# Enteral Nutrition and Access

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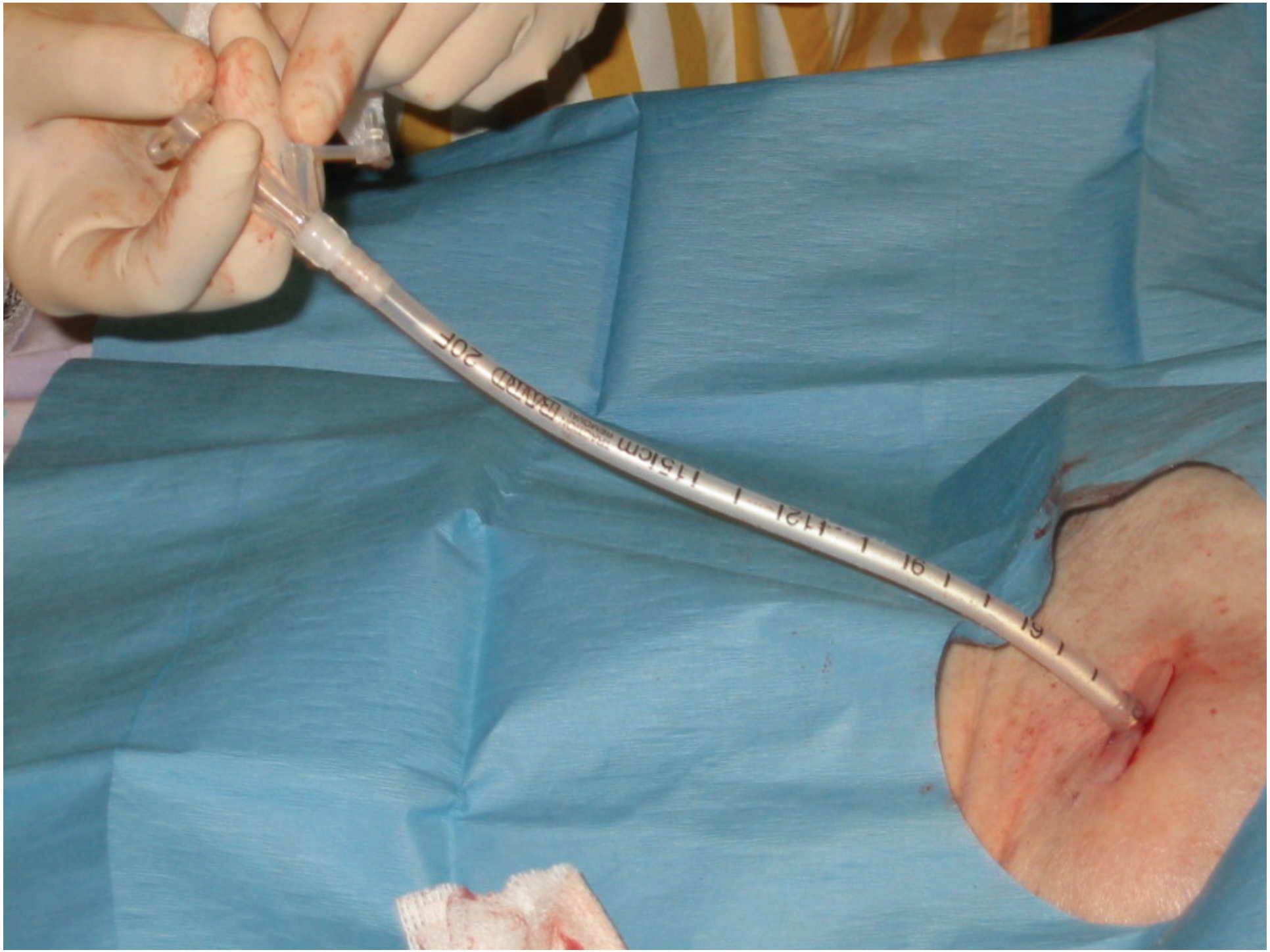
# Why me?

- A surgeon interested in metabolism and nutritional support.
- Endoscopist (PEG-audits).

- ”Growth and integrity of the small intestine in malnutrition and trauma. Effects of glutamine-supplemented nutrition” Thesis 1995
  - Experimental studies on glutamine, intestinal resection and barrier function.

# 1995 - glutamine in animal studies

- In glutamine-deficient states glutamine will stimulate intestinal regeneration and nutrient absorption.
- After major bowel resection glutamine stimulates rapid enterocyte proliferation.
- Glutamine interacts with growth factors and regulatory peptides.


STANDARD 20F
15cm
12
16
19

# Malabsorptive procedures

FIGURE 2
JUJUNO-ILEAL
BYPASS (JIB)
END-TO-SIDE (PAYNE)

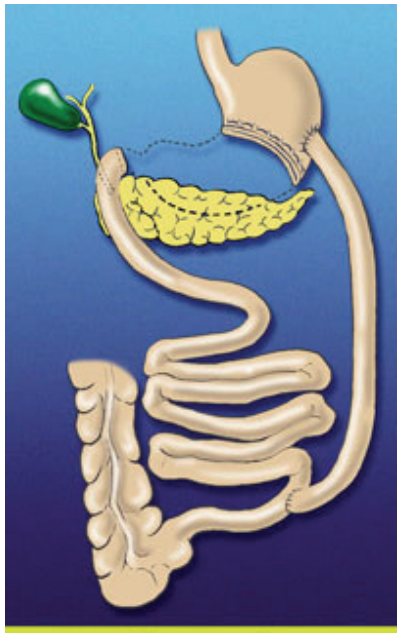


FIGURE 4
BILIOPANCREATIC
DIVERSION (BPD)
(SCOPINARO)

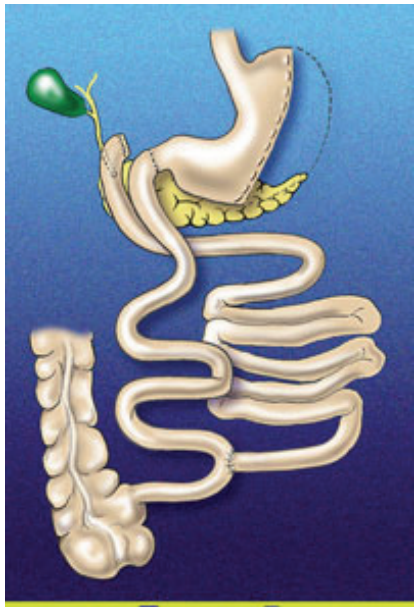
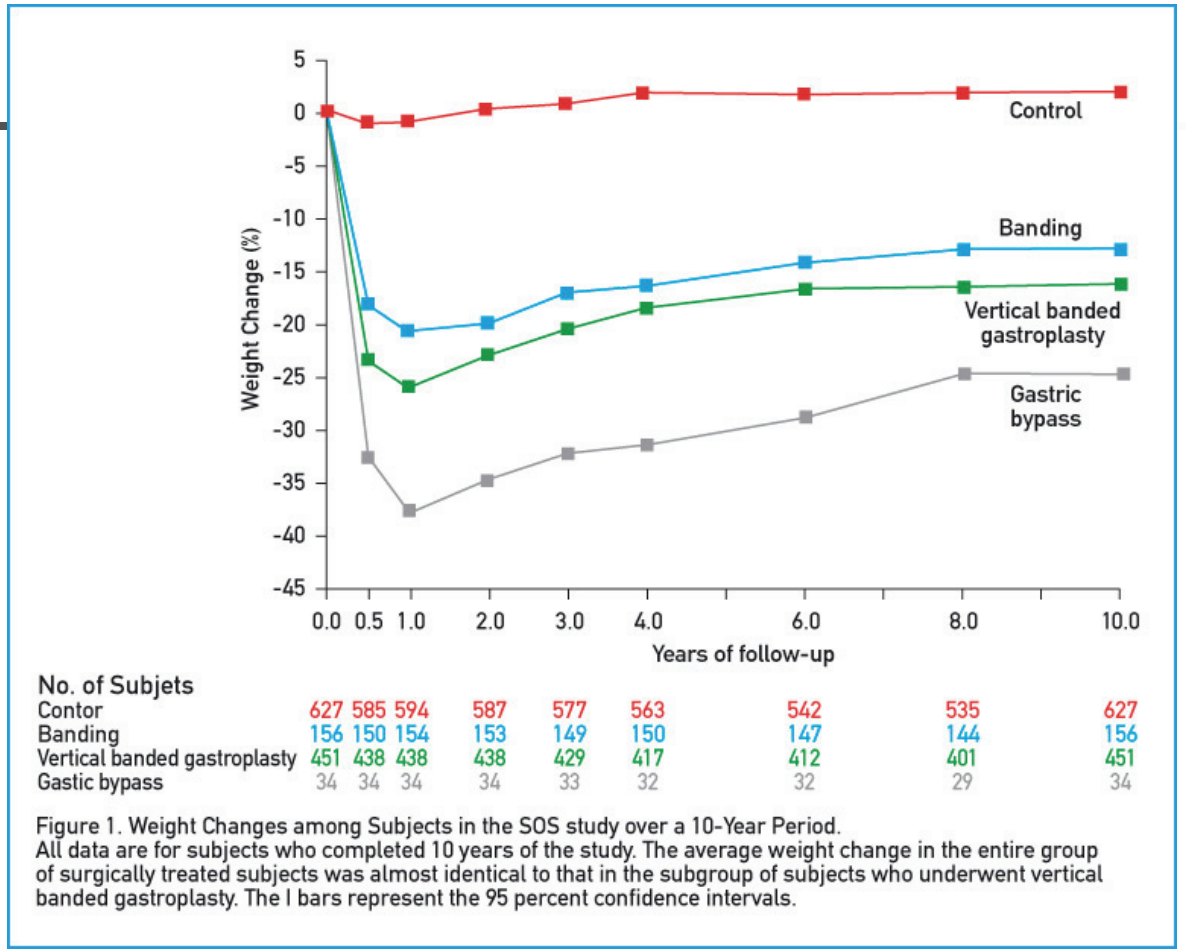


FIGURE 5
BILIOPANCREATIC
DIVERSION (BPD) WITH
DUODENAL SWITCH
(HESS/MARCEAU)

# Swedish Obese Subjects (SOS)




| No. of Subjets | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Contor | 627 | 585 | 594 | 587 | 577 | 563 | 542 | 535 | 627 |
| Banding | 156 | 150 | 154 | 153 | 149 | 150 | 147 | 144 | 156 |
| Vertical banded gastroplasty | 451 | 438 | 438 | 438 | 429 | 417 | 412 | 401 | 451 |
| Gastic bypass | 34 | 34 | 34 | 34 | 33 | 32 | 32 | 29 | 34 |

Figure 1. Weight Changes among Subjects in the SOS study over a 10-Year Period.
All data are for subjects who completed 10 years of the study. The average weight change in the entire group of surgically treated subjects was almost identical to that in the subgroup of subjects who underwent vertical banded gastroplasty. The I bars represent the 95 percent confidence intervals.

