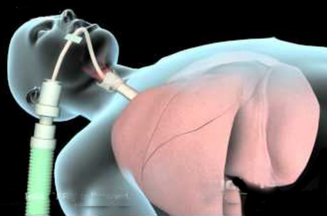
MALNUTRITION : INTERET DE LA CALORIMETRIE INDIRECTE

Pr M. FAROUDY

Réanimation des Urgences Chirurgicales
CHU Ibn Sina

Rabat - Maroc



INTRODUCTION

- Nutrition = indispensable au support des fonctions vitales
- La malnutrition est fréquente, méconnue
- Sous nutrition et surnutrition = morbi-mortalité

- Evaluation de la dépense énergétique : base de prescription.
- Limites des équations prédictives
- Calorimétrie indirecte :
  - Précise, reproductible
  - Peu disponible (investissement, complexité)

INTERETS DU MONITORAGE DU METABOLISME EN REANIMATION

Adaptation des apports caloriques

Adaptation de la ventilation

Suivi et prédiction du sevrage par la VO2

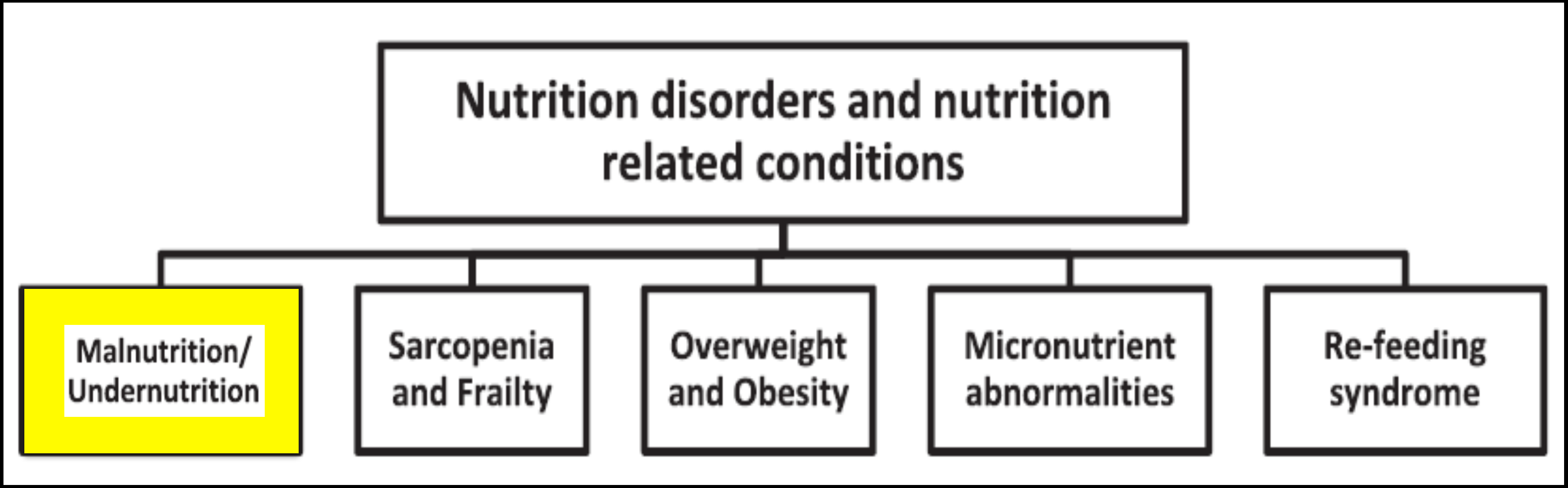
Mesure de l'espace mort

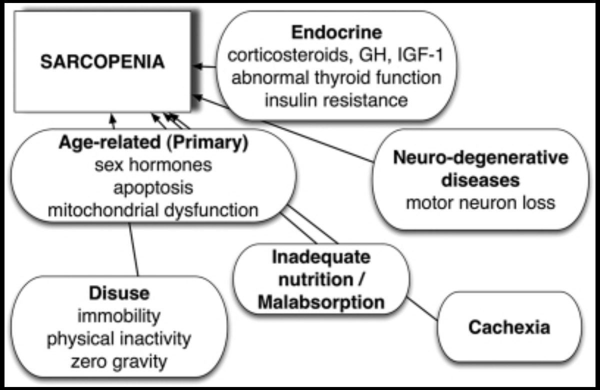
Mesure de la CRF

Détermination de la "best" PEEP

Evaluation du volume recruté

NUTRITION DISORDERS

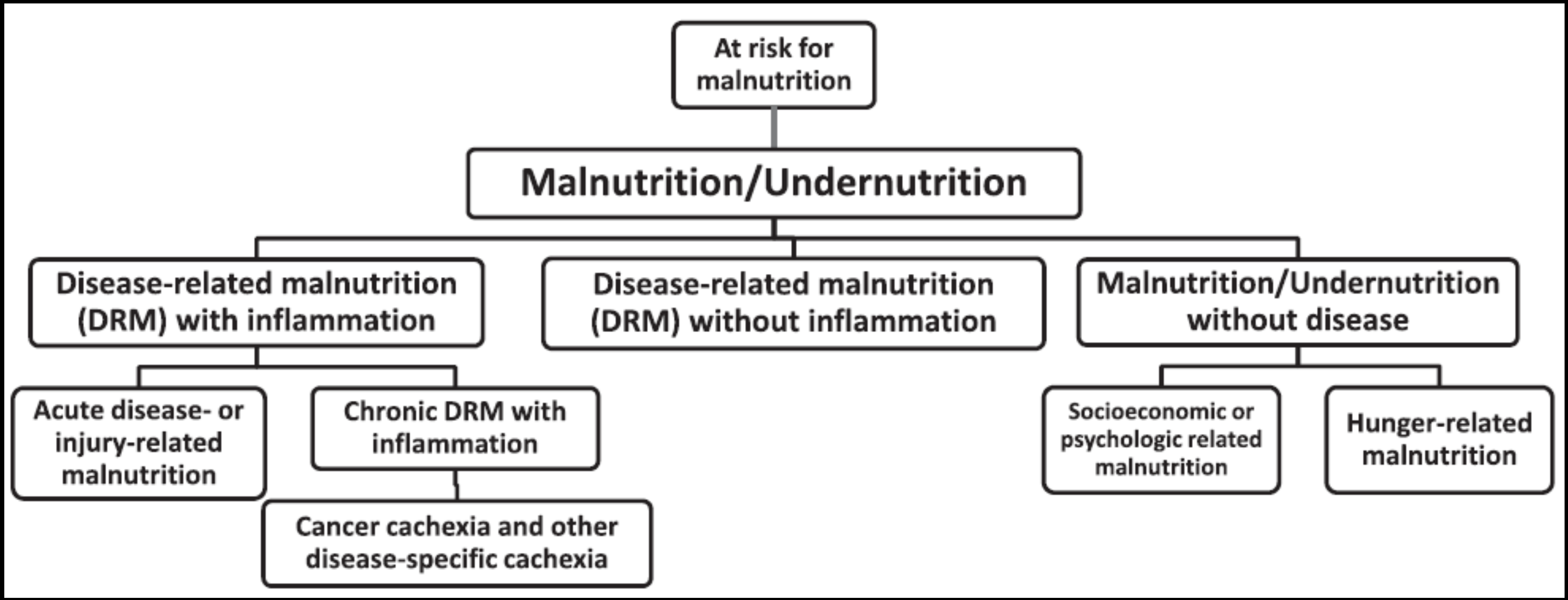




DEFINITION

Malnutrition

"a state resulting from lack of intake or uptake of nutrition that leads to ….altered body composition (decreased fat free mass and body cell mass) leading to diminished physical and mental function and impaired clinical outcome from disease"[1]



