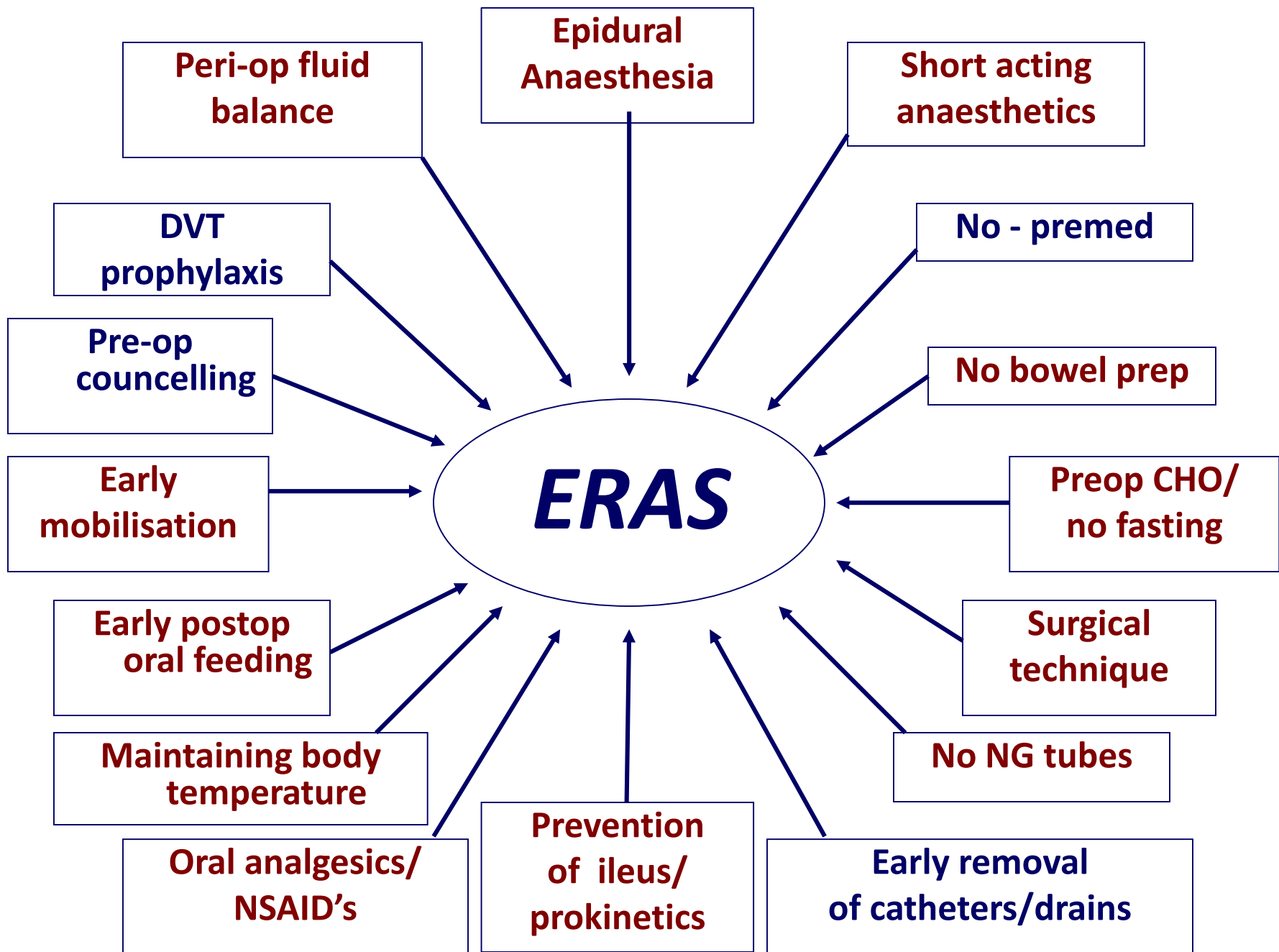
Postoperative insulin resistance increase the risk for complications

273 patients open cardiac surgery, insulin sensitivity determined at the end of op

Complication	OR for every decrease by 1 mg/kg/min (Insulin sensitivity)	P value
Death	2.33 (0.94-5.78)	0.067
Major complication	2.23 (1.30-3.85)	0.004
Severe infection	4.98 (1.48-16.8)	0.010
Minor infection	1.97 (1.27-3.06)	0.003