Sjostrom L, Lindroos A, Peltonen M, et al. Lifestyle, diabetes, and cardiovascular risk factors in 10 years after bariatric surgery. The New England Journal of Medicine 2004, December 23

# Use it or loose it!

Bacterial translocation is the motor of multiple organ failure!

# Use it or loose it!

Bacterial translocation is the motor of multiple organ failure?

# Gut barrier integrity

- Structural
- Functional
- Immunological

# Enteral nutrition and gut barrier integrity

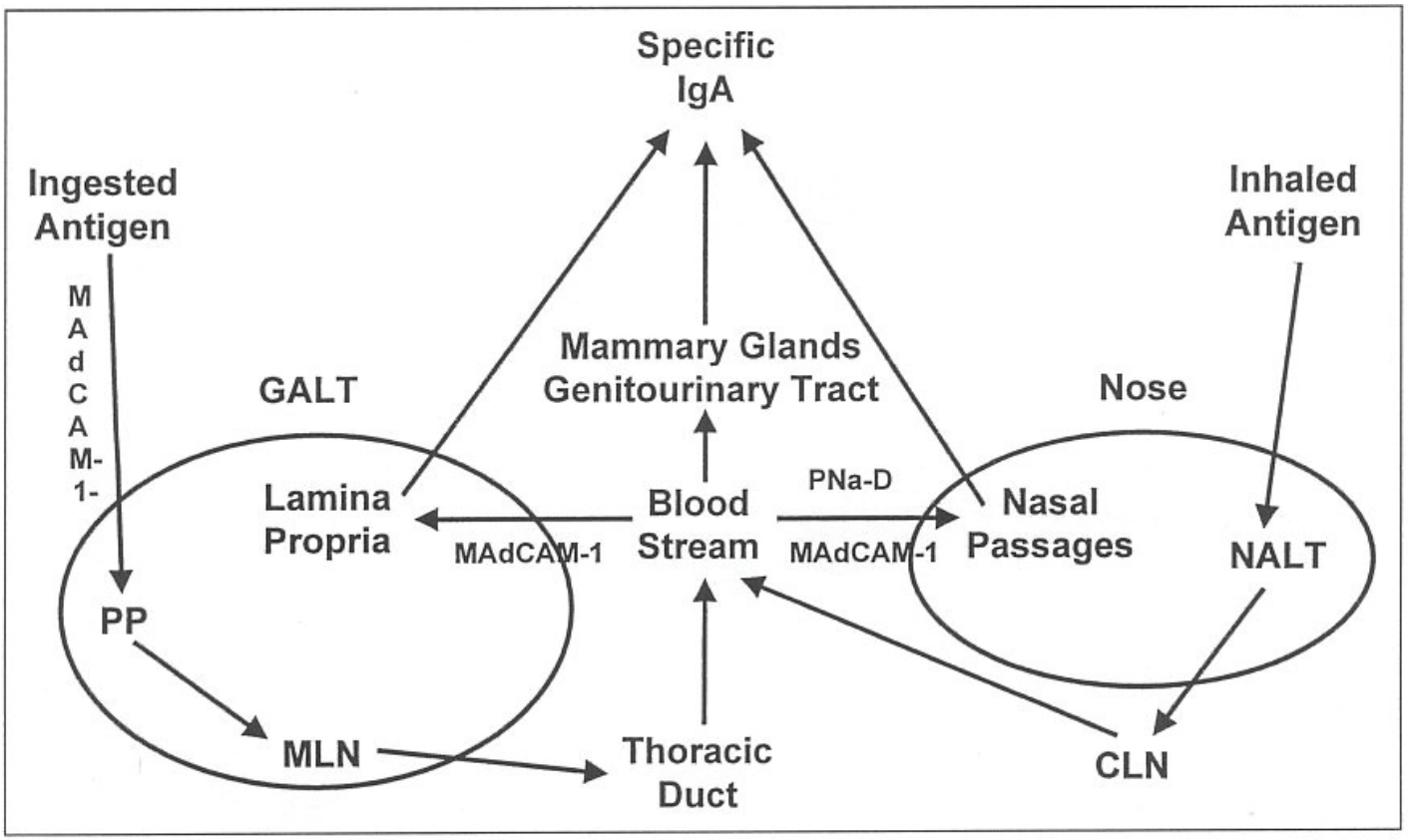
- Structural
  - Mucus layer
  - Villus heigth
  - Crypt permeability
- Functional
  - Intestinal transit
  - Nutrient, growth factors and regulatory peptide feed-back
- Immunological
  - Intraluminal flora
  - GALT

# Gut Associated Lymphatic Tissue (GALT)

- Intraepithelial lymfocytes (IEL)
- Lamina propria
- Peyers patches
- Mesenteric lymph nodes (MLN)

# Effects of route and type of nutrition on intestine-derived inflammatory responses.

Kudsk AK. Am J Surg 185 (2003)16-21



# Gut Associated Lymphatic Tissue (GALT)

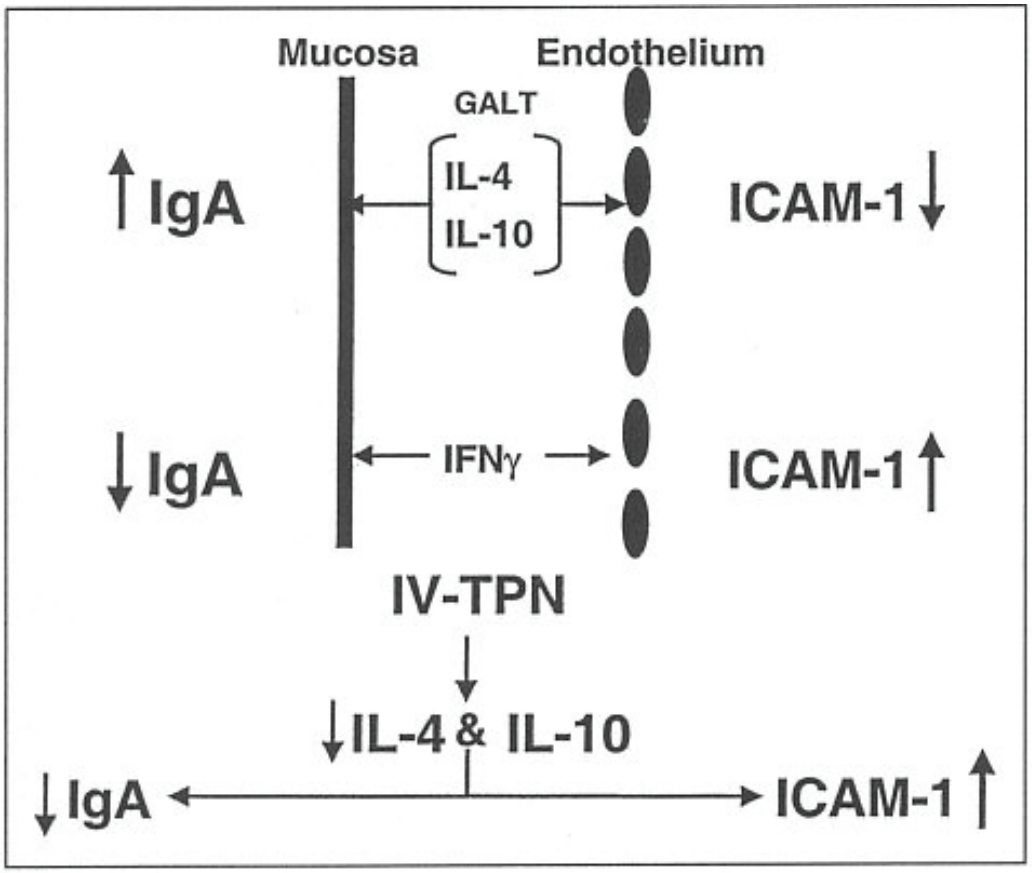
- Intraepithelial lymfocytes (IEL)
- Lamina propria
- Peyers patches
- Mesenteric lymph nodes (MLN)
- Kupffer cells in the liver

# The entero-hepatic immunologic communication

- Primary sclerosing cholangitis and primary biliary cirrhosis in IBD
- TPN-related hepatic dysfunction
- Primary peritonitis in liver cirrhosis and ascites

# Current aspects of mucosal immunology and its influence by nutrition.

Kudsk AK. Am J Surg 183 (2002) 390-398



# Enteral nutrition – the surgeons perspective

- When artificial nutritional support is necessary and there is sufficient nutrient uptake from the small bowel mucosa
- Burns (A)
- Trauma (B)
- Pancreatitis (B)
- Adjuvant to major abdominal surgery, neurosurgery, transplantation and in the ICU

# Agenda

- Surgical practice - Access
- NCJ
- Bacterial translocation and EN
- Practical considerations
- EN better than PN in the ICU???

# Surgical indications

- Orofaryngeal dysphagia, palsy
- GI obstructions
  - malignancies
  - benign stenoses
- Pre- or postop in major abdominal surgery
- Malnutrition

# Access

- Nasogastric tube
- Nasojejunal
- Gastrostomy
- Gastrojejunostomy
- Jejunostomy

# Access

- Nasogastric tube
- Nasojejunal (with gastric decompression)
- Gastrostomy
- Gastrojejunostomy
- Jejunostomy

# Access

- Nasogastric tube
- Nasojejunal (with gastric decompression)
- Gastrostomy
- Gastrojejunostomy (dopamine infusion)
- Jejunostomy

# Prerequisites

- Intestinal absorptive capacity
- Operability
- Expected need of support for 2-3 weeks
- Informed consent by patient or relative!