CAUSES DE DÉNUTRITION

Déficit d'apport énergétique, protéique et en micronutriments

- Régime pauvre
- Anorexie
- Jeûne pour bilan ou intervention…
- Douleur
- Nausées
- Dysphagie
- Depression
- Incapacité de se nourrir
- Troubles de conscience

CAUSES DE DÉNUTRITION

Altération fonctionnelle (tube digestif, foie…)

- Iléus réflexe
- Choc
- Douleur, sédation

Pertes digestives

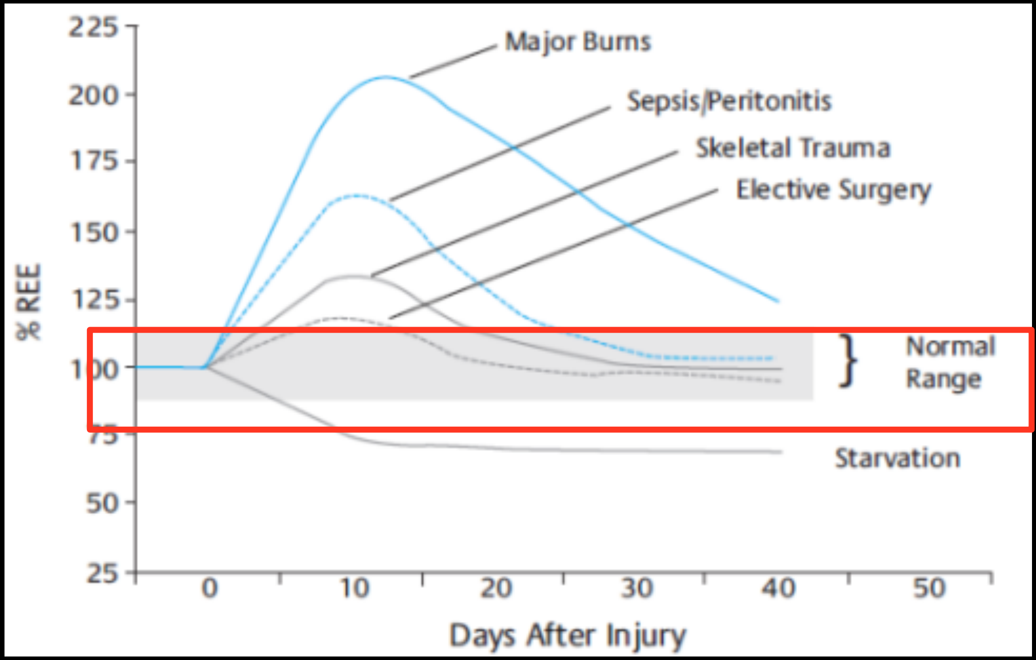
- Vomissements
- Sonde gastrique
- Diarrhées, grêle court
- Drains chirurgicaux
- Fistules
- Stomies

CAUSES DE DÉNUTRITION

Réponse hypercatabolique

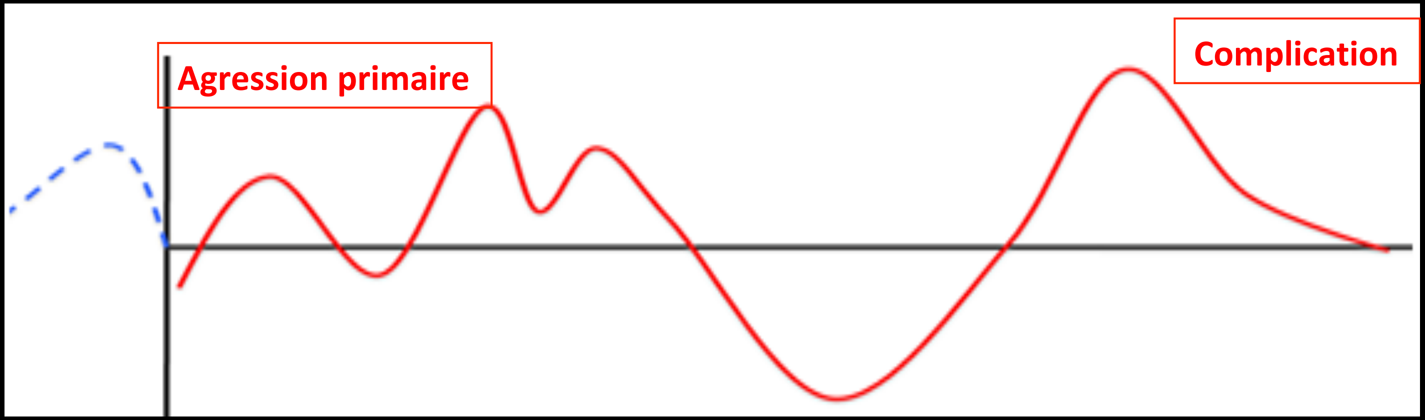
- Inflammation
- Cancer
- Trauma
- Brûlures

VARIATION DES BESOINS MÉTABOLIQUES



Selon la pathologie

Dans le temps



IN THE ICU

- Age usually older
- Acute illness ,hypercatabolic state.
- Coexisting chronic diseases
- Mechanical ventilation
- Haemodynamic instability from the 1ry insult
- Interruptions of meal times
- Nutrition is not a priority issue????

CONSEQUENCES DE L'INADEQUATION DES APPORTS

Effects of overfeeding and underfeeding.

	Insufficient energy intake	Excessive energy intake
Early signs	Hypoglycemia Hypothermia	Hyperglycemia Hyperlipidemia (triglycerides) Hypercapnea
Delayed signs	Infectious complications Impaired immunity Impaired healing Loss of lean and fat body mass Impaired muscle function	Infectious complications Impaired immunity Liver steatosis Increased fat mass

Perte tissulaire : diminution de la masse maigre, 2 % par jour (fonte musculaire)

Difficulté de sevrage de la ventilation mécanique.
Augmentation de la durée de séjour en réanimation et à l'hôpital

Effectiveness of intensive nutritional regimes in patients who fail to wean from mechanical ventilation

Larca L., 01 May 1982

2-year period, 14 ventilator-dependent patients

- group 1 (N = 6) did not wean from MV, died in the hospital
- group 2 (N = 8) weaned from M, eventually discharged.