The ORs were adjusted for potential confounders





ERAS elements to reduce insulin resistance

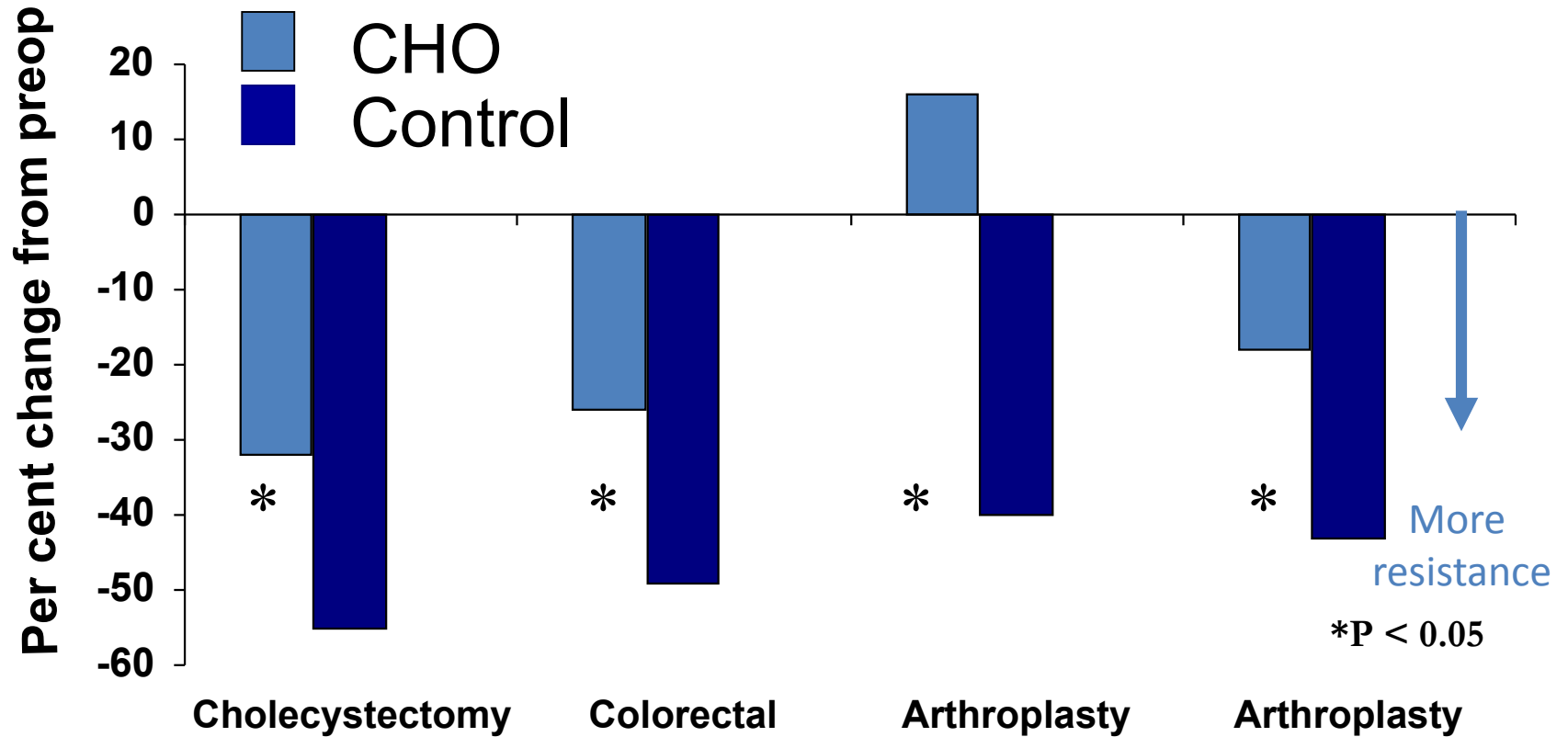
Preoperative

- **Preoperative carbohydrates**
- **Epidural anesthesia**

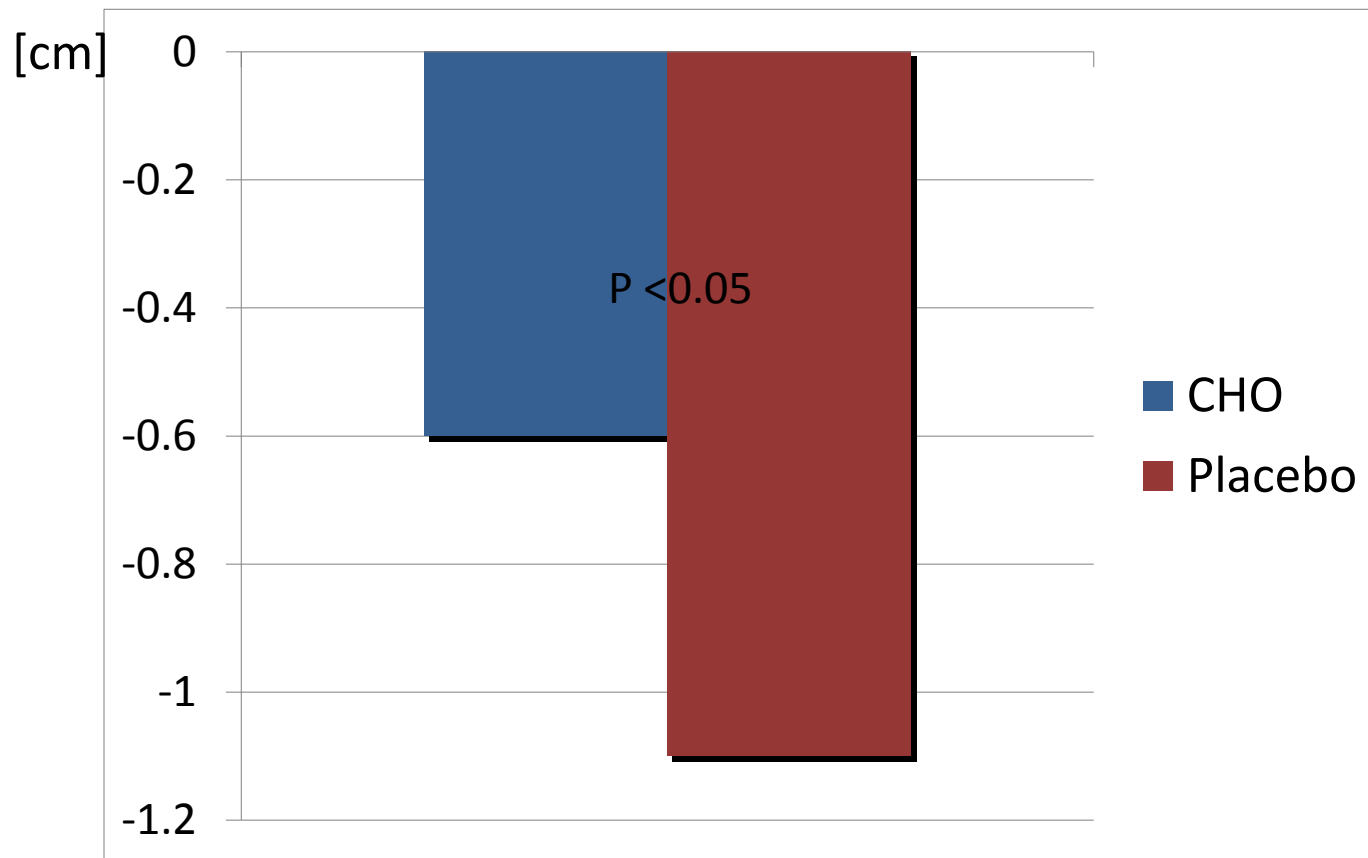
Postoperative

- **Pain control**
- **Early postop feeding**

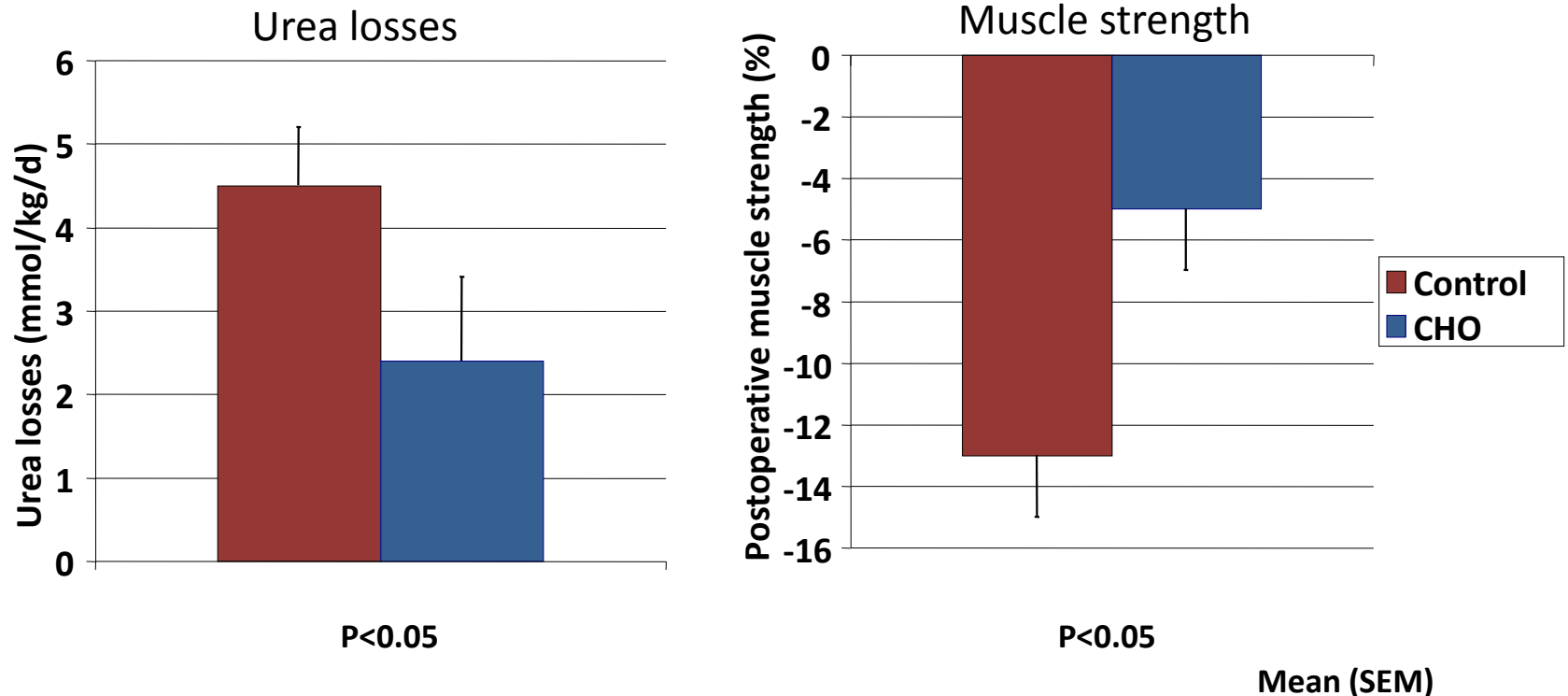
Preoperative CHO reduces postop insulin resistance