# Techniques

- Endoscopic
- Open surgery
  - adjunct to major surgery
  - minilaparotomy
- Laparoscopy
- Radiology (Push procedure)

# Jejunostomy

- Surgically placed
- Needle-Catheter-Jejunostomy
- Submucosal tunnelation
- Suturing to peritoneum and skin

# Dislocation of jejunostomy

- Radiology!
- Adjustment under x-ray supervision

- Suturing

# Needle catheter jejunostomy in elective upper gastrointestinal surgery

Literature review

Kjellin A, Wenner J, Wirén M

Huddinge & Lund University Hospitals

# Background

- Needle catheter jejunostomy (NCJ) has been suggested to be beneficial to patients undergoing major resections in the upper GI-tract.

- What evidence is there to suggest that NCJ should be placed routinely in elective surgery for malignancies of the esofagus, stomach or pancreas?

# History of needle catheter jejunostomy

**Pro**

-73 Delany described the technique

-86 Moore & Moore showed positive effects in trauma

-88 Sarr-feasibility in elective surgery

-92 Kudsk-effects in trauma

-95 Myers, Page et al presented retrospective survey of n=2022

**Con**

-82 Strain, Moore et al described ”Pneumatosis intestinalis”

- 85 Gaddy et al presented cases of small bowel ischemia

-88 Smith-Choban et al suggested that EN could be used as a ”stress test”

# History of early enteral nutrition

- The frequency of infectious complications after major trauma can be reduced using early enteral nutrition (EEN) compared to parenteral nutrition (Moore, Moore and Kudsk 1986-)
- EEN has been proposed as a routine procedure in trauma, burns and at reoperative GI-surgery.
- Enteral immunonutrition has been more effective than standard enteral or parenteral nutrition in reducing infectious complications after elective abdominal surgery (Braga, Andreotti…1995-)

# Uncontrolled series NCJ

| Report | N | Surgery | Complications |
|---|---|---|---|
| Delany -73 | **110** | Upper GI | **3,6%** |
| Page –79 | **199** | Elective/emergencies | **2,0%** |
| Eeftincle –83 | **210** | Upper GI | **5,0%** |
| Strickland –86 | **114** | Elective/emergencies | **0,8%** |
| Sarr –88, -99 | **500** | Upper GI | **1,6%** |
| Gerndt –94 | **523** (1976-91) | Esofageal | **2,1%** |
| Myers –95 | **2022** (1978-94) | N=1248 upper GI | **1,7%** |
| D.Gottardi -99 | **100** (1994-97) | Upper GI | **5,0%** |
| Biffi 2000 | **80** | Upper GI | **1,3%** |
| Braga 2002 | **402**/650 NCJ (92-2000) | Malignancies Malnutrition | **2,7%** |

# Controlled trials EEN vs PN

| Trial | EN/PN | Surgery | Outcome |
|---|---|---|---|
| Smith –85 | 25/25 | Upper GI | PN better |
| Bower –86 | 10/10 | Upper GI | Cost only, EN better |
| Baigrie –96 | 50/47 | Esofago-gastric | EN better |
| Watters –97 | 13/15 | Esofagectomies | EN ⇨ respiration ⇩ |
| Heslin –97 | 97/98 | Upper GI | N.S. |

**Feeding related discomfort (diarrhoea,distension…) 15-33%**

# Procedure related complications of NCJ

| **Complication** | **Prophylaxis** |
| --- | --- |
| ▪ Intestinal obstruction | ▪ 3-4 anchoring sutures |
| ▪ Dislocation - leakage - peritonitis | ▪ Radiology if dislocation is suspected |
| ▪ Intestinal ischemia - necrosis | ▪ Never EN in circulatory instability! |
| ▪ Pneumatosis intestinalis | ▪ No profylaxis known |

# Conclusions

- NCJ is technically feasible with a low complication rate when used routinely.
- Malnourished patients are probably doing better with perioperative enteral support.
- There is solid evidence for the use of EEN in burns and trauma.
- NCJ is probably of benefit in abdominal re-operations.
- The evidence for routine use of NCJ in elective upper GI-surgery is week.

# Percutaneous Endoscopic Gastrostomy in the Elderly – Indications and Survival

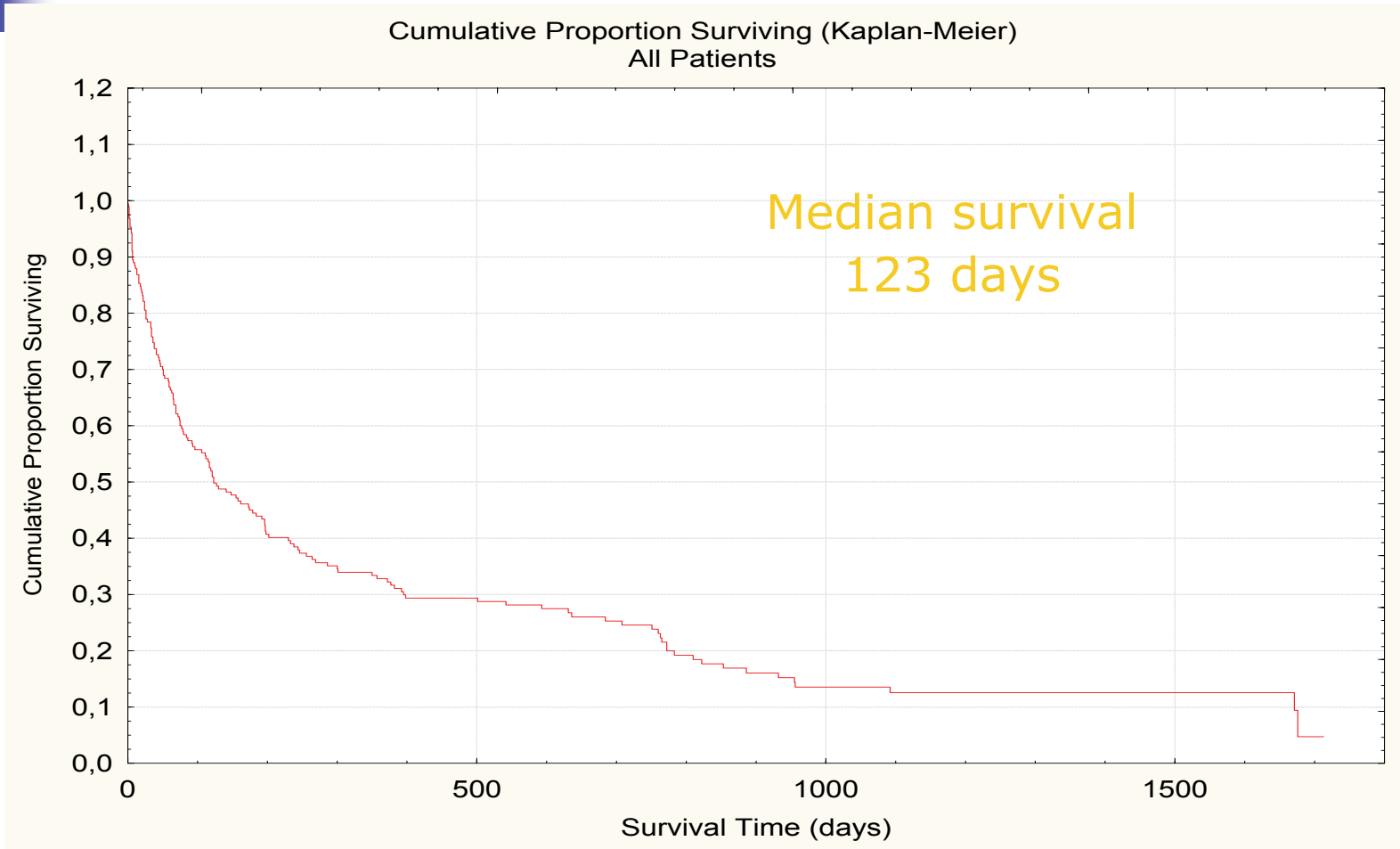
Malmgren A, Cederholm T, Faxén-Irving G, Karlström B, Lundquist P, Wirén M

Submitted

# Material and Methods

- 200 patients (94 females, 106 males), 65 years or older (mean age 79±7 years) received a nutritional PEG between 1997-2000.
- A retrospective registration of age, sex, diagnosis, indication (defined as dysphagia, nutritional support or inability to eat), operation date, possible date of PEG removal and date of death were found in three journal systems.

# Survival




**30-day mortality 22%**

# Komplikationer och mortalitet i litteraturen (PEG)

| | Prospektivt N=5-9 | Retrospektivt N=4-5 | Aktuell studie |
|---|---|---|---|
| Lindriga kompl. | **13-30 %** | 5-15 % | 85 % |
| Svåra kompl. | **1-6 %** | 1-6 % | 15% |
| Mortalitet 30 dgr<br>Procedur-relaterad | **7-27 %**<br>**<2 %** | 4-29 %<br><2% | 33%<br>6 % |

# Bacterial translocation

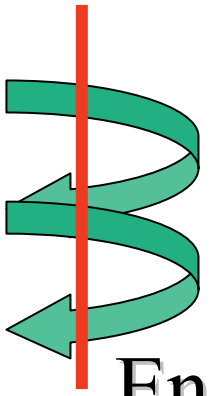
The motor of MOF?