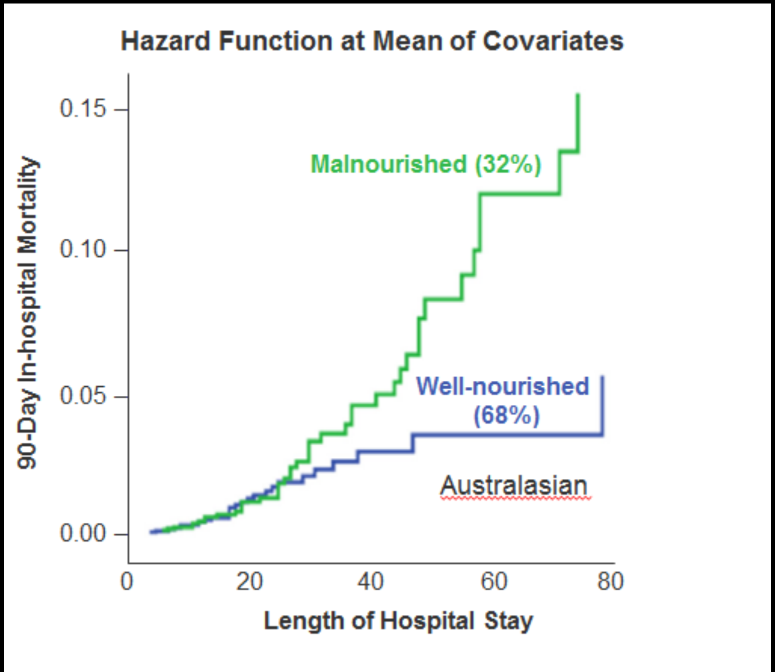
the two groups did not differ with regard to serum albumin or transferrin levels, or in total lymphocyte count.

After the period of aggressive nutritional support, group 2 patients showed an increase in serum albumin and transferrin whereas patients in group 1 showed a decrease.
The lymphocyte count did not change significantly.

Ventilator-dependent patients who respond to nutritional support with an increase in protein synthesis are more likely to wean from mechanical ventilation than those who do not.

MALNUTRITION ET MORTALITE

- 3,122 patients, 56 hospitals, Australia and New Zealand
- 32% malnourished
- Odds of 90 day in hospital mortality twice greater



il est admis que la dénutrition augmente …. la mortalité en réanimation, à l'hôpital et à six mois

Nutrition artificielle en réanimation

RECOMMANDATIONS FORMALISÉES D'EXPERTS

Annales Françaises d'Anesthésie et de Réanimation 33 (2014)

BMI, AGE ET MORTALITE

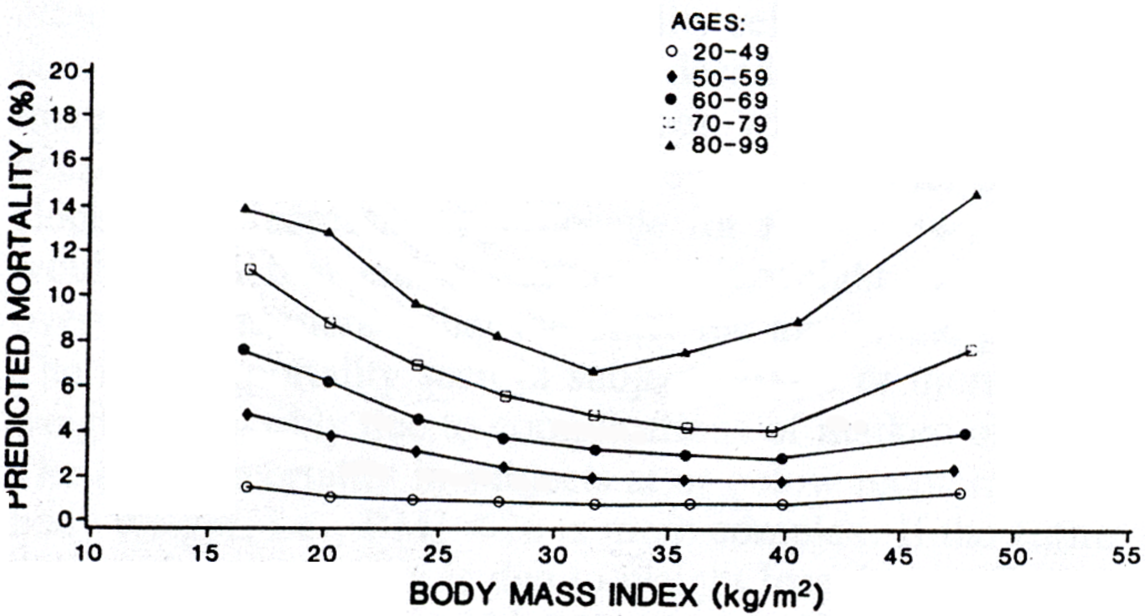
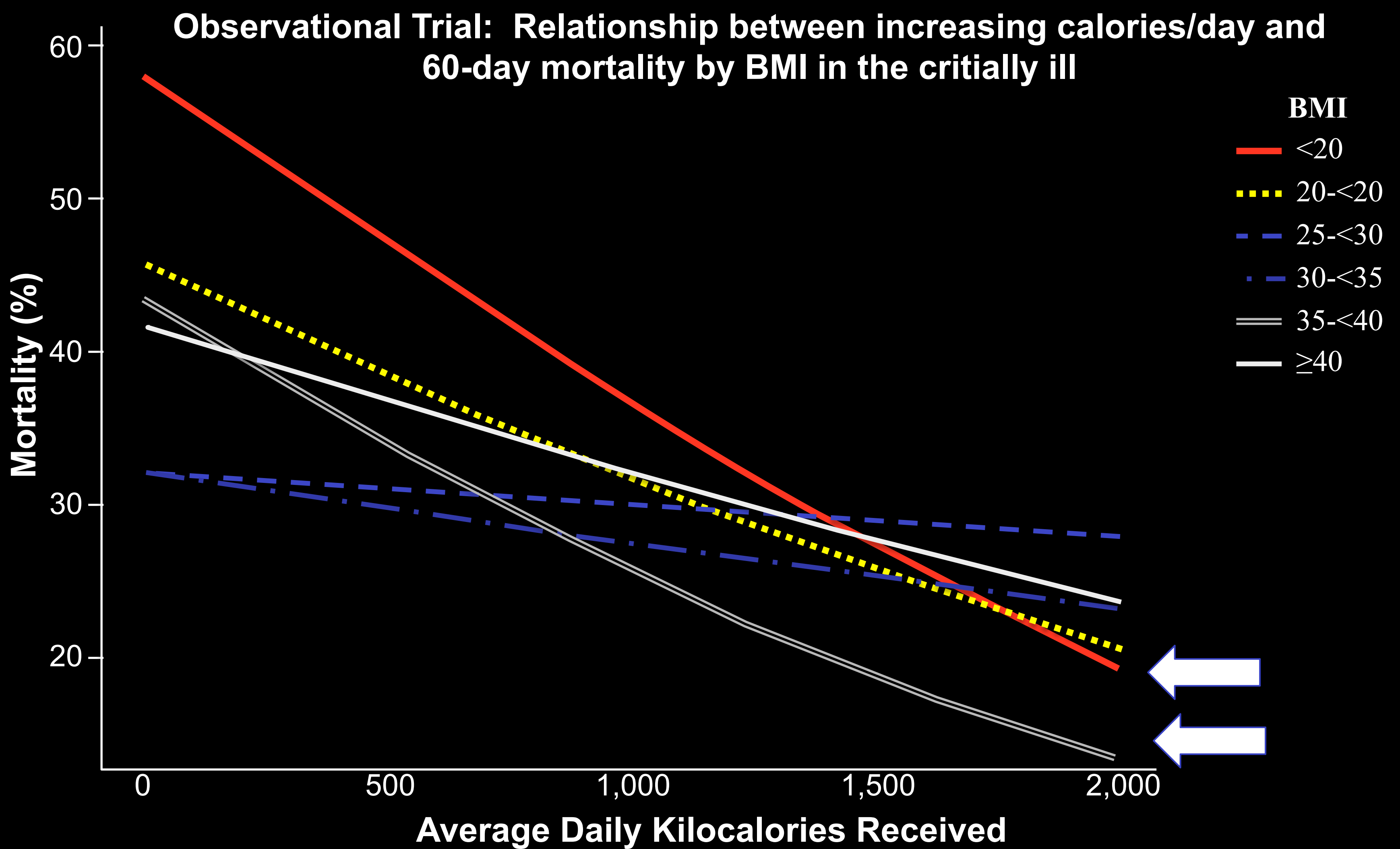


