Feeding the malnourished diabetic

Marc Raucoules-Aimé
Feeding malnourished diabetic patients

Professeur Marc Raucoules-Aimé
Anaesthesiology
CHU de Nice

Professeur Didier Quilliot
Diabetology/Nutrition
CHU de Nancy

Recommandations formalisées d’experts
La nutrition en périopératoire chez le patient diabétique
According to studies: 30-50% of hospitalized patients are malnourished (elderly patients +++)

5-20% of hospitalized patients are diabetics for whom nutritional support is necessary:

- oral nutritional supplements (ONS)
- tube feeding (TF): continuous, cyclic, …
- parenteral nutrition

Indications, methods of administration, energy and protein needs, micronutrients, vitamins, ...

not different

diabetic-specific formula: GI, solubles fibers, MUFAs
Why?
Objectives?
How to do?
In practice
Malnutrition and diabetes mellitus

Consequences

Chronic situation

Elderly patients

- Sarcopenia
- Chronic inflammation

- Insulin resistance
- Insulin secretion

Acute situation

- Hyperglycaemia

- AVC/AMI
- Septic shock

- Polytraumatism
- Surgery

Counter regulatory hormones+++:
- Catecholamines, cortisol, GH, glucagon, ...

Hyperglycaemia

- Hepatic glucose output

- Glucosuria

- Caloric loss

- Weight loss

- Sarcopenia

- Anabolic action

- Insulin resistance
Hyperglycaemia is an important risk factor of complications, especially in malnourished (and diabetic) patients.

- Sepsis
- Candidosis
- Feet wound
- Bedsore
- Infections
- Delayed wound healing
- Hyperglycaemia
- Malnutrition

- Nosocomial infections: UTI, RR = 6
- Catheter infection: X 5
- Mortality (ICU and non-ICU): ↑↑

References:
- Boyko EJ et al, Diabetes Care 2006
- Meta analysis de Feuchtenger et al, Heart and Lung 2005
- Am J Infect Control. 2006
- Overett TK et al, JACN, 1998
- Umpierrez et al, JCEM, 2002
Early enteral nutrition was associated with a significantly lower incidence of infections (relative risk reduction, 0.45) and a reduced length of hospital stay (mean reduction of 2.2 days). There were no significant differences in mortality or noninfectious complications between the two groups of patients.

Conclusions: The results of this meta-analysis support the experimental data demonstrating the benefit of the early initiation of enteral nutrition.
Objectives?

To correct malnutrition

To avoid complications due to nutritional support

acute and chronic hyperglycaemia
Acute hyperglycaemia and malnutrition

increase of mortality

Feeding of malnourished diabetic patients

Hyperglycaemia

Standard formula

Insulin needs ↑ 26 %
The short-term risks

Table 4. Independent Risk Factors of Severe Adverse In-hospital Outcome in Diabetic Patients after On-pump Cardiac Surgery (n = 200)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Odds Ratio (95% CI)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pulmonary hypertension*</td>
<td>12.4 (2.7–57.4)</td>
<td>0.001</td>
</tr>
<tr>
<td>Poor intraoperative glycemic control</td>
<td>7.2 (2.7–19.0)</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Intraoperative erythrocyte transfusion</td>
<td>5.4 (2.3–12.6)</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Hypothermic CPB†</td>
<td>3.0 (1.2–7.3)</td>
<td>0.01</td>
</tr>
<tr>
<td>Preoperative plasma creatinine</td>
<td>1.02 (1.00–1.03)‡</td>
<td>0.001</td>
</tr>
<tr>
<td>Cardiopulmonary bypass time</td>
<td>1.02 (1.01–1.04)§</td>
<td>0.01</td>
</tr>
</tbody>
</table>

Hosmer Lemeshow statistic associated with the current model is 7.57 (P = 0.48).

* Systolic pulmonary artery pressure greater than 50 mmHg. † Hypothermic cardiopulmonary bypass was defined by a systemic temperature less than 32°C. ‡ Odds ratio per 1 μM increase. § Odds ratio per minute bypass time increase.

CI = confidence interval; CPB = cardiopulmonary bypass.
The long-term risks

What about the importance of the postprandial hyperglycaemia?

1) Influences the HbA1c
   (Monnier et al, Diabetes Care 2003)

2) Independant Risk factor of Cardio-vascular disease
   (Hanefeld et al, Diabetologia,1996)

3) A low food Glycaemic Index ð Ø CV risk
   (Willett et al, Frost et al, Liu et al)

However, it is likely that a strict glycaemic targets before and during long term artificial nutrition are necessary
ÓPP hyperglycaemia
How to do?

Insulin therapy

Ó GI and/or Ó CHO
When injecting subcutaneous insulin?