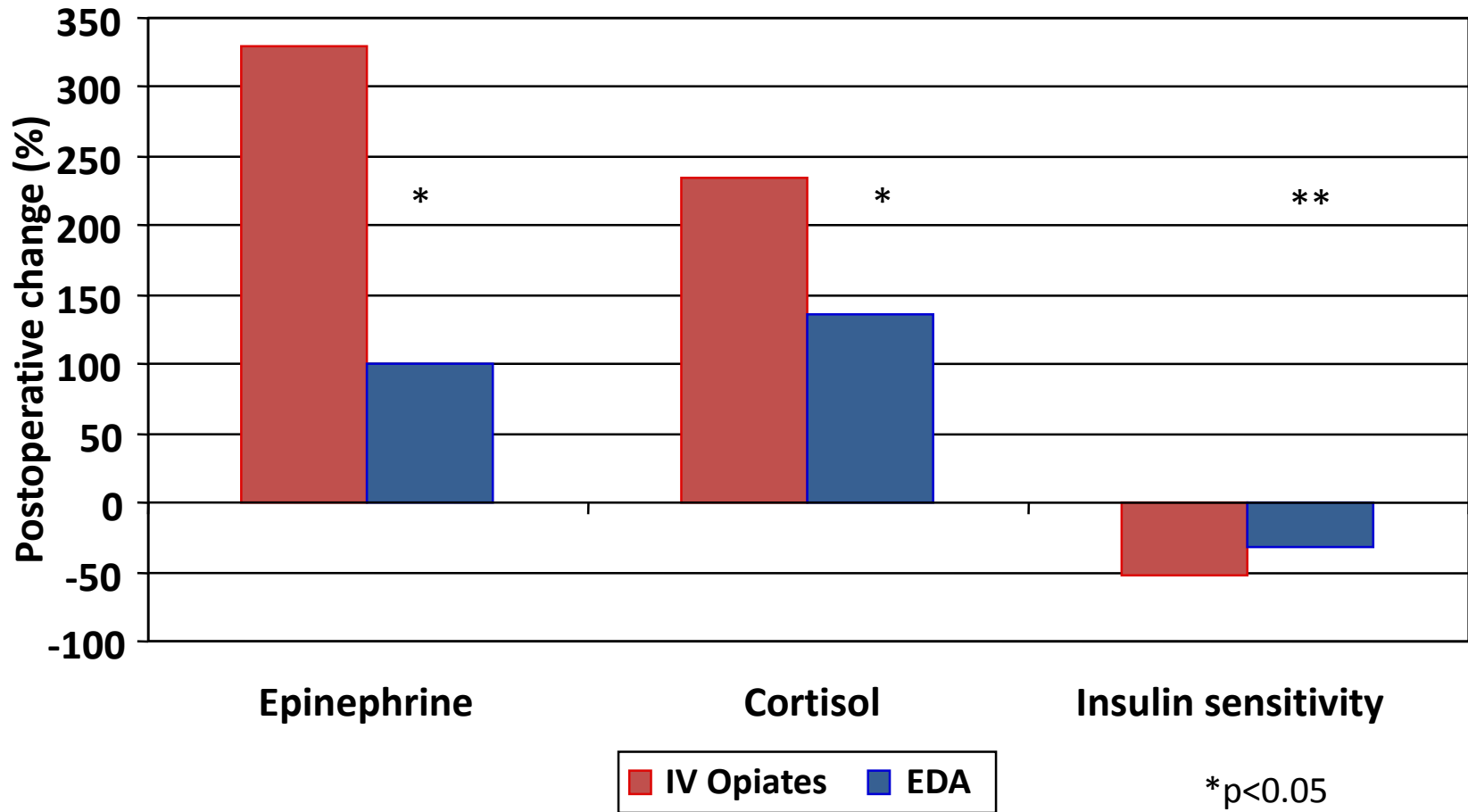
Preoperative carbohydrates retains lean body mass (MAC)