# Translocation – Hypothesis/dogma?

Gut barrier defect

Bacterial translocation

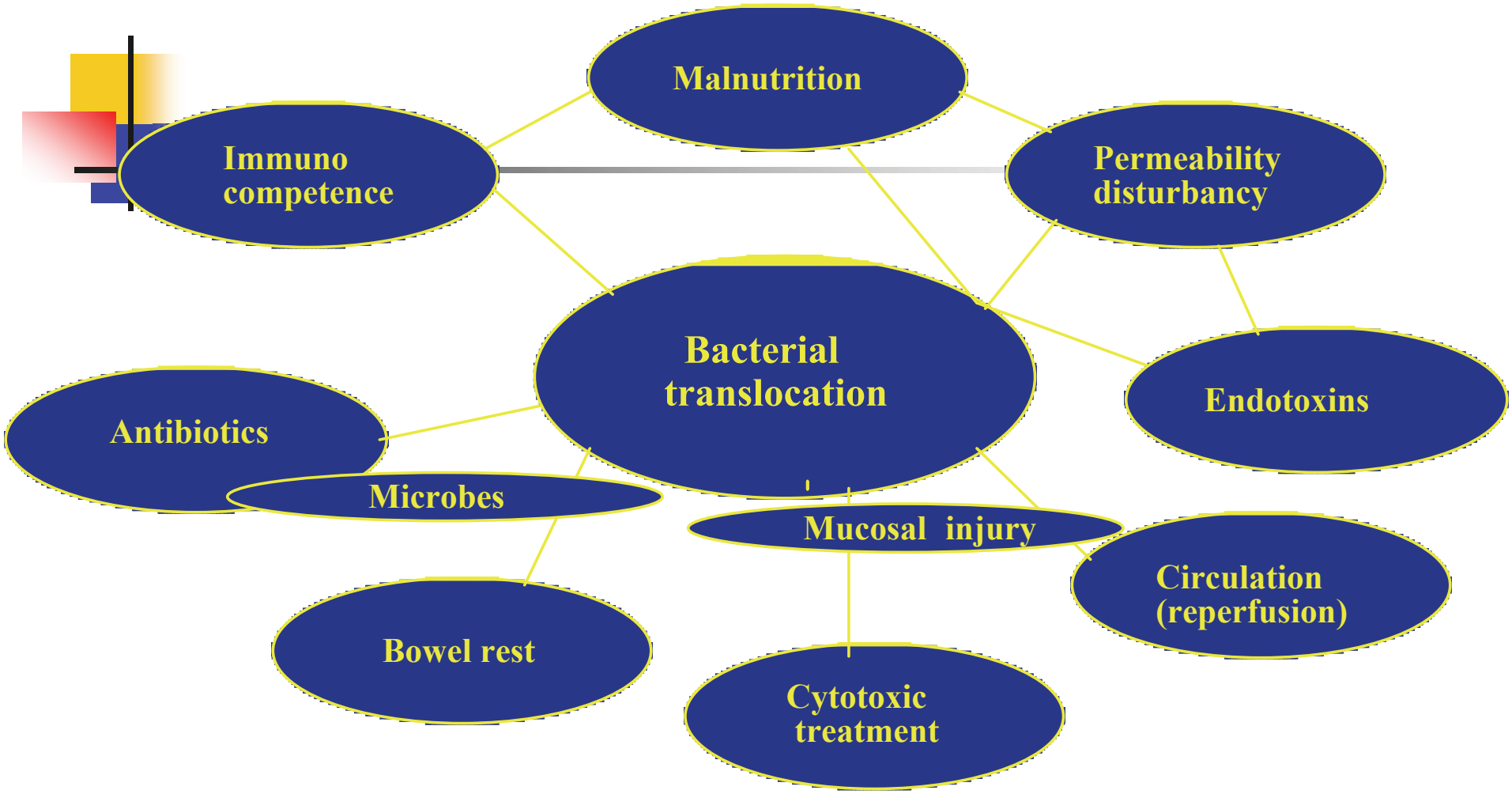
Infection/sepsis



Enteral nutrition

Specific substrates

Enteral nutrition using specific substrates will reduce infectious complications after surgery!


Malnutrition
Immuno competence
Permeability disturbancy
Bacterial translocation
Antibiotics
Endotoxins
Microbes
Mucosal injury
Circulation (reperfusion)
Bowel rest
Cytotoxic treatment

# Clinically relevant states

- Burns
  - Enteral feeding is clinical practice
- Pancreatitis
  - Enteral/gastric feeding is feasible
- Primary peritonitis in cirrhotic ascites
  - The entero-hepatic axis

# GALT-immunocompetence

Suppression

- Malnutrition
- Irradiation
- Antibiotics
- Cytostatics
- Steroides
- Immunsuppression

Stimulation

- Nutrition
- Prebiotics
- Probiotics
- Immuno-nutrientes
  - Glutamine
  - Arginine
  - Nukleotides
  - Omega-3-FA
  - Structurered lipides

# Evidence

- EN/PN in trauma (Moore)
- Immunonutrition/EN in elective surgery (Braga)
- Glutamine in IBD (Van der Hulst)
- Glutamine in EN/PN in ICU (Griffiths, Houdijk)

- Immunonutrition/hypocaloric rehydration (Heslin at Sloan Kettering)

## Perioperative immunonutrition in patients undergoing cancer surgery: results of a randomized double-blind phase 3 trial. Braga et al. Arch Surg 1999 Apr;134:428

- N=206, CRC, gastric/pancreatic cancer
- Study protocol; drink EN 1 l/day, 7 days pre-op + 7 days jejunostomy
- Immuno vs. standard EN
- Results;
  - Infections 14% vs. 30% ($p<0.01$)
  - LOS 11.4 (4.4) vs 12.9 (4.6) ($p<0.05$)

# A prospective, randomized trial of early enteral feeding after resection of upper gastrointestinal malignancy
Heslin MJ. Ann Surg 1997;226:567

- 98 patients recieved crystalloids, caloric intake was 22 % of goal

  (25 kcal/kg/day)

- 97 patients recieved Impact, caloric intake was 65 % of goal

## A prospective, randomized trial of early enteral feeding after resection of upper gastrointestinal malignancy
Heslin MJ. Ann Surg 1997;226:567

- No significant differences in infectious complications, outcome or LOS

## A prospective, randomized trial of early enteral feeding after resection of upper gastrointestinal malignancy Heslin MJ. Ann Surg 1997;226:567

- Anaesthesia time was longer in treatment group ($p<0.005$)
- Same frequency of abdominal complications but 3-4 days later in controls

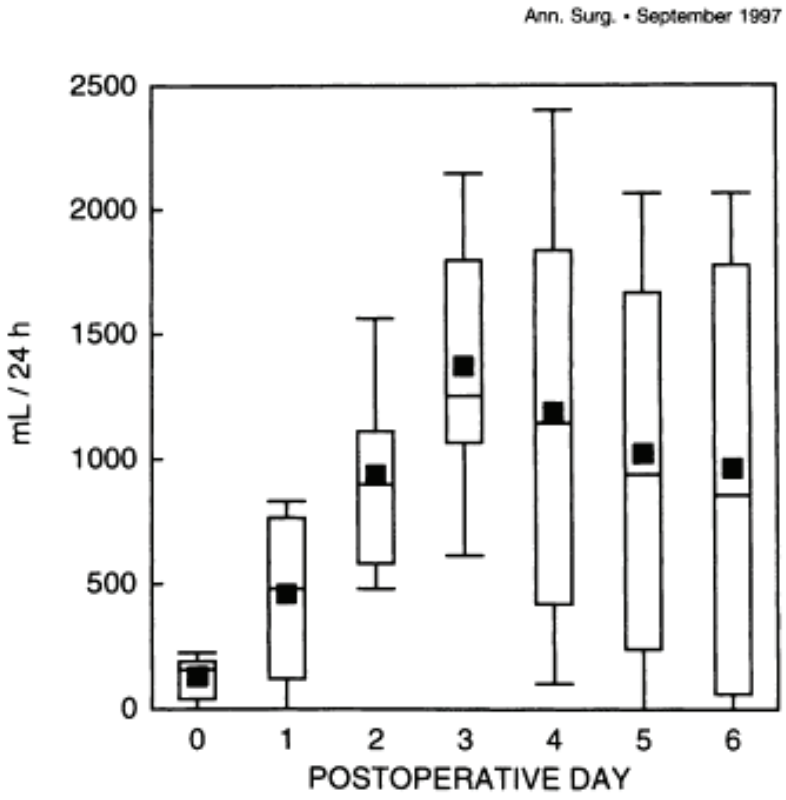
# Early enteral nutrition
# Pros and cons

- PN-complications are avoided
- Cost is reduced
- Intestinal tolerance is increased
- Intestinal integrity is upheld
- Avoidance of fluid/sodium overload
- Less risk of hyperglycemia

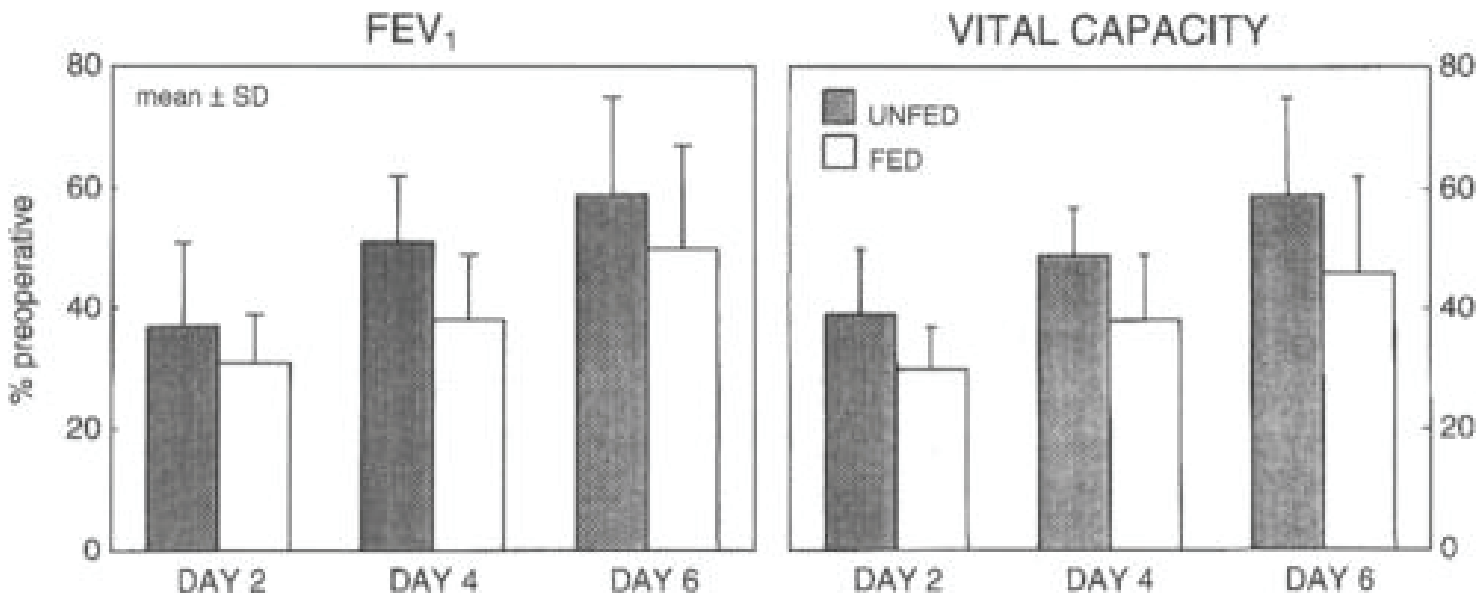
- CVC is used anyhow in these procedures
- Immunonutrients=PN
- Diarrhoea is still a problem
- Mainly animal results
- Procedure-related complications