Figure 1. Predicted probability of death as a function of body mass index (BMI) calculated from the logistic model for each of 5 age groups. The plotted points are mean values for subjects in a given weight group. Highest mortality almost always occurs at lowest BMI and mortality also increases at greatest BMI.

being underweight is a more potent threat to life than obesity

The relationship between nutritional intake and clinical outcomes in critically ill patients: results of an international multicenter observational study.

Alberda, et al. *Int Care Med.* 2009;35:1821.



EN (69% of patients), TPN (8%), EN+SPN (17.6%), none (5.4%).

COUT DE LA DENUTRITION

hospital costs were increased by 60.5% in malnourished patients compared with well-nourished patients…

…and by 308.9% when the costs for medications and tests were included

Durée de séjour
Durée de VM
Complications

Correia M, et al. *Clin Nutr.* 2003;22:235-239.

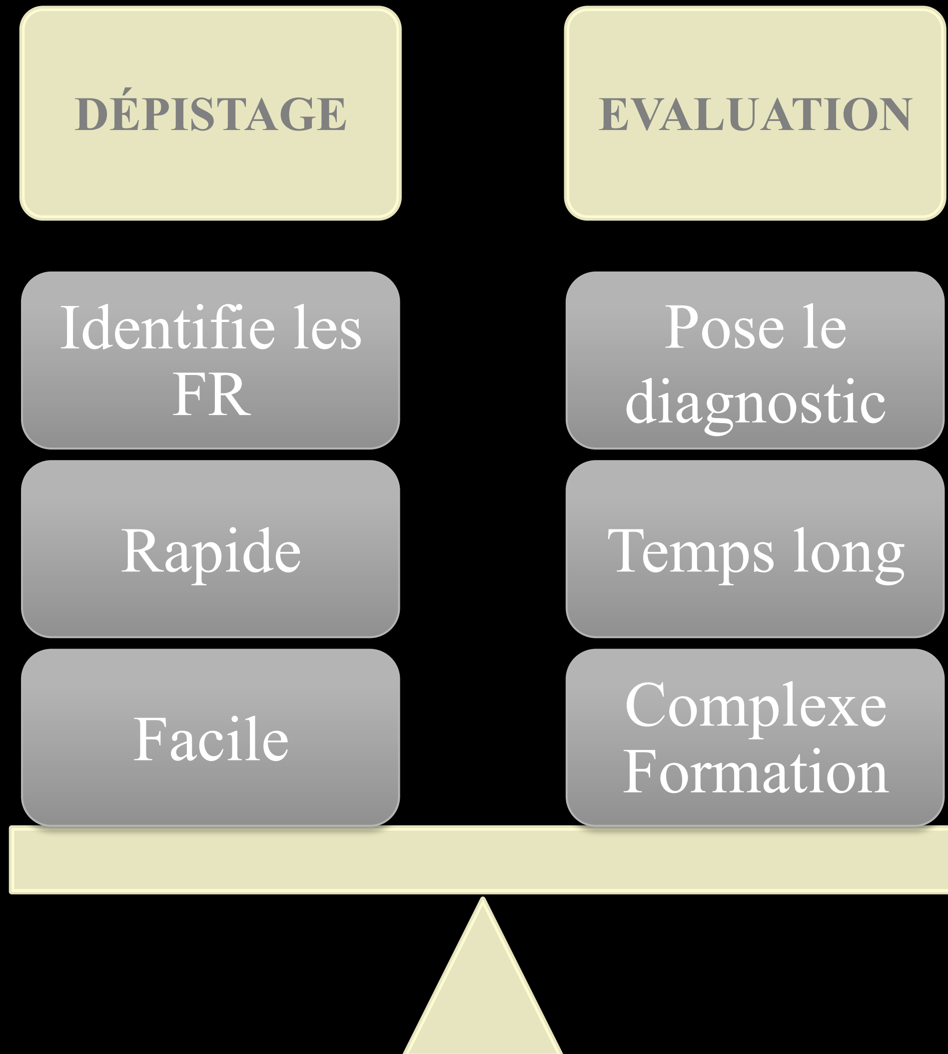
COUT DE LA NUTRITION

La nutrition parentérale est plus coûteuse que l'entérale

VS

Les coûts indirects sont à prendre en compte

QUE FAIRE ?



Encadré 3.1 – Il faut probablement évaluer l'état nutritionnel des patients à l'admission au minimum en calculant l'IMC et en évaluant la perte de poids (Accord faible).

Nutrition Day ICU: A 7 year worldwide prevalence study of nutrition practice in

August 2016

9777 patients of 880 units from 46 countries …

…this study shows that most of the ICU patients are fed enterally, that enteral feeding is started after a median of 1 day …

…the nutritional target is rarely reached, if ever after 5 days… most surprisingly there appears to be no adaptation of energy intake to body weight as it is generally recommended.