Preoperative carbohydrates reduces protein losses and improves muscle strength

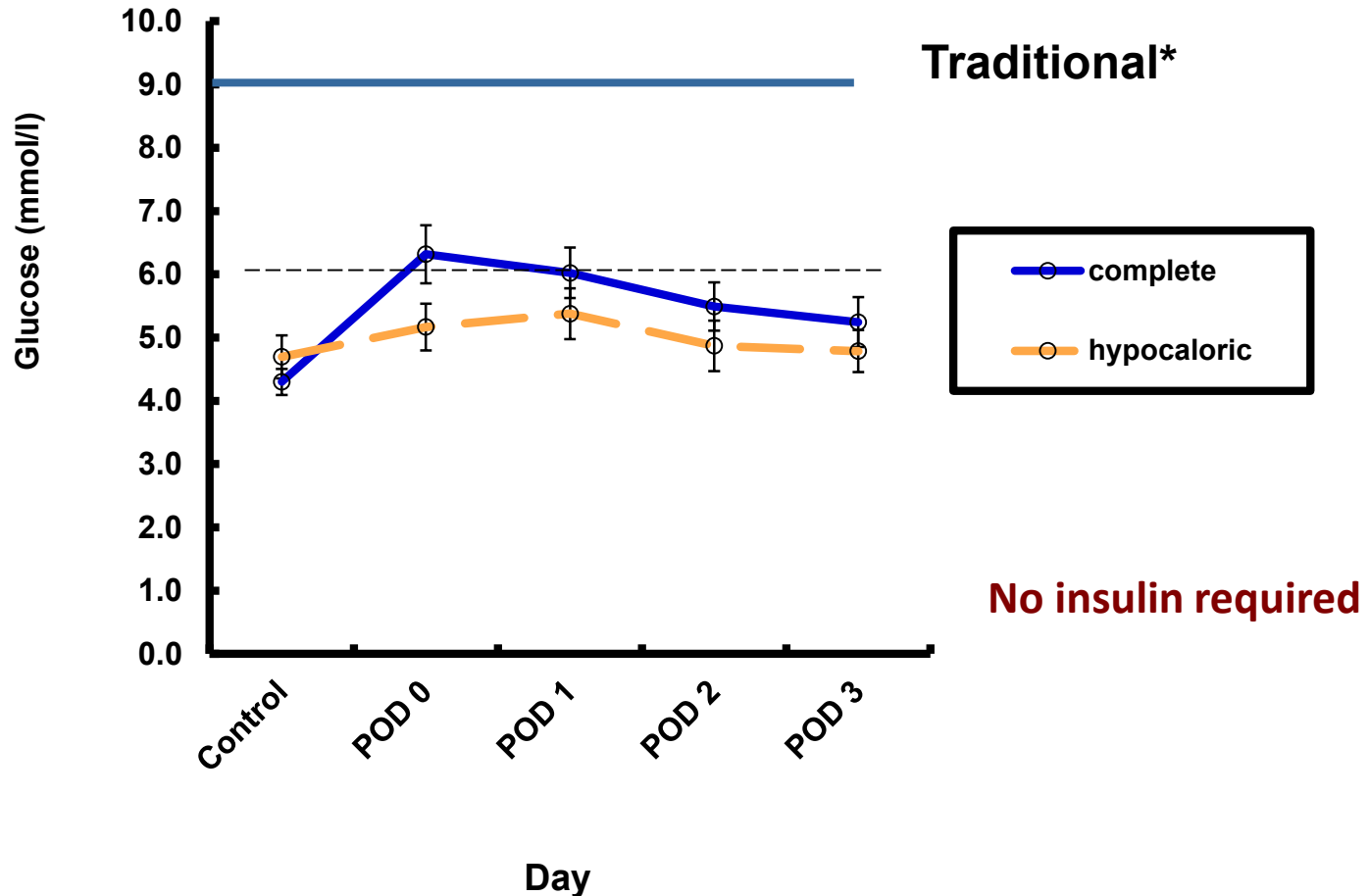


EDA reduces postoperative insulin resistance

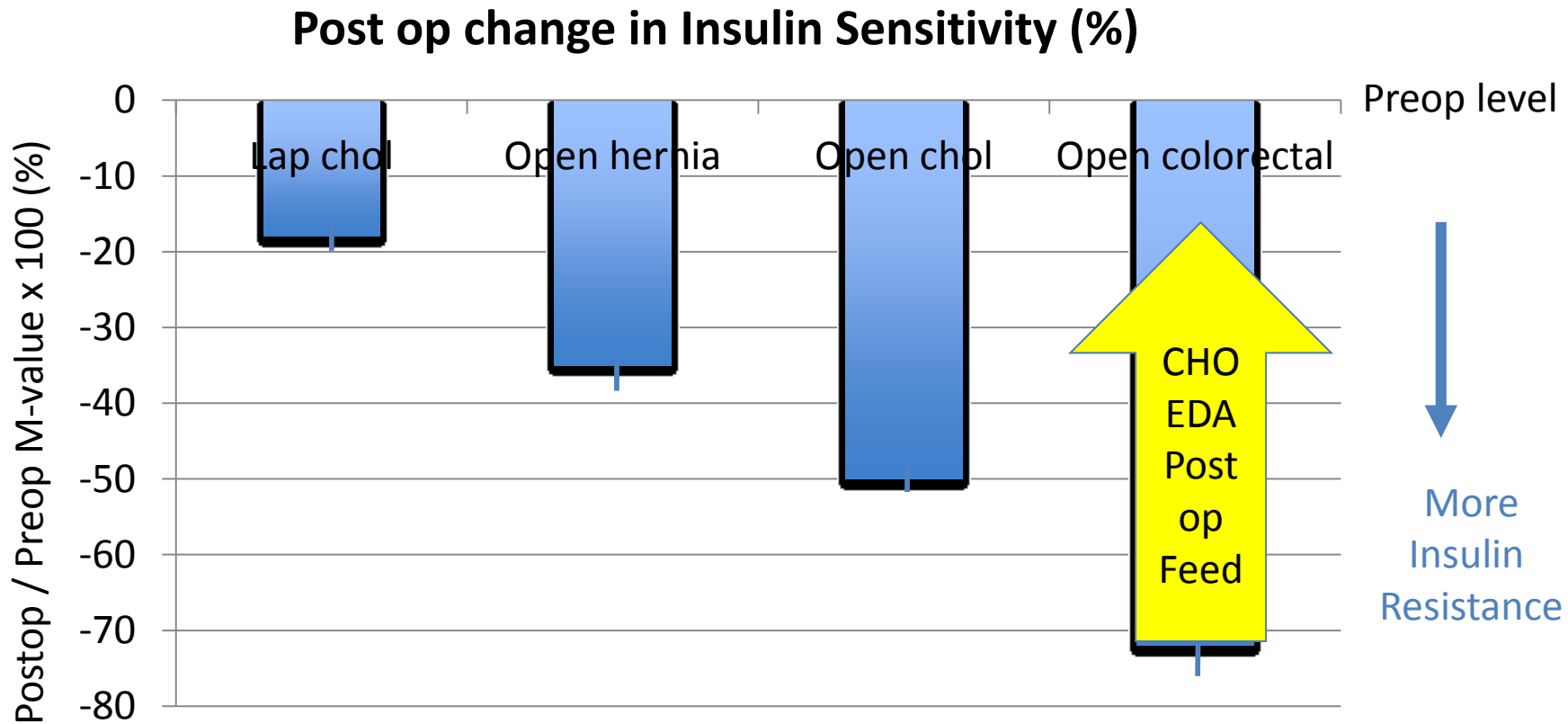


*p<0.05
**p<0.01

EDA + Preoperative CHO to control glucose during enteral feeding