**Immediate postoperative enteral feeding results in impaired respiratory mechanics and decreased mobility.**
J M Watters et al. Ann Surg 1997;226:369-380

- Esophagectomy or pancreatoduodenectomy
- N=28
- Enteral feeding vs. parenteral fluids



**Immediate postoperative enteral feeding results in impaired respiratory mechanics and decreased mobility.**
J M Watters et al.

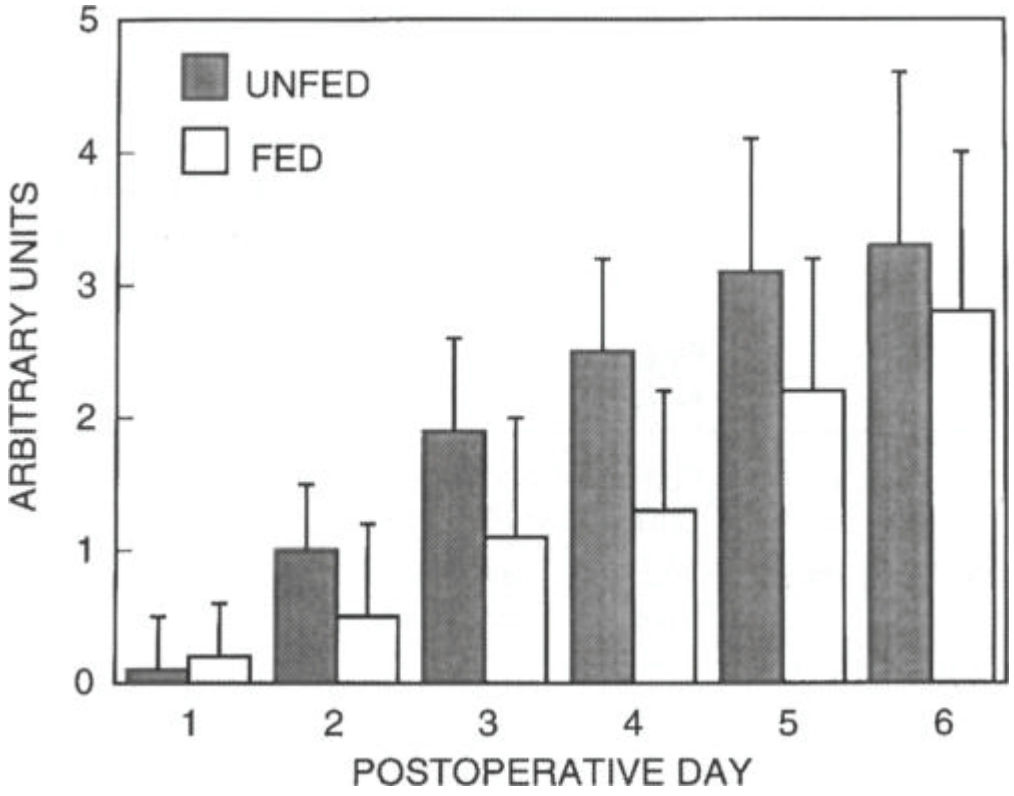



- Vital capacity 18-29% lower in the fed group ($p<0.05$)
- $FEV_1$, max. insp. pressure and grip strength NS.

## Immediate postoperative enteral feeding results in impaired respiratory mechanics and decreased mobility.

J M Watters et al.

- Daily maximal level of activity post-op ($p<0.01$)



# Primary peritonitis

- Cirrhosis
- Portal hypertension
- Ascites

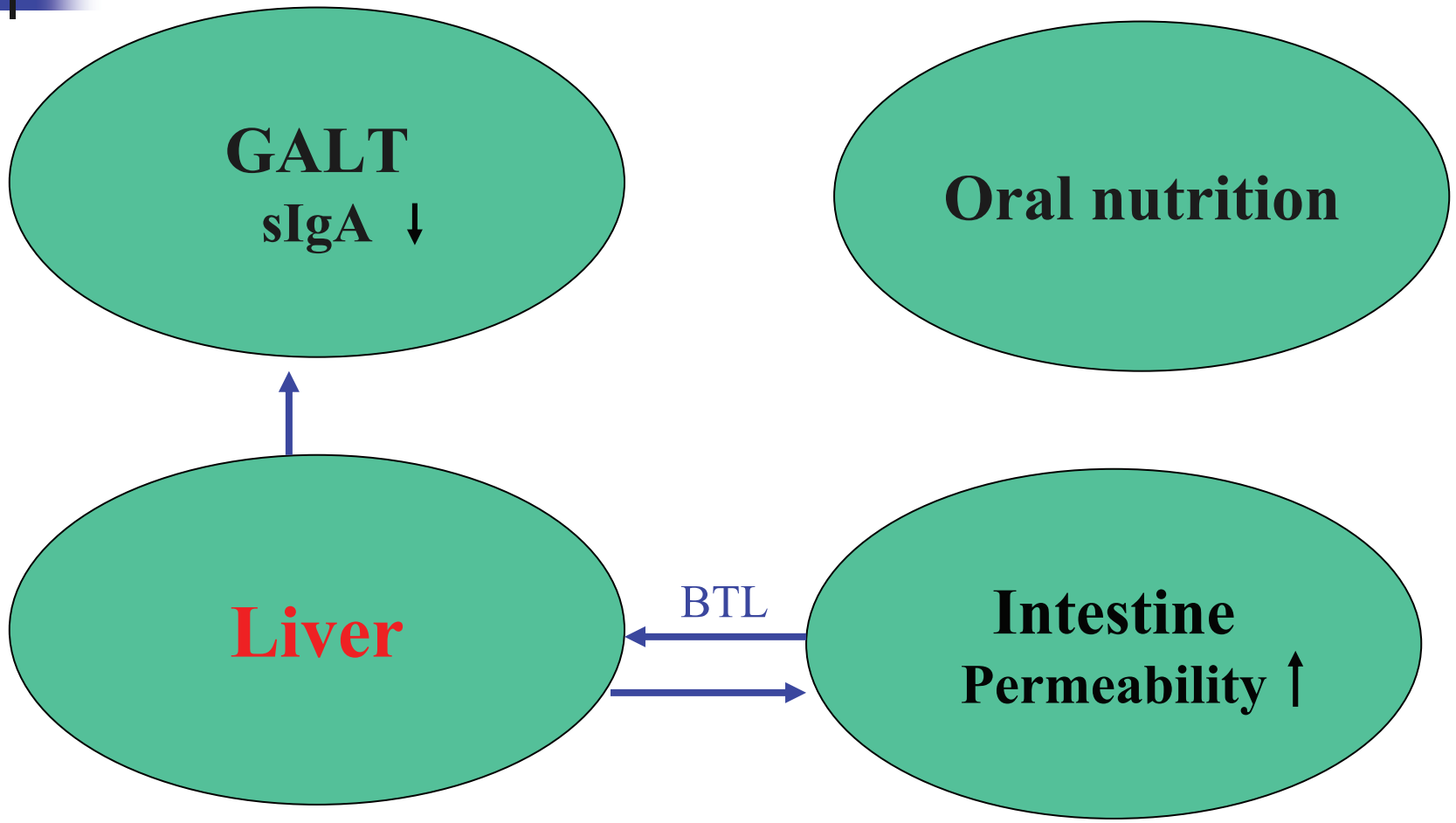
# Primary peritonitis

- Cirrhosis
  - s-IgA ⇩
- Portal hypertension
  - Intestinal permeability ⇧
- Ascites
  - Intestinal permeability ⇧

# Primary peritonitis

- Bacterial overgrowth
- Translocation to;
  - Lymphatics
  - Blood
  - Ascites

# Intestinal barrier and liver disease

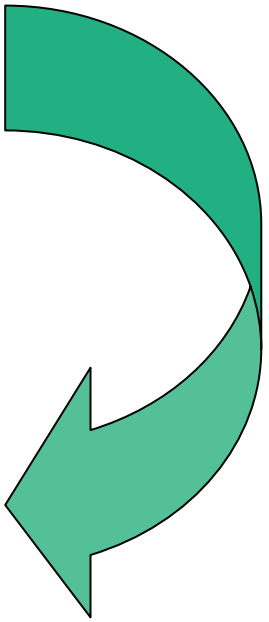


# Progressive liver dysfunction during TPN

# Progressive liver dysfunction during TPN

- Infants
- Adults

- Cholestasis
- Gall stones
- Steatosis



**Cirrhosis**

AST → ALP → Bilirubin

# Progressive liver dysfunction during TPN – causes?

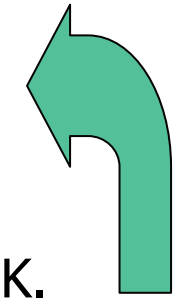
- Nutritional
- Physiological
- Infectious
- Others; medication, disease…..