ESTIMATION DE LA DEPENSE ENERGETIQUE PAR EQUATIONS

Harris Benedict (basic):
  Men: 13.75(wt) + 5(ht) – 6.8(age) + 66
  Women: 9.6(wt) + 1.8(ht) – 4.7(age) + 655
Harris Benedict (variants): HBEa(25) substitutes adjusted body weight in obese patients calculat
    (Actual wt – ideal wt[b])0.25 + ideal wt
  HBEa(25) × 1.25 uses the HBEa(25) value and multiplies it by a 1.25 stress factor
  HBEa(50) substitutes adjusted body weight in obese patients calculated as (adj ideal wt[b])0.50 + ideal wt
  HBEa(50) × 1.25 uses the HBEa(50) value and multiplies it by a 1.25 stress fac
Mifflin St. Jeor:
  Men: 10(wt) + 6.25(ht) – 5(age) + 5
  Women: 10(wt) + 6.25(ht) – 5(age) – 161
American College of Chest Physicians (ACCP):
  25kcal/kg (actual wt in obese subjects)
  25 kcal/kg (adjusted wt in obese subjects)

Poids / Taille /Age

Swinamer: BSA(941) – Age(6.3) + T(104)[c] + RR(24)[c] + Vt(804)[c] – 4243
Ireton-Jones: Wt(5) – Age(10) + Male(281) + Trauma(292) + Burn(851)
Brandi: HBE(0.96) + HR(7)[c] + Ve(48)[c] – 702

+ FR / VT

Sexe/Trauma/Brûlure

Penn State:
  PSU(HBE) = HBE(0.85) + Tmax(175)[d] + Ve(33)[d] – 6344
  PSU(HBEa) = HBEa(1.1) + Tmax(140)[d] + Ve(32)[d] – 5340
  PSU(m) = Mifflin(0.96) + Tmax(167)[d] + Ve(31)[d] – 6212
Faisy: Wt(8) + Ht(14) + Ve(32)[c] + T(94)[c] – 4834

+ Temp / VM

Analysis of Estimation Methods for Resting Metabolic Rate in Critically Ill Adults

David C. Frankenfield, Abigail Coleman, Shoaib Alam and Robert N. Cooney

Journal of Parenteral and Enteral Nutrition 2009

202 ventilated, adult critical care patients

resting metabolic rate

Standardized indirect calorimetry

VS

Harris Benedict
Mifflin
Penn State equation,
Faisy
Brandi
Swinamer
Ireton-Jones

- Accuracy… 67% for the Penn State equation to 18% for the weight-adjusted Harris Benedict equation
- Within subgroups…highest accuracy rate was 77% in the elderly nonobese using the Penn State equation and the lowest was 0% for the weight-adjusted Harris Benedict equation.
- The Penn State equation was the only equation that was unbiased and precise across all subgroups.
- The obese elderly group was the most difficult to predict.

NUTRITION: RECOMMANDATIONS

Annales Françaises d'Anesthésie et de Réanimation 33 (2014) 202–218

2014

RECOMMANDATIONS FORMALISÉES D'EXPERTS

Nutrition artificielle en réanimation
Guidelines for nutrition support in critically ill patient

J.-Y. Lefrant [a,*], D. Hurel [b], N.J. Cano [c,d,e], C. Ichai [f], J.-C. Preiser [g], F. Tamion [h]

[a] Services des réanimations, division anesthésie réanimation douleur urgence, CHU de Nîmes, place du Pr-Robert-Debré, 30029 Nîmes cedex 9, France

Encadré 1.1 – Tout patient admis en réanimation pour une durée présumée supérieure à 3 jours est à risque de dénutrition. Cette dernière augmente la morbi-mortalité (infection en particulier) et les durées de ventilation, de séjour et d'hospitalisation (Accord fort).

Encadré 2.1 – Pour évaluer précisément la dépense énergétique d'un patient de réanimation, il faut utiliser la calorimétrie indirecte (méthode de référence en tenant compte de ses limites d'utilisation) plutôt que les équations prédictives (Accord faible).

Encadré 4.5 – En cas d'utilisation de calorimétrie indirecte, il ne faut probablement pas dépasser la dépense énergétique mesurée (Accord faible).

Encadré 9.6.3 – En tenant compte de ce poids ajusté, il faut probablement apporter 20 kcal/kg par jour dont 2 g/kg par jour de protéines (Accord faible).

RECOMMANDATIONS
EVALUATION DE LA DEPENSE ENERGETIQUE

Preiser *et al. Critical Care* (2015) 19:35
DOI 10.1186/s13054-015-0737-8

2015

CRITICAL CARE

REVIEW Open Access

Metabolic and nutritional support of critically ill patients: consensus and controversies

Table 2 Areas of consensus (ICU patients with a more than 4-day length of stay)

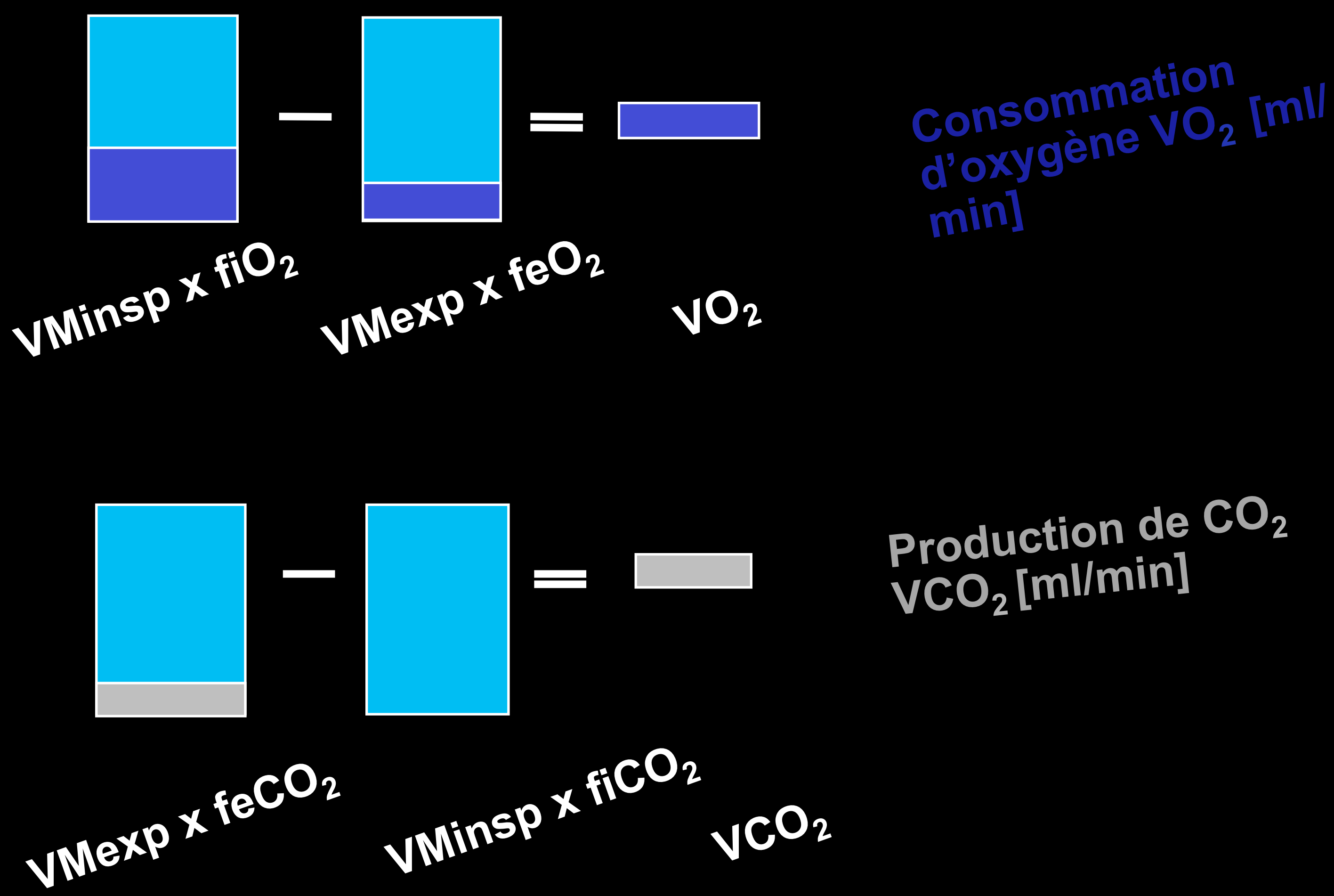
	Consensus
Early enteral feeding	Consider in each patient without absolute contraindication; prevents mucosal atrophy
Risks of overfeeding	Early phase
Estimation of energy expenditure	Requires indirect calorimetry – cannot be predicted by equations
Arginine	Not recommended in sepsis; beneficial in perioperative patients outside the ICU
Vitamins, trace elements	Mandatory, in nutritional doses; particularly true in parenteral nutrition