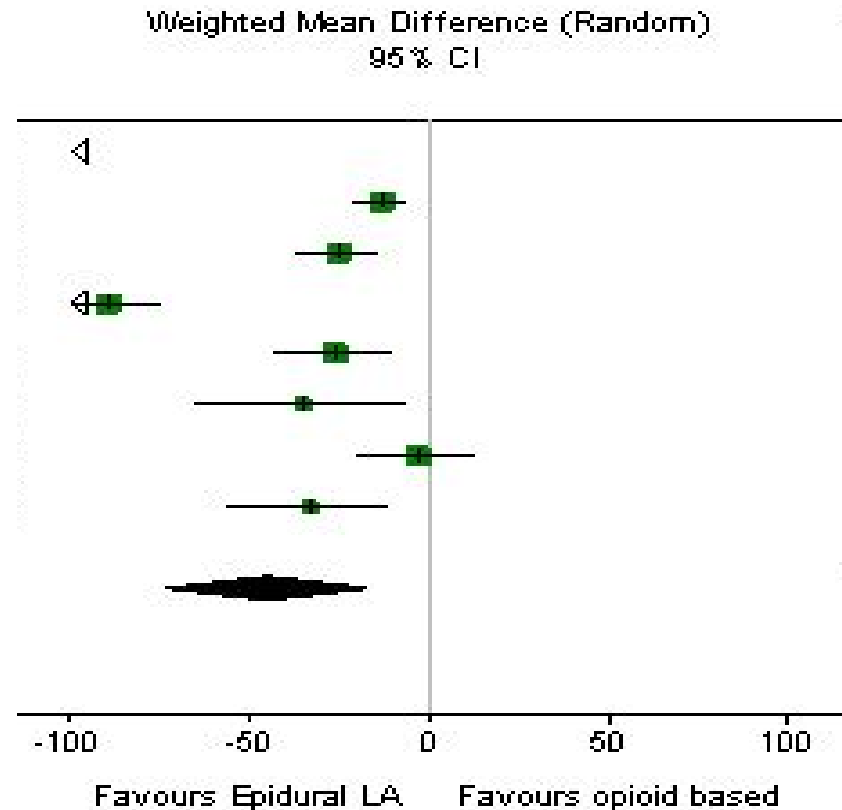


Insulin sensitivity improved with pre op Carb, EDA + post op feed

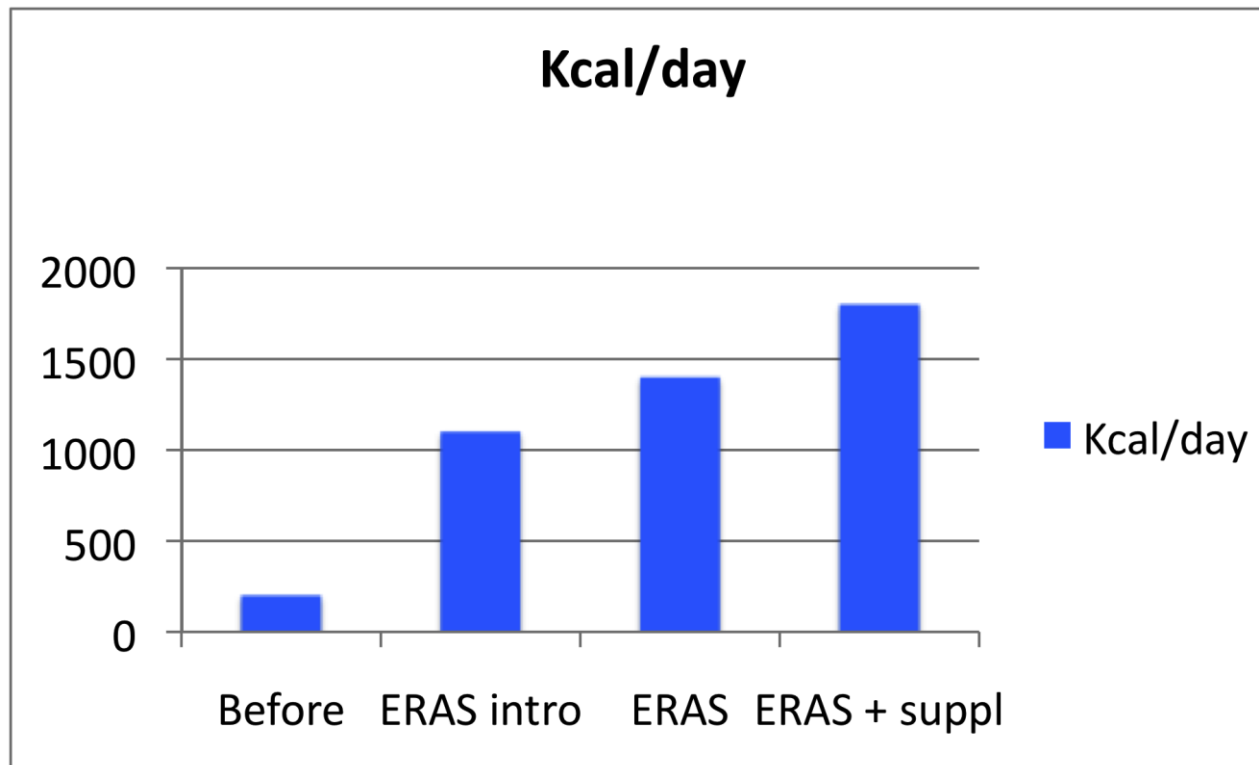


Epidural - less paralysis

EDA vs. Iv opiates



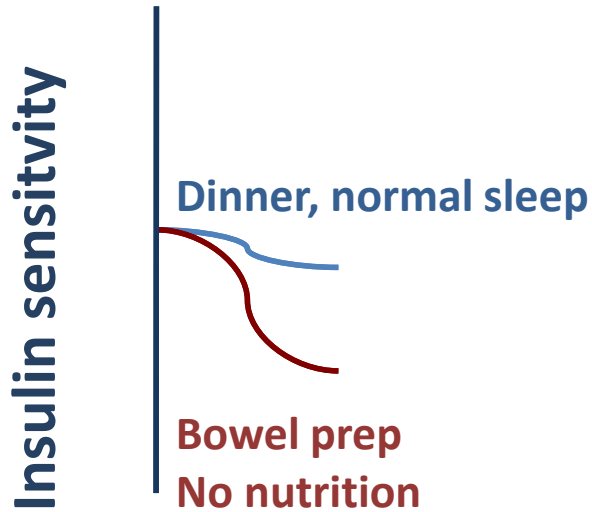
ERAS: oral intake development (mean intake postop day 1-4)