# Progressive liver dysfunction during TPN – causes?

- Nutritional
  - Malnutrition increases risk
  - Caloric overload
  - Lack of essential fatty acids
  - Inbalance in amino acids
  - Manganese toxicity
- Physiological
- Infectious

# Progressive liver dysfunction during TPN – causes?

- Nutritional
- Physiological (Fasting state)
  - Villous atrophy
  - Bile stasis
  - Slow intestinal transit
  - Bacterial overgrowth
  - Hormonal ”deficit” CCK.

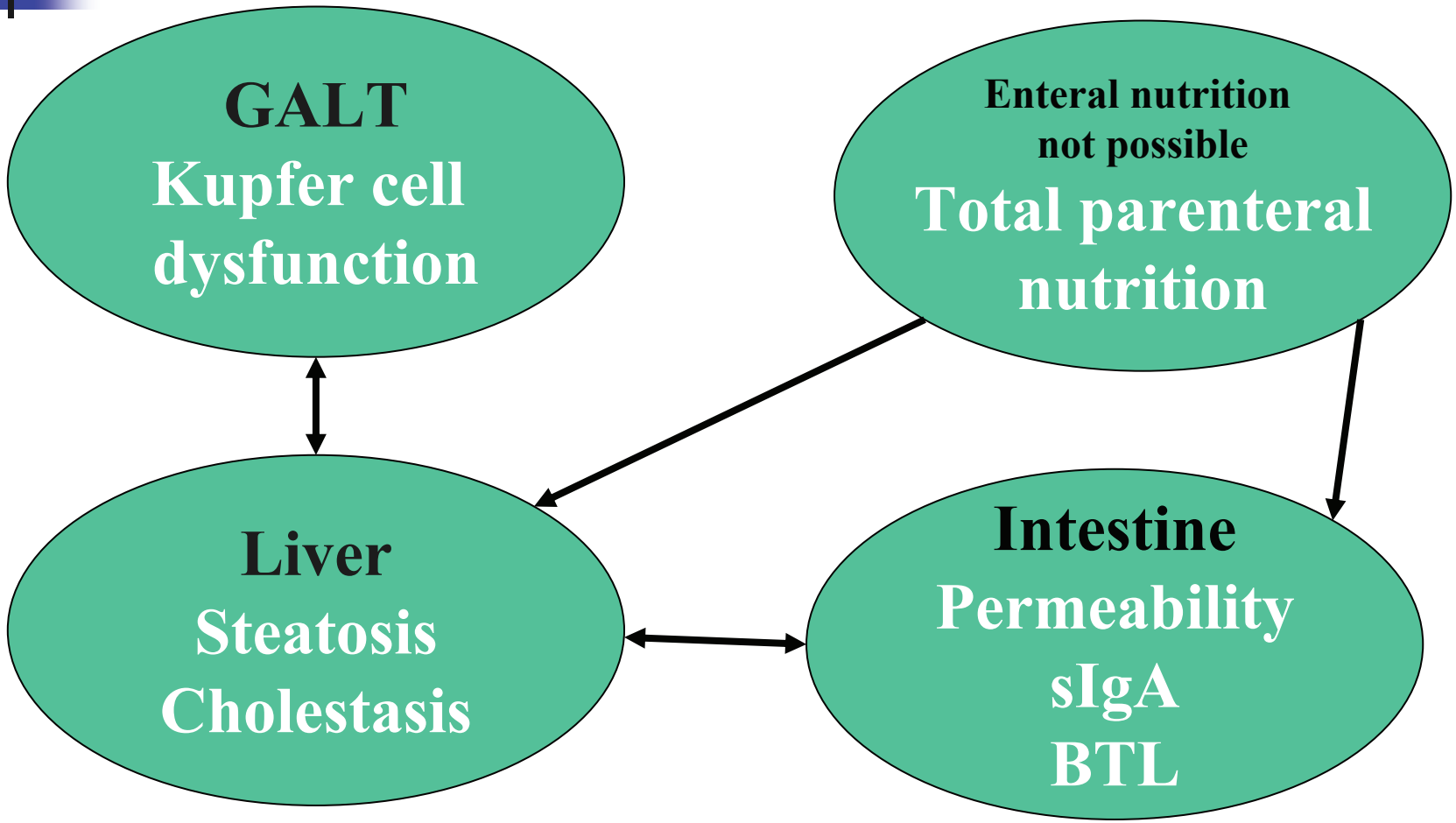


- Infectious

# Progressive liver dysfunction during TPN – causes?

- Nutritional
- Physiological
- Infectious
  - Recurrent central line sepsis
  - Bacterial translocation

# Nutrition, intestinal barrier and liver function



# Progressive liver dysfunction during TPN –treatment

- Nutritional
  - Reduce caloric load (Indirect calorimetri)
  - Reduce glucose
  - Cyclic nutrition
  - Add MCT/LCT
- Physiological
- Infectious

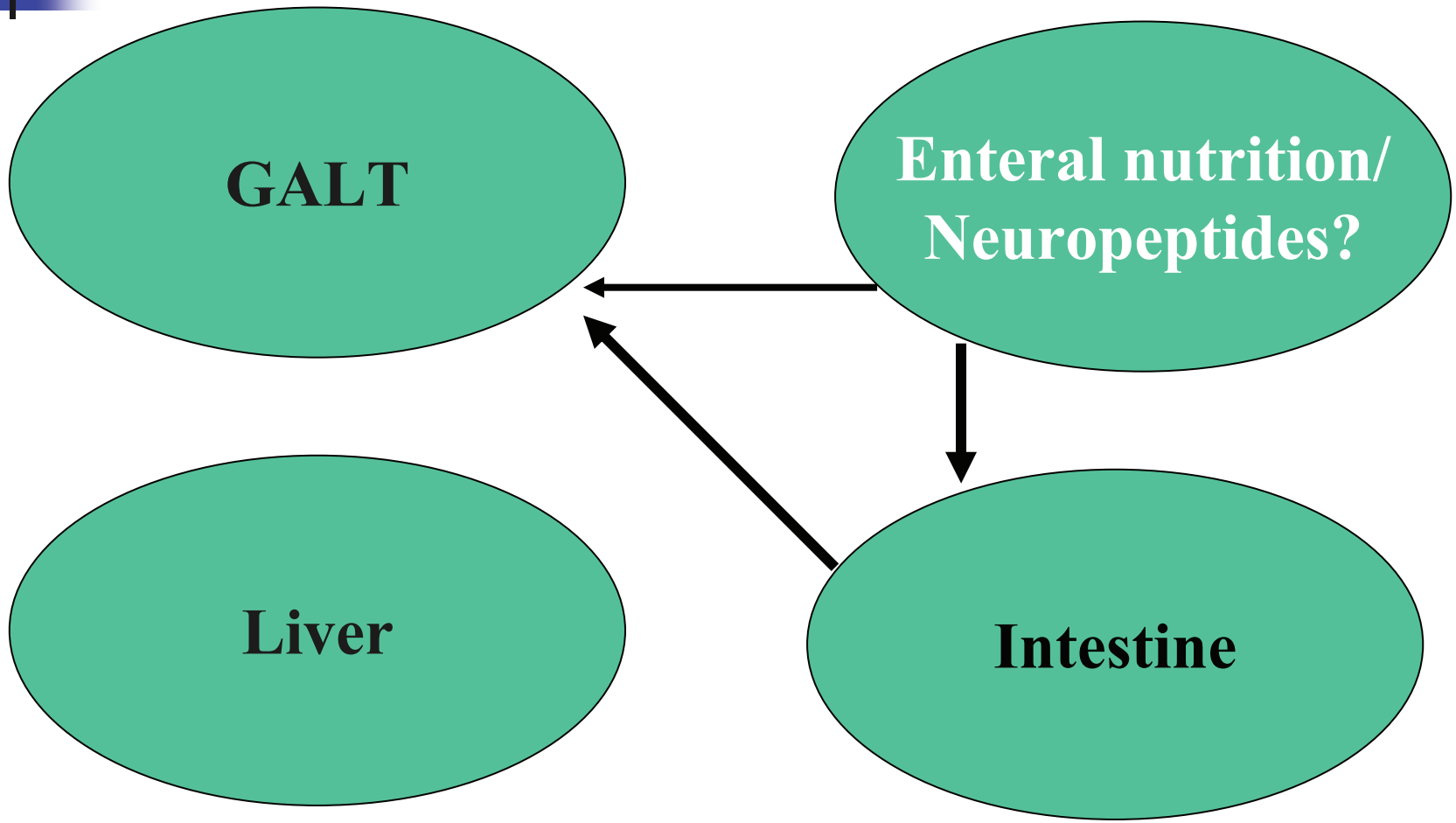
# Progressive liver dysfunction during TPN –treatment

- Nutritional
- Physiological
  - Enteral nutrition possible?
  - Add enteral fiber
  - Bile salts (Ursodeoxycholic acid)
  - Hormones/neuropeptides
    - CCK, bombesin?
    - GLP-1?
- Infectious

# Progressive liver dysfunction during TPN –treatment

- Nutritional
- Physiological
- Infectious
  - Aseptic techniques
  - Metronidazole
  - Probiotics?

# Nutrition, intestinal barrier and liver function



# Enteral nutrition

- How early?
- How much/at what rate?
- When is it absolutely contraindicated?

# Enteral nutrition

- How early?
  - Within 48 hours
  - As early as the patient is circulatory stable
- How much/at what rate?
- When is it absolutely contraindicated?

# Enteral nutrition

- How early?
- How much/at what rate?
  - 30 ml/ hour is suggested
- When is it absolutely contraindicated?