Short acting insulin
- Humalog®
- Novorapide®

Rapid acting (Actrapid-umuline)®

Long acting insulin
- Insulatard® - NPH
- Levemir®
- Lantus® (insulin glargine)
- Mixtard HM30®
- Humalog Mix25®

Tube feeding Nutrition

To cover the insulin needs during artificial nutrition and in fasting
**Divided TF:** Adapt the insulin action on the duration of the TF

**Principle:** 1 bag / 1 injection

### 3 bags/day

**very quickly (< 2h)**
- Schema: « basal bolus »
- or humalog mix 30 – 50

### If > 4 h: « classical Schema »
- 3 rapid-acting insulin, with 1 NPH (ou mix 30 – 50)

### 1 to 2 bags/day

- 1 or 2 injections with a mix of insulin (rapid or short acting + NPH)

**For night tube feeding or PN:** 1 injection or insulin in the bag?
What targets for blood glucose level?

Strict targets: 0.8 – 1.10 g/l, before and during artificial nutrition:
For surgical ICU (?) and major surgery (ERAS programme)

Generaly: HbA1c < 7% (ADA); < 6.5% (EASD)

• Fasting: 0.80 – 1.30 g/l
• Postprandial: < 1.8 g/l (ADA et EASD)
• During artificial nutrition: strict targets are probably necessary because the duration of postprandial hyperglycaemia is very long
  » < 1.6 g/l = reasonable target
  » Strict target < 1.3 g/l, if delayed wound healing, bedsore, neuropathy… (tissue hypoxia)

Elderly patients, or if life expectancy is short or if risk of hypoglycaemia is high: targets wider

• HbA1c = 8%
• Fasting: 1 – 1.50 g/l
• Postprandial: below 2.50 g/l ð < 2 g/l (?) Nathan et al, Diabetologia 2006
Decrease the glycaemic index (GI)

The CHO-rich foods are classified on the basis of their effects on PP glycaemia, as indicated by their Glycaemic Index (GI) and the reduction of the GI of diabetic foods can reduce the CV risk.

GI = \( \frac{\text{AUC diabetes-specific formula}}{\text{AUC glucose}} \)

Glycemic load = \( \text{CHO amount} \times \text{GI for 100 g of food} \)
The diabetic-specific formulas (TF & ONS) permit to decrease the glycaemic load (GI and/or CHO load) but amylose + fibers (Low Glycaemic Index) but Tg et Hg.

![Graph showing blood glucose levels over time with different carbohydrates and fibers.](image)

1. **Ó glycaemic index**
   - Amylose + Fibers

2. **Fructose**
   - (Low Glycaemic Index)
   - but Tg et Hg
   - Maximal dose: 60g/d?

3. **Ó CHO load**
   - Lipid content (MUFA)
   - Ó Gastric tolerance

Parks et al Am J Clin Nutr 2000
Effects of different formulas on Glycaemic Index

**Diabetic-specific formula**
MUFA (25 – 35%) and fibers (1.5 à 2.5%)

**Diabetic-specific formula**
MUFA (25 – 35%) and fibers (1.5 à 2.5%)

**Standard formula**
Fat 35%
Carbohydrates 50%

**GI = 19.4 ± 1.8**

**GI = 42.1 ± 5.9**

*J de van drunen, Numico Research*
Feeding malnourished diabetic patients

How to do?
Parenteral nutrition in diabetics

Specificities? No (BGC + 0.8 g/l)

**Glucose**: 50 - 70% (France) 70 - 85% (ASPEN)
**Lipids**: 20-40% be careful! *Keep Tg under surveillance!*

- Insulin deficiency
- Hyperglycaemia
- Insulin-resistance

**Duration** of PN = short but no short break! → hypoglycaemia

**Constant infusion rate**: It is better if the amount of glucose does not change from one day to the next

Alternative (glucose/fructose/xylitol 2:1:1)? : **no**

- fructose (not better and È Tg)

*Valero, EJCN 2001*
Tube feeding (or ONS): as soon as possible!

Better tolerance and more physiological route

- Incretin secretion (GLP1, PYY....)
  = increase the insulin release

- Trophic effect on gastrointestinal cells

- Lesser complications than PN (infections....)

- Lower cost, ....
2 types of enteral formulas can be used for diabetics

Standard formula

- low amount of fat (30%)
- high supply of complex CHO (50-60%): maltodextrins, starch, fructose, ...

Newer diabetic formulas (LCHM, low Glycaemic Index)

- low amount of CHO
- MUFAs: colza, olive, fish, (35%)
- soluble fibers
Beneficial specific effects

MUFAs (oleic acid/palmitic acid)

- blood pressure and improvement of lipid profile,
  - insulin sensitivity, ...