Insulin sensitivity

Day before surgery

ERAS Care

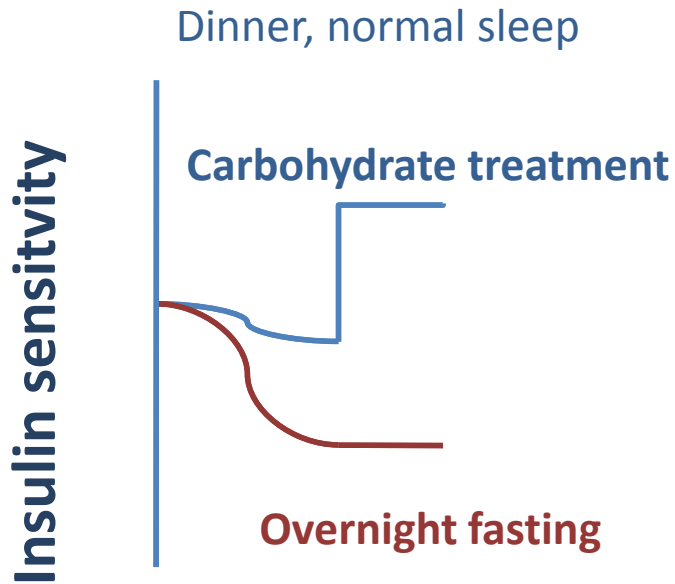


Traditional care

Insulin sensitivity

Morning of surgery

ERAS Care



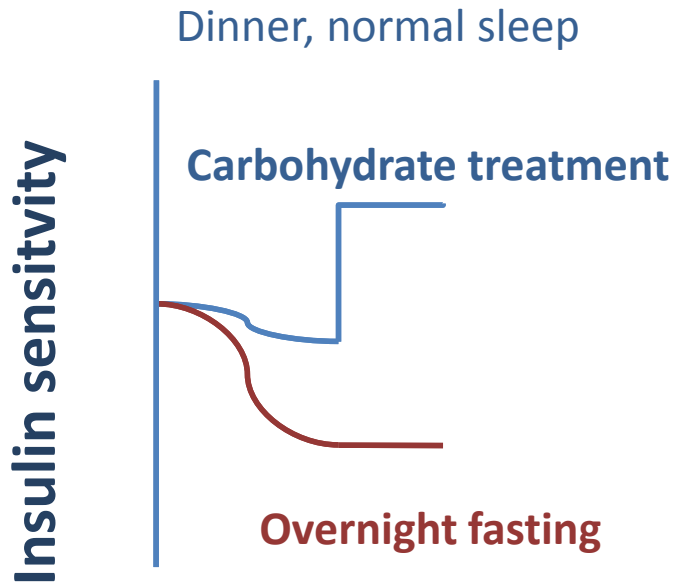
Bowel prep
No nutrition

Traditional care

Insulin sensitivity

Morning of surgery

ERAS Care



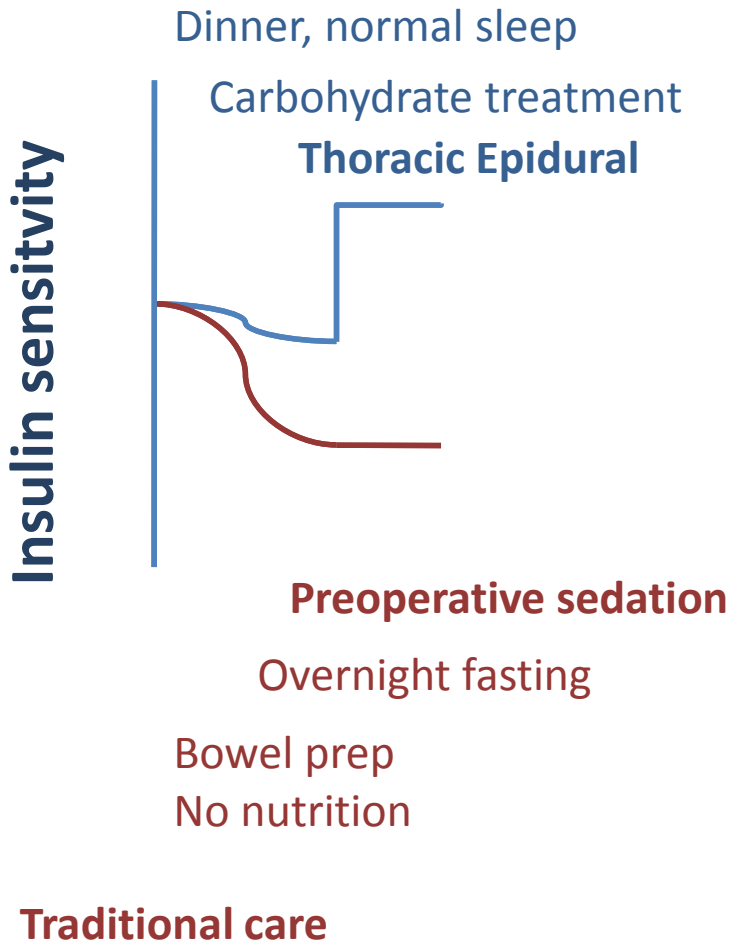
Bowel prep
No nutrition

Traditional care

Insulin sensitivity

Anesthesia start

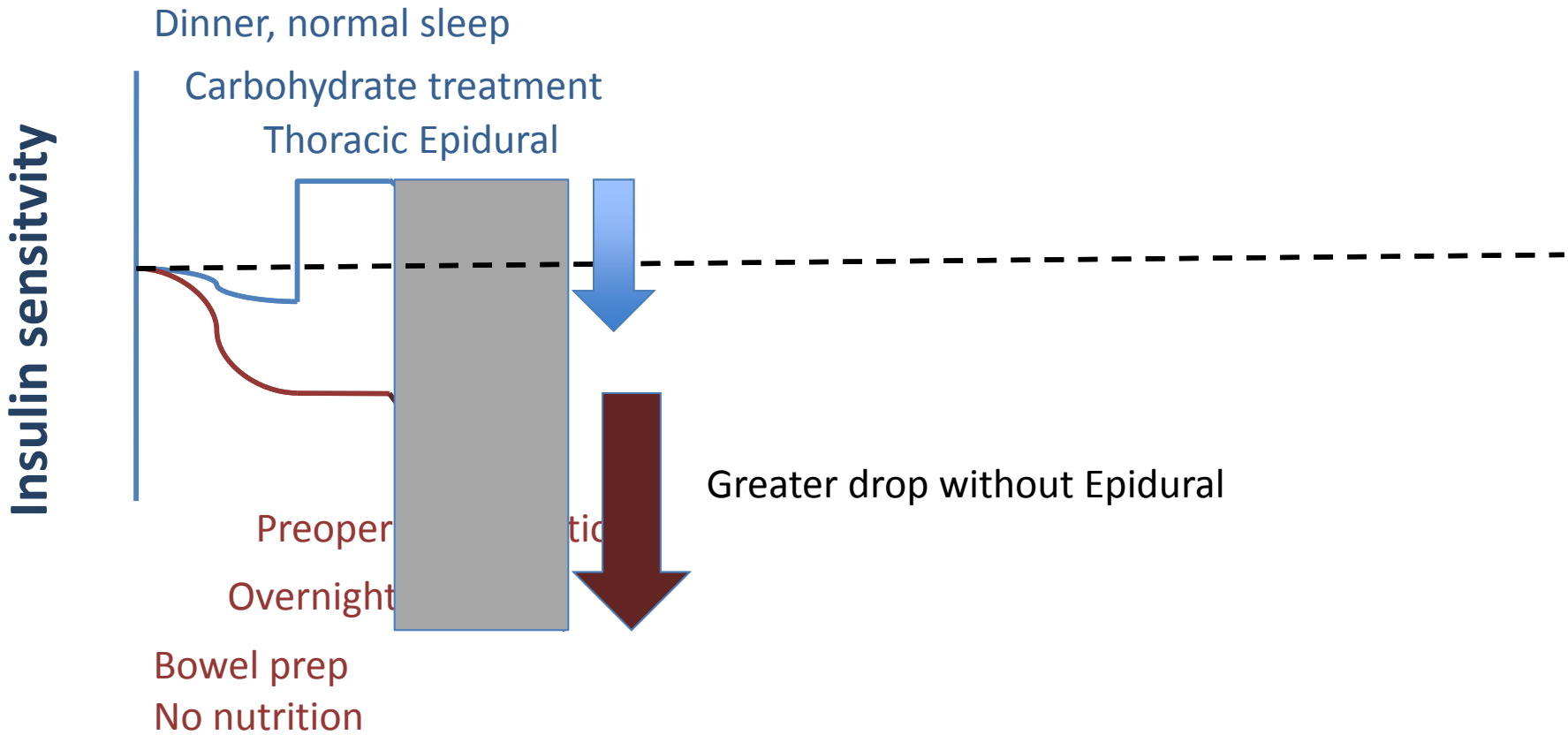
ERAS Care



Insulin sensitivity

Reaction to surgery

ERAS Care

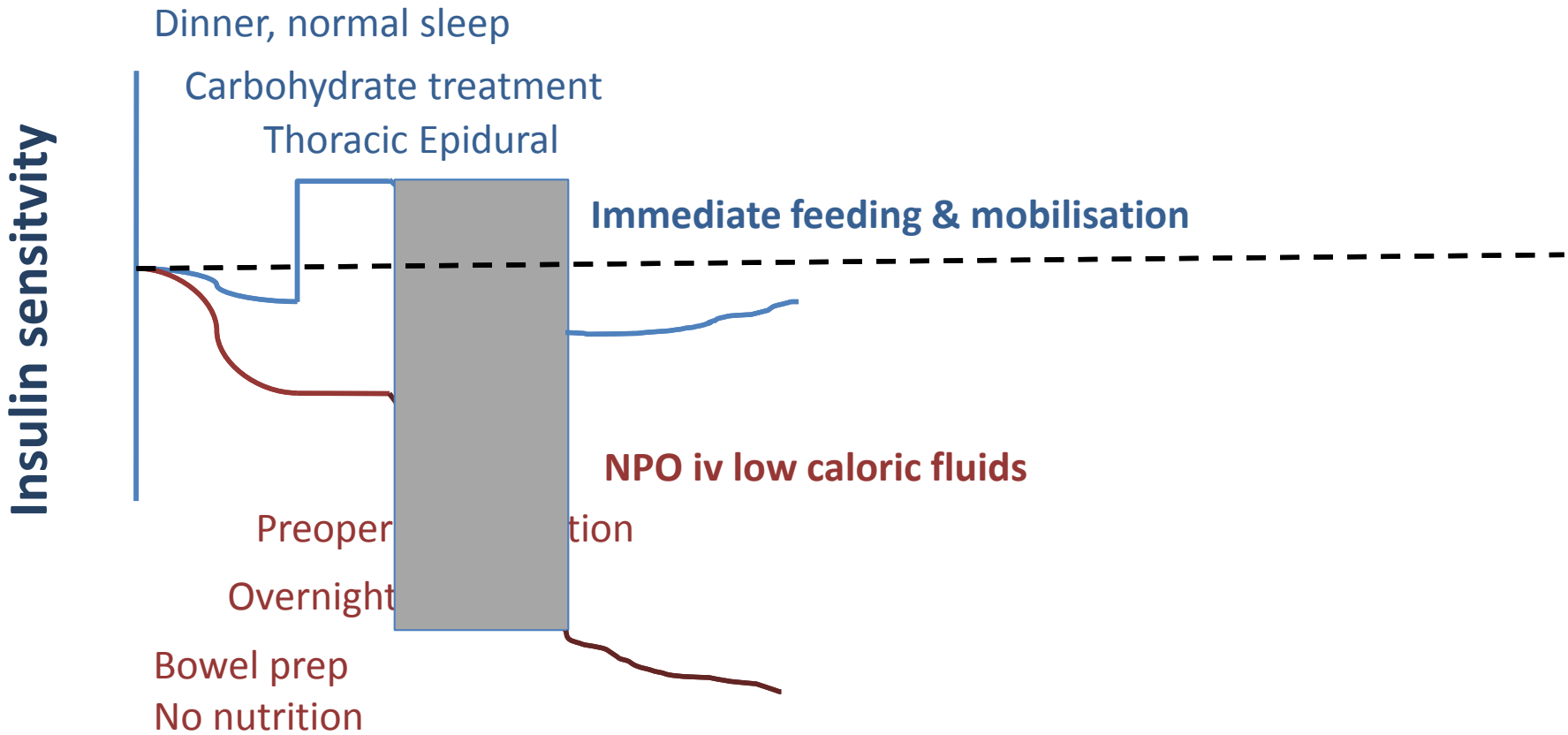


Traditional care