# Amount of enteral nutrition five days postop.

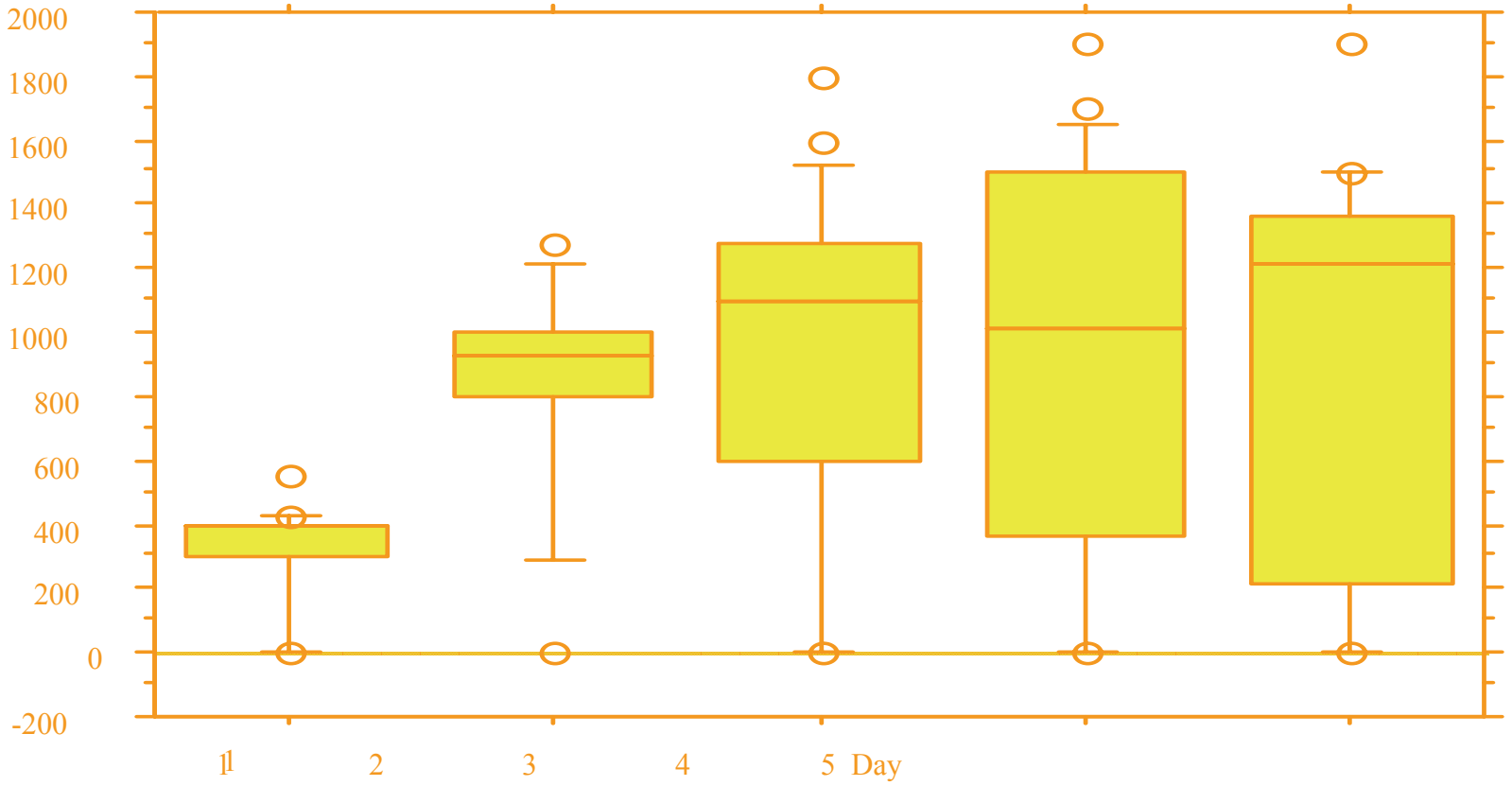



Figure 7. Amount of enteral nutrition given (ml)/day in both enteral groups.

# Enteral nutrition

- How early?
- How much/at what rate?
- When is it absolutely contraindicated?
  - Circulatory instability
  - Intestinal obstruction

# Does enteral nutrition compared to parenteral nutrition result in better outcomes in critically ill adult patients?
# A systematic review of the literature

**Leah Gramlich MD, Krikor Kichian MD, Jaime Pinilla MD, Nadia J. Rodych RD, Rupinder Dhaliwal RD and Daren K. Heyland MD, MSc**

**Nutrition, October 2004,(20): 843-848**

# Hypocaloric EN vs PN

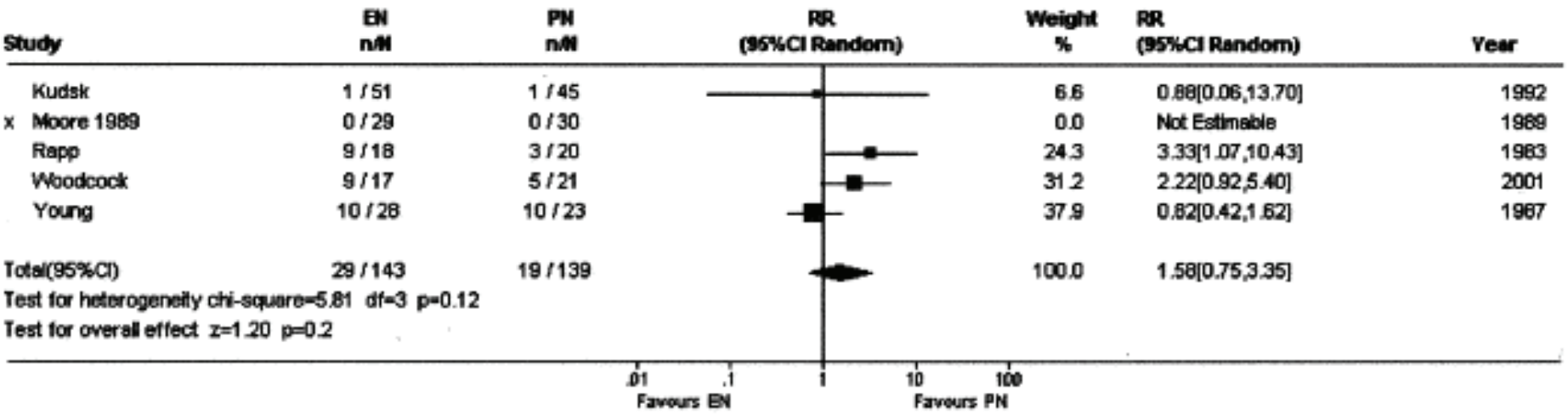



FIG. 3. EN in non-isocaloric studies (in which the PN group received more calories than the EN group) is associated with a trend toward an excessive mortality rate. 95% CI, 95% confidence interval; EN, enteral nutrition; PN parenteral nutrition; RR, relative risk

# Mortality in ICU

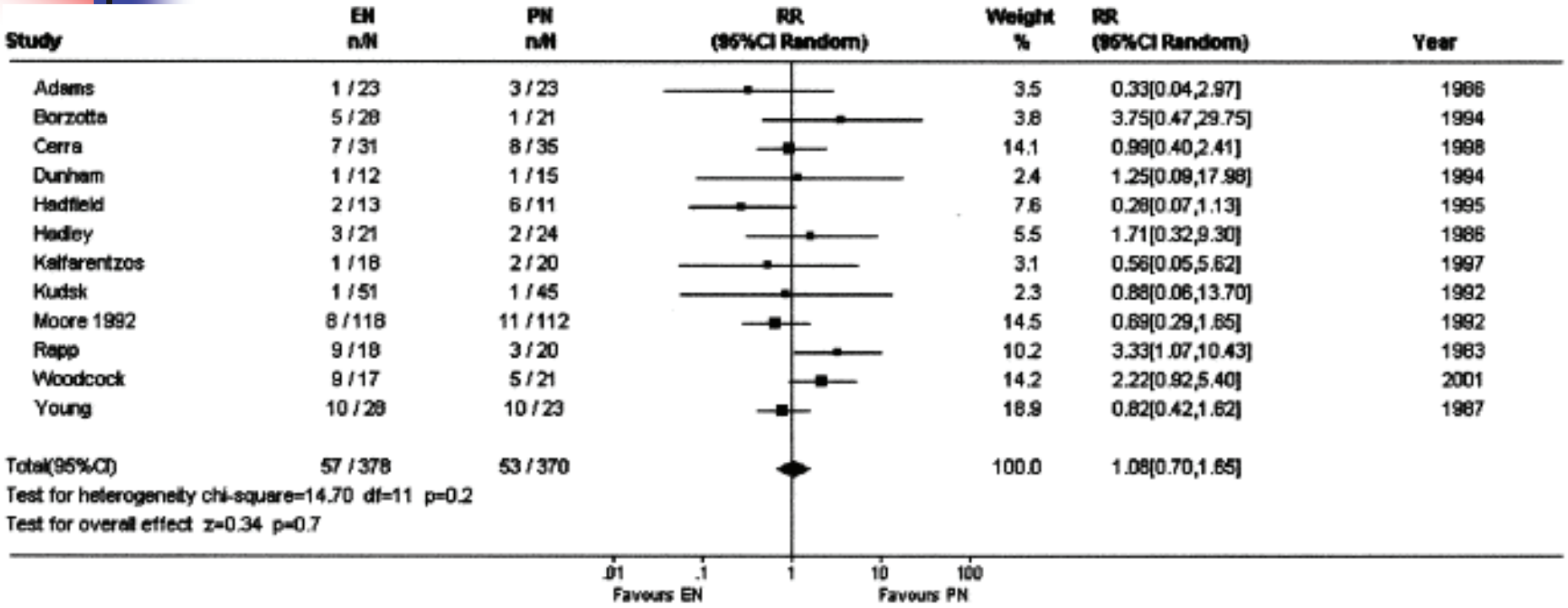



FIG. 2. EN does not differ from PN with respect to mortality rate (RR = 1.08, *P* = 0.7). 95% CI, 95% confidence interval; EN, enteral nutrition; PN parenteral nutrition; RR, relative risk.