The effects on long term have to be confirmed
Type 2 Diabetic patients

Controls

Intake per os 200 kcal/200 ml

%G : % L : % P

A = 49:35:16 (Maltodextrin)
B = 49:35:16 (Saccharose/maltose)
C = 45:38:17 (fructose/starch)
D = 35:49:16 (fructose/starch/MUFA/fiber)

MUFA content (g/100 ml) C = 2.8 / D = 3.4

Short Communication

The effect of different nutritional feeds on the postprandial glucose response in healthy volunteers and patients with type II diabetes.

SHORT COMMUNICATION

Diabetic-specific formulas
= Ó glycaemic load (Ó GI & Ó CHO et Ï lipids)
But diabetics require insulin and CHO!

Comparison of two formulas for diabetics (cans)
lipid: 50% or 34%
2 ONS/day during 10 days

In conclusion, a high monounsaturated fatty acid diabetes-specific supplement improved glucose, HbA1c and albumin levels. A diabetes-specific supplement with lower fat percentage than the first improved weight and protein levels without metabolic effects.

More insulin (and more CHO) in group: 34% of lipid!

Decrease the Glycaemic Index and the GL and give MUFA have some interest but insulin and CHO are necessary for diabetic patients.
Diabetic-specific formulas for patients with diabetes: yes or no?

Meta analysis on 23 studies ONS (16) or TF (7)
16 studies < 24 h // 7 studies (6 d to 3 months)
*Elia et al Diabetes care 2005*

### Results

<table>
<thead>
<tr>
<th>Measure</th>
<th>Value (Range)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Δ glycemic (4 CT + 3 LT)</td>
<td>Ö 0.19 g/l (0.10 – 0.27)</td>
</tr>
<tr>
<td>postprandial peak (2 CT)/AUC</td>
<td>Ö 0.29 g/l (0.16 – 0.42)</td>
</tr>
<tr>
<td>Hb A1c (3 à 6 months)</td>
<td>1/3 significant Ö 0.8%</td>
</tr>
<tr>
<td>Ö in the needs in insulin (2)</td>
<td>Ö U/j 26% et 71%</td>
</tr>
<tr>
<td>Fasting blood glucose</td>
<td>NS</td>
</tr>
<tr>
<td>Lipids</td>
<td>NS</td>
</tr>
<tr>
<td>Complications</td>
<td>NS</td>
</tr>
</tbody>
</table>

*Enteral Nutritional Support and Use of Diabetes-Specific Formulas for Patients With Diabetes
A systematic review and meta-analysis*
No consensus on the most relevant markers:

- BGC, need for insulin, blood lipids,
- glycated Hb, micro/macrovascular complications?

Nutritional support:

- food fortification, EN, TF, ONS, ...

Short term studies (1d-3 m, in mean 1 day!)
Enteral nutrition with MUFA

78 diabetics treated with insulin
27 kcal/kg : standard (52% CHO: 174g maltodextrins/1500 ml), 30% lipid (32% MUFA), 18% protein vs diabetes (LCHM: 37% CHO (94.5 g starch/24 g fructose/6.8 g maltodextrins/1500 ml), 45% lipid (32% MUFA), 18% protein)

Rate of infusion as a function of tolerance (8 hrs off)

After 84 days
insulin requirements - 6.0 IU
fasting blood glucose: 0.27 g / l
HbA1c - 0.8% (21 vs 23 patients)

32 elderly diabetic patients (type 2)
Fibers (30% fat) vs MUFA (50% fat)
Fasting blood glucose: 7.1 mmol/l vs. 7.6 mmol/l
HbA1c: 6.5% vs 7 NS
Lower insulin requirements
105 diabetics undergoing enteral nutrition with TF (neurological disorders)

Diabetic formula
37/45/18
Starch/fructose/fibers/MUFA

Insulin requirements: - 8.0 IU vs 2.0 IU

fasting BGC: - 2.17 mmol/l vs - 0.67 mmol/l

BGC in the afternoon: - 2.36 mmol/l vs - 0.49 mmol/l

hypoglycaemia episode: 1 vs 5

HbA1c NS

G > 1.2 g/l ou
HbA1c > 7%

Standard formula
50/35/15
Long-term (3 months) tube feeding with a disease-specific enteral formula is safe and well tolerated in diabetic patients. Glycaemic control is improved.
In practice

The control of diabetes is the main element for a good nutritional management of malnourished diabetics!

The BGC must be controlled during artificial nutrition.

For $TF = \text{the Glyceamic Load and the postprandial BGC}$ depend on the infusion rate. So infusion rate of enteral (parenteral) nutrition must be controlled!
In practice

Concerning the use of diabetes-specific formulas

Low GI: ↑ control of diabetes & ↓ insulin needs

Low CHO-high MUFA (LCHM) formulas seem to improve CV risk factors but fail to show clinical CV benefits on long term