Moreover, predictive equations are not sufficiently accurate for reliable use in critically ill patients [28]. Nevertheless, measurement of EE is feasible using indirect calorimetry, and guidelines from both the European Society for Clinical Nutrition and Metabolism [41] and the American Society for Parenteral and Enteral Nutrition [42] recommend use of this technique,

Calorimétrie indirecte pour les patients qui doivent séjourner en réanimation

CALORIMÉTRIE
PRINCIPE DE MESURE

Mesure/calcul continus de fiO_2, feO_2, feCO_2, fiCO_2 et VM



CALORIMÉTRIE INDIRECTE
PARAMETRES CALCULES

Consommation Energétique

$$CE = 5.5\ VO_2 + 1.76\ VCO_2 - 1{,}99UN$$ (en Kcal/jour)

UN = Azote Urinaire (N2) quotidien produit
*A défaut de valeur personnalisée: UN = 13 g/jour

Weir's equation
$$EE = [(VO_2 \times 3.941) + (VCO_2 \times 1.11) + (u\ N_2 \times 2.17)] \times 1.44$$

REE = Rest Energy Expenditure – Consomation énergétique de repos/24h
(en L/jour pour les gaz, g/jour pour les substrats oxydés)

Calculés en continu

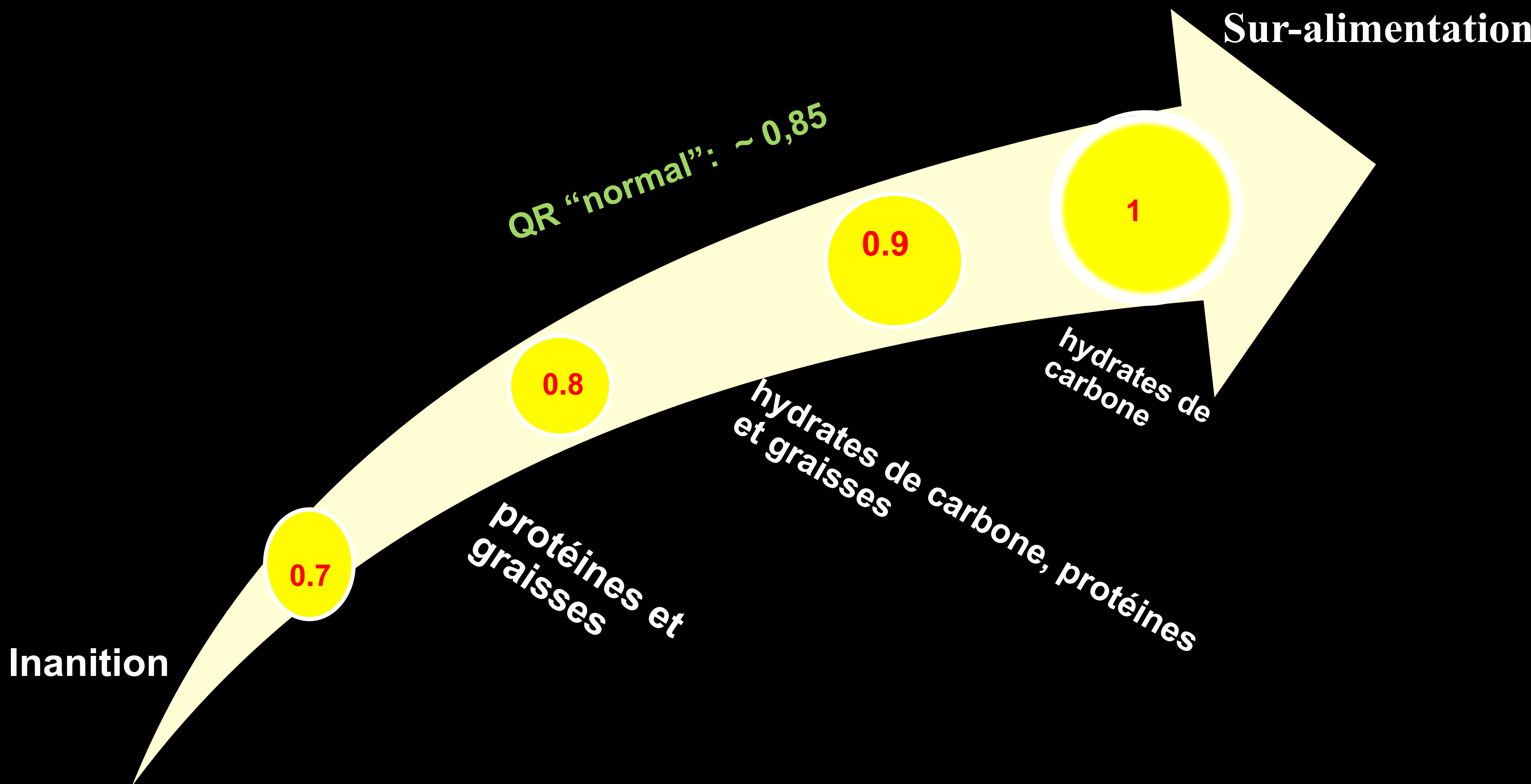
Quotient Respiratoire

$$RQ = VCO_2/VO_2$$

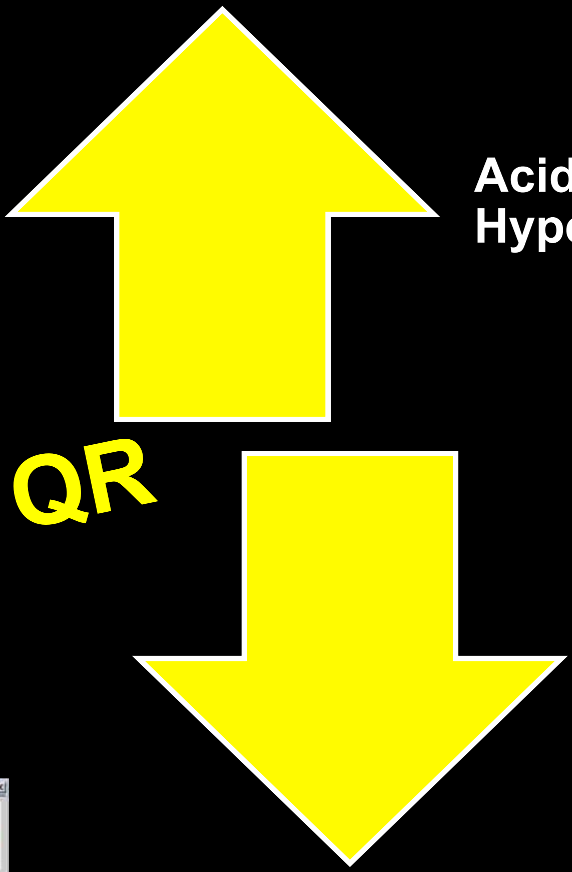
Respiratory Quotient =Respiratory Exchange Ratio

INFLUENCE DES SUBSTRATS SUR LE QR

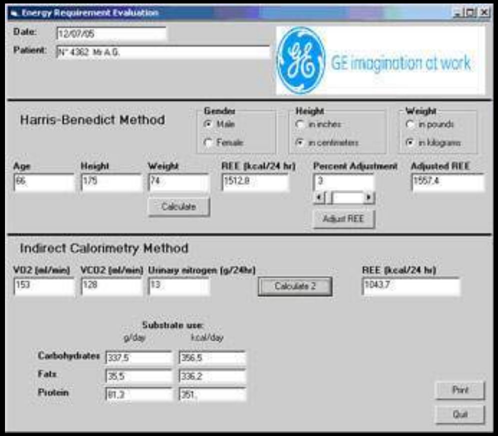
Détermination directe de l'influence de chaque substrat dans le métabolisme



VARIATION DE QR EN REANIMATION



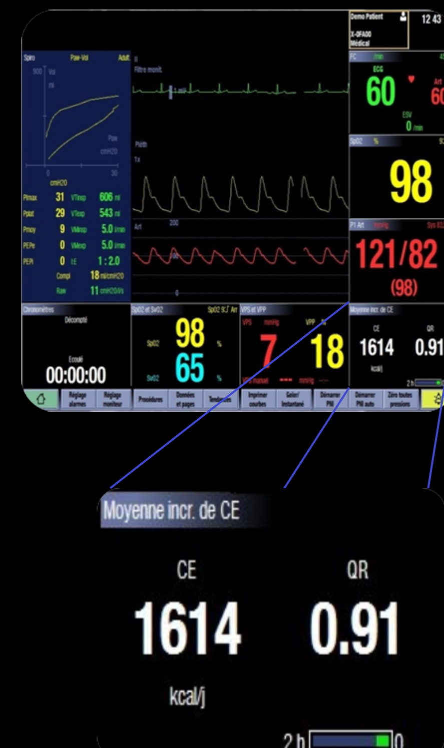
Suivi du métabolisme du patient



INTEGRATION DE LA CALORIMETRIE INDIRECTE AU MONITORAGE CONVENTIONNEL

Respirateur
R860

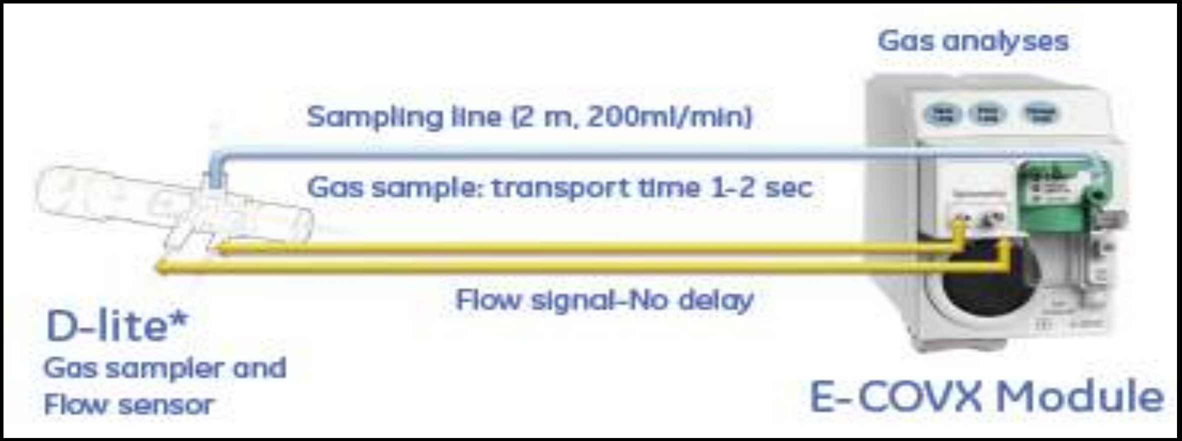
Moniteur
B650



Avantages :
Facilité
Coût

Module d'échange gazeux et métabolisme E-sCOVX

Monitorage (des gaz halogénés), de l'O_2, du CO_2, de la spirométrie proximale et de la calorimétrie indirecte



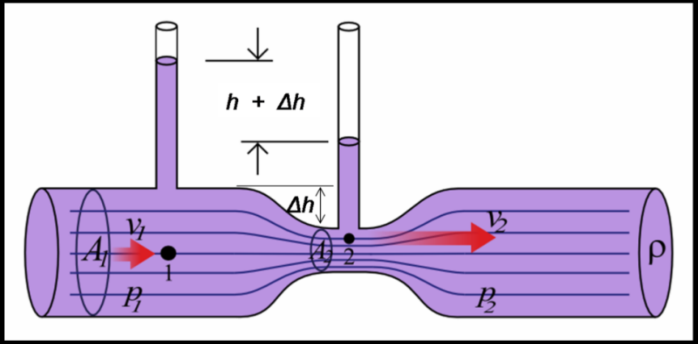
Capteur D-Lite

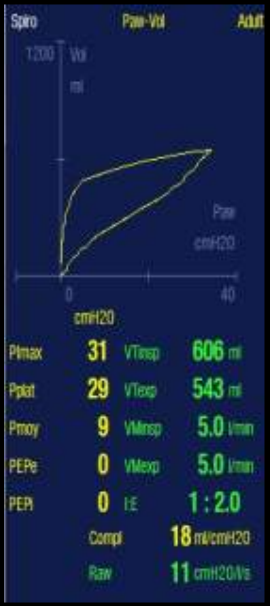
(espace mort 8ml)