# Infectious complications

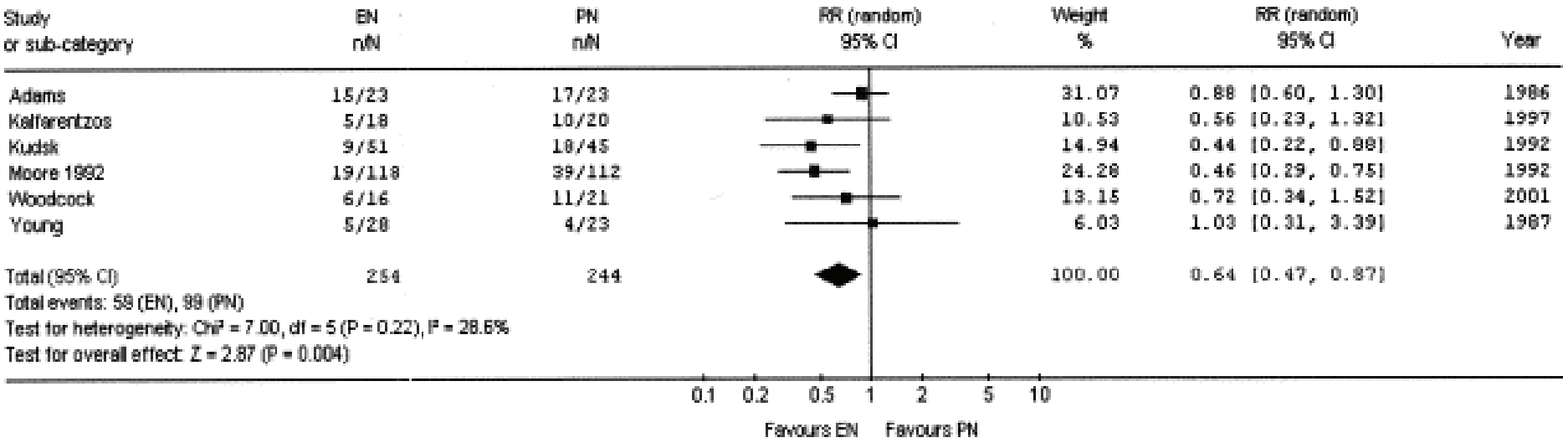



FIG. 1. EN is associated with fewer infectious complications than is PN (RR = 0.64, *P* = 0.004). 95% CI, 95% confidence interval; EN, enteral nutrition; PN parenteral nutrition; RR, relative risk.

## Does enteral nutrition compared to parenteral nutrition result in better outcomes in critically ill adult patients? A systematic review of the literature

In conclusion, when EN and PN are compared in the critically ill patient, EN is associated with fewer infectious complications and, if possible, should be the chosen route for nutritional support.

It is fundamental that, in the provision of EN and PN, strategies be adopted to optimize benefit and minimize potential harm.

# The gut and oxygen free radicals

- The gut is the predominant region for reactive oxygen species production in burns, trauma and haemorrhage
- ”First organ exposed to shock and last to be resuscitated” (Deitch 2001)
- Antioxidant depletion and mitochondrial dysfunction (Brealey et al. 2002)

# Reducing deaths due to oxidative stress- The REDOXS Study

- Glutamine and antioxidants
- Dose-ranging study completed
- 2x2 design, placebo-controlled
- N=1200 ventilated ICU patients
- 28-day mortality - primary outcome

- www.criticalcarenutrition.com

# A new paradigme

- ✓ Preoperative fasting
- ✓ Tubes, drainages
- ✓ Gut rest
- ✓ Gut decontamination
- ✓ Analgesia on demand
- ✓ Cristalloids/kg
- ✓ Hyperglycemia is a natural phenomenon after surgery

- ➢ Carbohydrate loading
- ➢ No tubes/drains
- ➢ Early enteral delivery
- ➢ Probiotics
- ➢ Planned analgesia
- ➢ No $Na/H_2O$ overload
- ➢ Normal blood glucose

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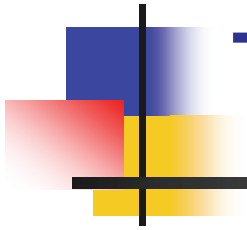
- ➢ Probiotics
- ➢ Planned analgesia
- ➢ No $Na/H_2O$ overload
- ➢ Normal blood glucose
- ➢ Combine PN/EN!



# Thanks for your attention!

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# Estimate immunocompetence

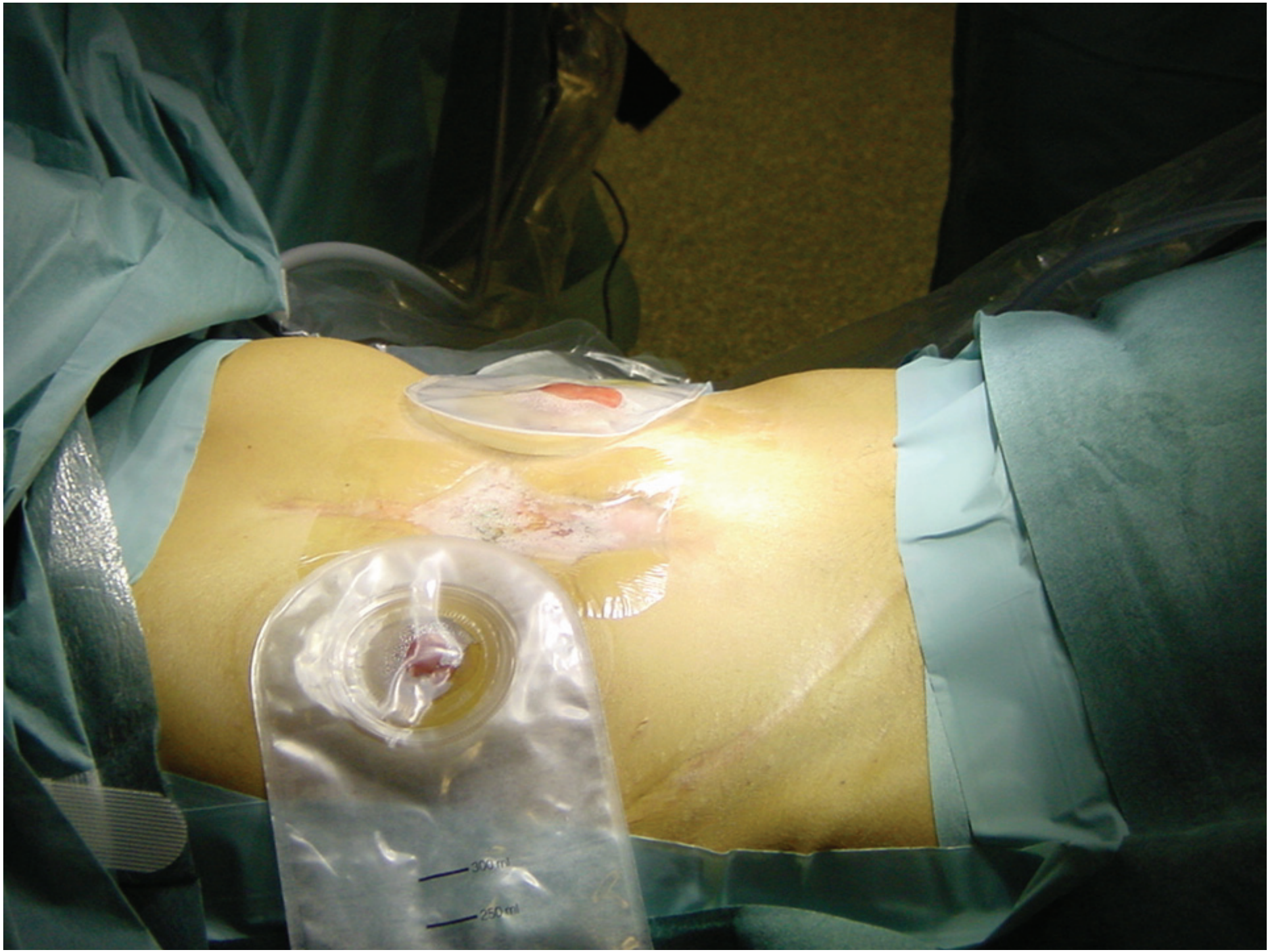
- CRP, cell counts, CD-profiles, cytokines, immunoglobulins, soluble receptors in blood, DHR
- In vitro studies of mitogen stimulation, phagocytic capacity, DNA/protein synthesis
- SIgA in lumen and in SIgA-producing cells, cytokines, DNA synthesis of LPL/IEL in tissue studies
- BTL - cultures, labelling, typing, PCR, Minimal bacterial transit time

# Soluble IL2-receptor is suggested to be a marker of immunological activation/competence

**IMMUNOLOGY DAY 6 (PRE-OP=1)**

| | Parenteral | Enteral |
|---|---|---|
| Lymfocyter | 0.94 (0.22) | 1.11 (0.11) |
| Monocyter | 1.42 (0.25) | 1.49 (0.26) |
| Granulocyter | 1.44 (0.48) | 1.68 (0.36) |
| CD 3 | 0.81 (0.12) | 1.08 (0.13) |
| CD 3+CD 25+ | 0.93 (0.16) | 1.29 (0.09)* |
| CD3+HLA-DR+ | 0.67 (0.19) | 0.69 (0.21) |
| CD 4 | 0.88 (0.22) | 1.13 (0.13) |
| CD 4+CD45RA+ | 1.06 (0.30) | 1.15 (0.17) |
| CD4+CD29+ | 0.86 (0.25) | 1.29 (0.11) |
| CD 8 | 0.80 (0.21) | 1.07 (0.16) |
| CD8+S6F1+ | 0.94 (0.33) | 1.07 (0.15) |
| CD 56 | 0.88 (0.29) | 0.99 (0.24) |
| CD 4/CD 8 | 1.11 (0.01) | 1.09 (0.09) |

**=p<0.05 vs. parenteral group day 6*


300 ml
250 ml

Early postoperative enteral immunonutrition:clinical outcome and cost-comparison analysis in surgical patients.
Senkal et.al. Crit Care Med 1997 Sep;25:1489

- N=154, NCJ after upper GI cancer surgery
- EN start < 24 h, 20-80 ml/h day 5
- Immuno vs. standard EN

| Compli-cations | Day 1-5 | Late |
|---|---|---|
| Standard | 11 | 13 |
| Immuno | 12 | 5 (<0.05) |

# Criticalcarenutrition.com, June 2005

- Feeding protocols
  - ID. If a feeding protocol is used - metoclopramide and high residuals (250 ml)
- Small bowel feeding vs Gastric
  - Reduction of pneumonia
- Continuous vs interrupted
  - Insufficient data for recommendation.
- Probiotics
  - Insufficient data for recommendation.