Insulin sensitivity

Afternoon of surgery

ERAS Care

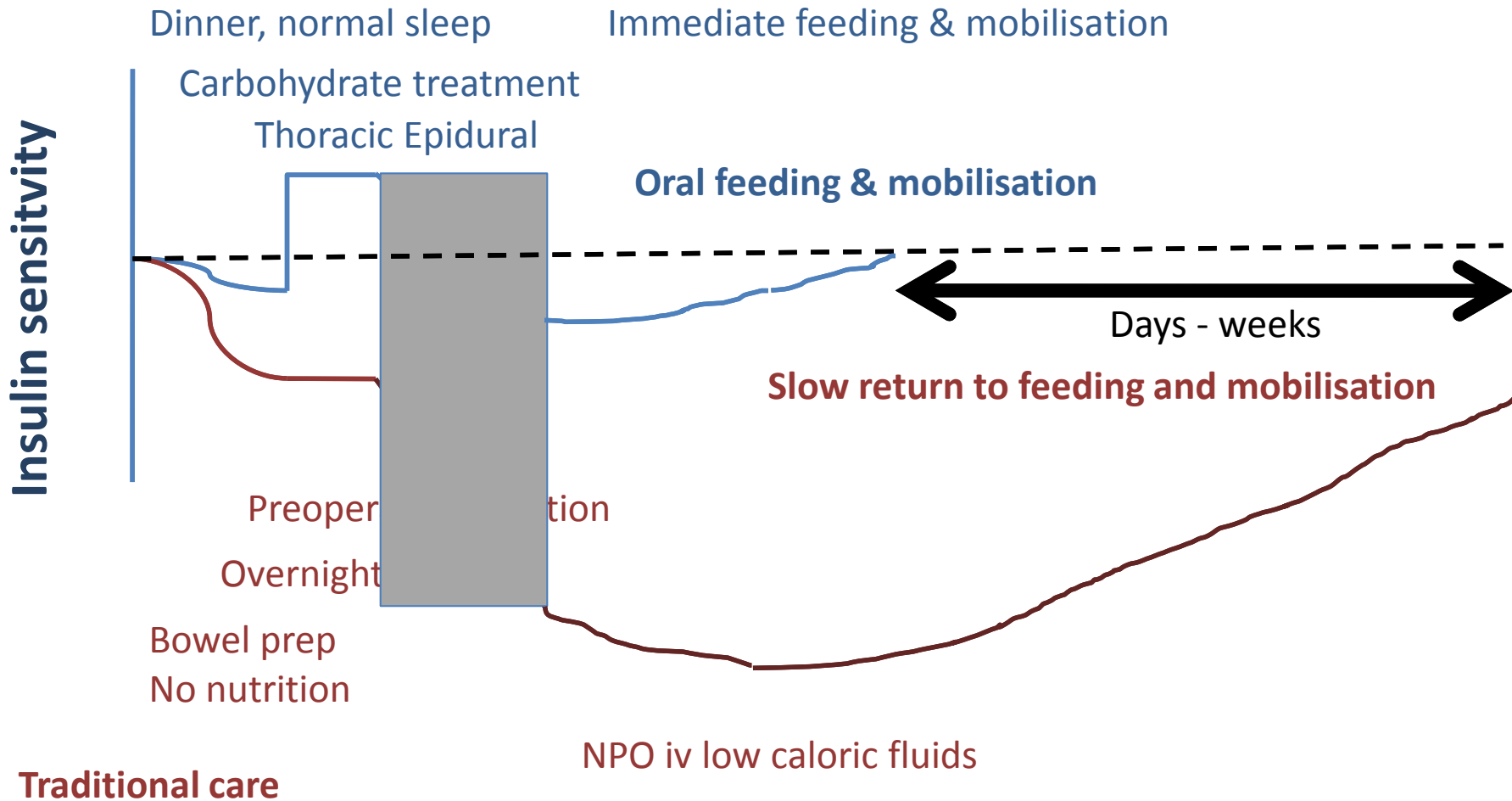


Traditional care

Insulin sensitivity

Days after surgery

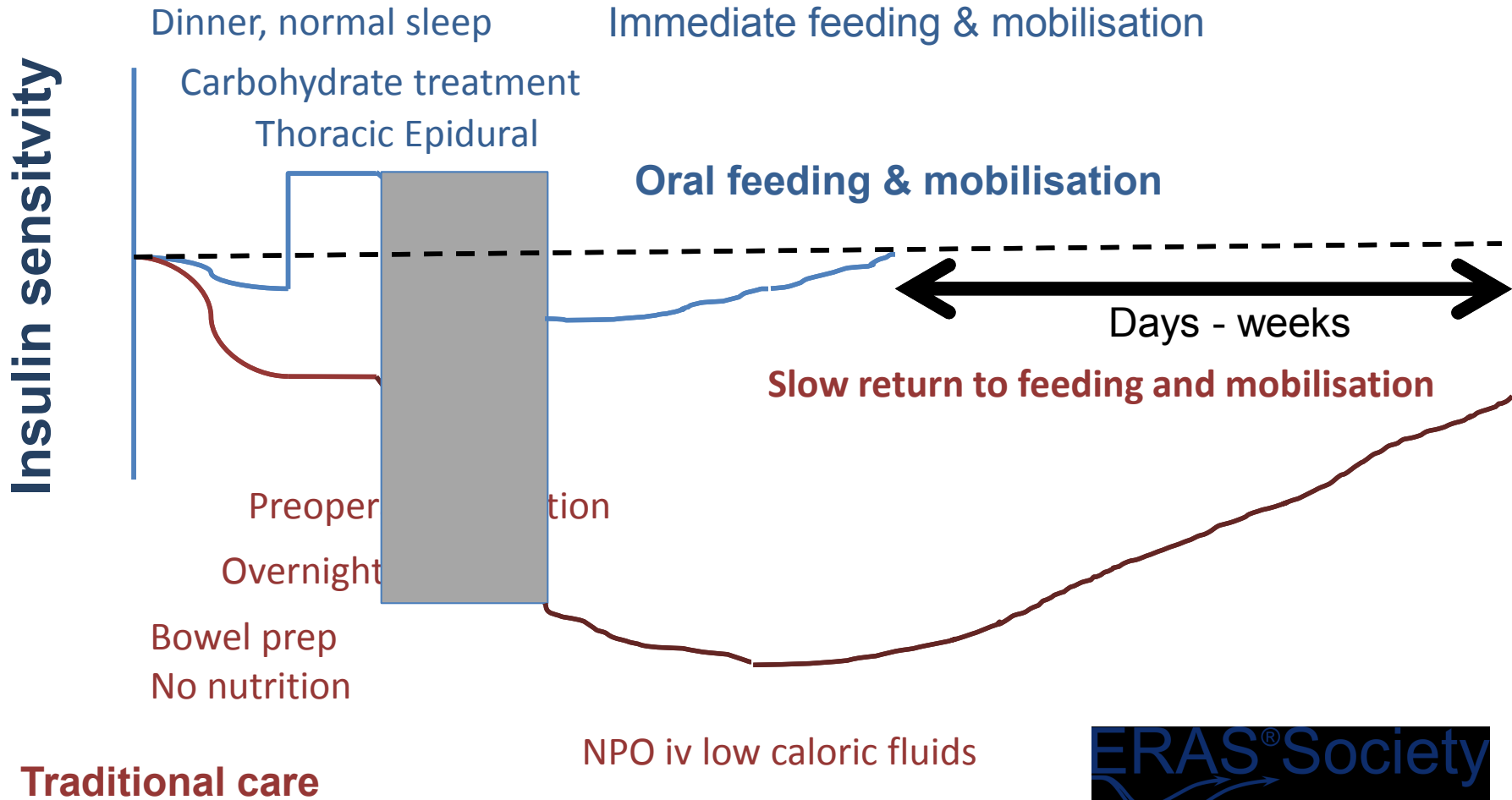
ERAS Care



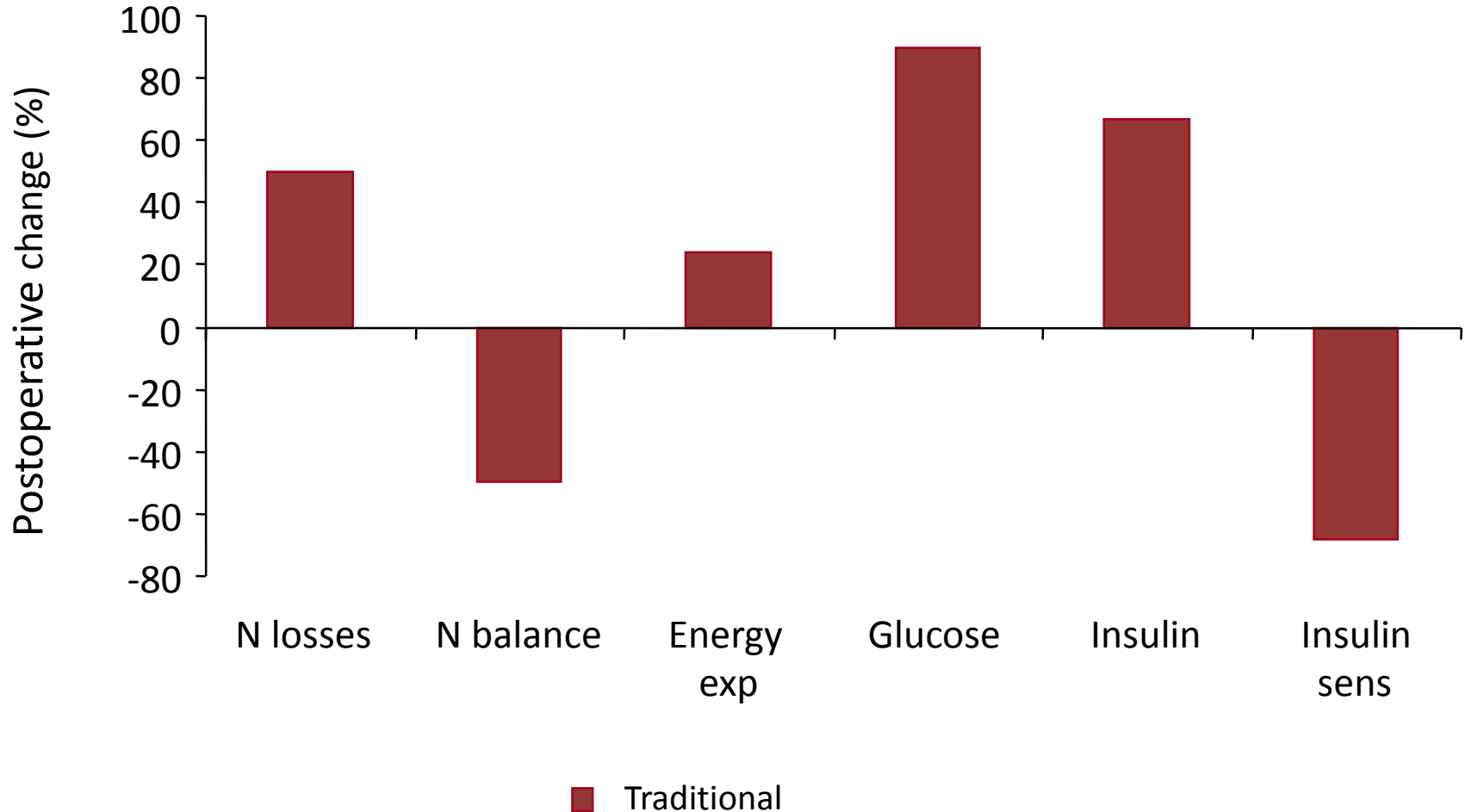
Insulin sensitivity

Days after surgery

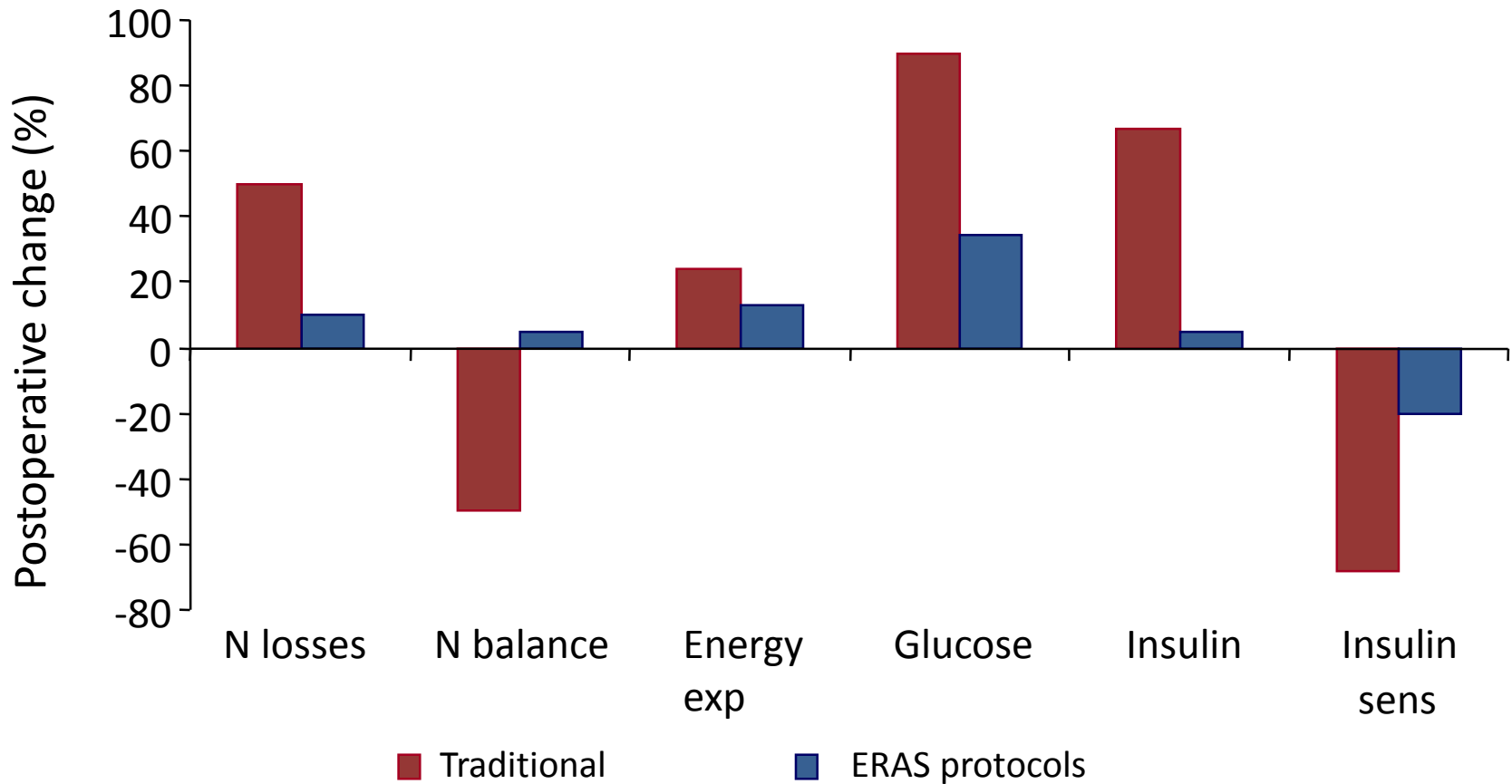
ERAS Care



Metabolic response to surgery in traditional perioperative care



Metabolic response to surgery in traditional perioperative care vs. ERAS protocols



Conclusions

- **Minimizing metabolic stress is key to improved recovery**
- **Insulin resistance is central**
- **ERAS principles works in all major surgery**
- **Many ERAS components reduce metabolic stress**
- **Combining ERAS elements for best results**

2nd World ERAS Congress

- Valencia Spain
- April 23-26, 2014
- Multiprofessional
- Multi disciplinary
- Patient, Practice & Outcomes
- Henrik Kehlet Lecture:
 - Economics of ERAS / A Senagore
- ERAS Lecture:
 - Postoperative cognition / S Newman
- World leaders in ERAS

ERAS® Society

2nd World ERAS Congress

Enhanced Recovery After Surgery

23-26 April 2014 Valencia • Spain

www.erassociety.org

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