Capteur Pedi-Lite

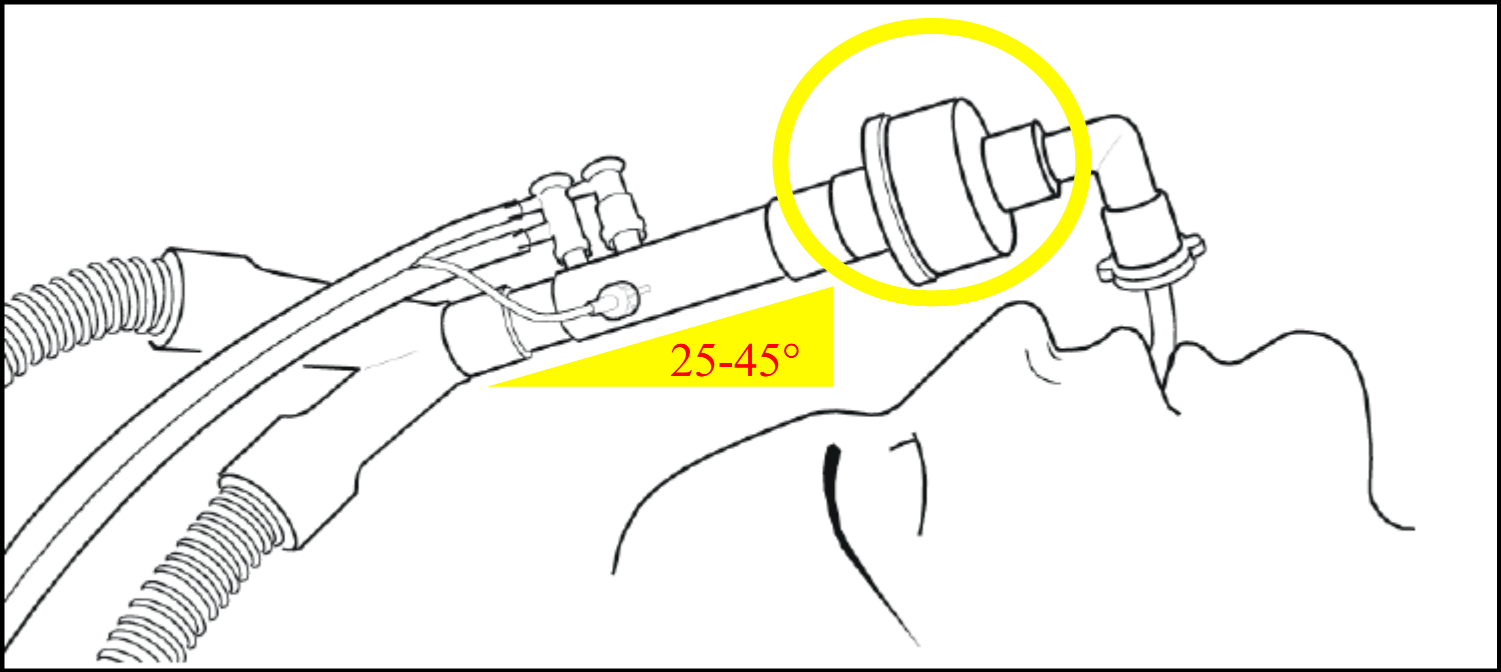
(espace mort 2ml)

Spirométrie





+ Mesure CRF, volume recrutés,
efficacité du recrutement, Best PEEP


25-45°

MESURE

R860

Période de surveillance

Période de zoom

Mesuré

Calculé

Durée de la moyenne (5mn/6H)

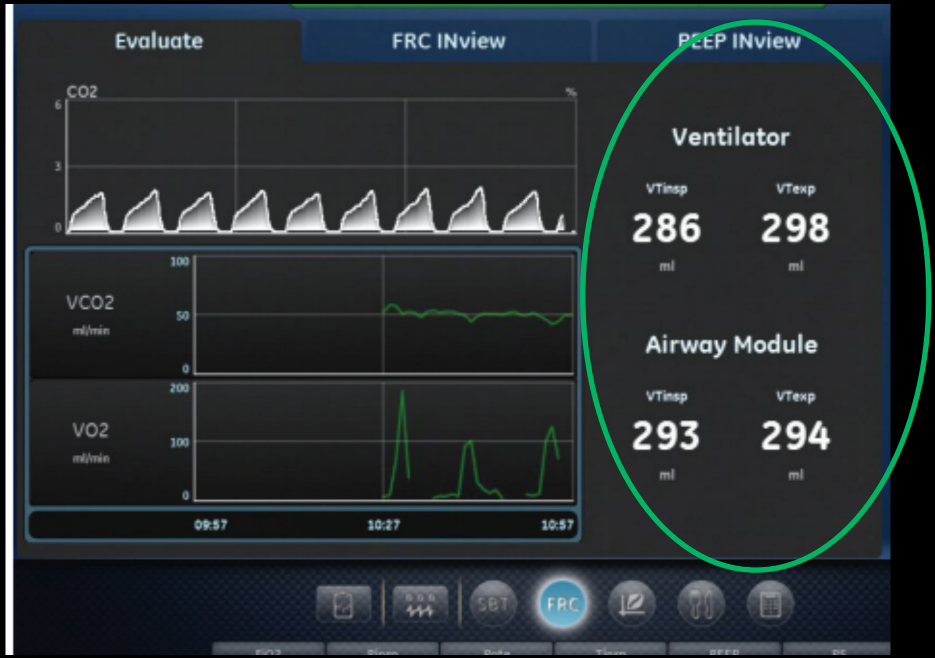
Enregistrement des données

Valeurs moyennes sur la durée choisie

OPTIMISATION CALORIMÉTRIE INDIRECTE

Maximizing the chances of Steady State

- Mesures fiables Si/si état stable.
- Période de repos prolongé, stimuli patient minimaux
- Mêmes réglages de ventilation sur 1 ou 2 H (VT, FR, PEP, FiO_2)
- Pièges des modes assistés (FR variable, rapport I/E non imposé, trapping)



Les mesures doivent être prolongées
Les mesures doivent être répetées

LIMITES

bronchial suction
nursing interventions
patient activity.

- Physical agitation or unstable sedation and/or analgesia
- Air leaks (>10% of minute volume) Ballonnet, hautes pressions
- Unstable body temperature (>±1 °C change over last 1 h)
- Unstable pH (>±0.1 change over last 1 h)
- Oxygen enrichment (FiO_2 >60%)
- Organ support therapies: renal replacement or liver support therapy (pH alterations when conducted intermittently), ECMO (direct O_2 supply to the blood and CO_2 removal from the blood)

Seizures
involuntary movements

The higher the FiO2, the lower the VO2 accuracy.

presence of N2O.

Limitations due to Respiratory Gas Module Specifications

Breath rate > 35 bpm

Tidal Volume < 200 ml D-lite(+) or < 15 ml Pedi-lite(+)

CONCLUSION

- La mesure de dépense énergétique en réanimation est utile.
- Les calculs empiriques sont peu précis
- La calorimétrie indirecte reste peu utilisée en pratique clinique
- Son développement =
  - Optimisation des réglages de la ventilation
  - Prédictibilité du sevrage
  - Suivi continu des variations du métabolisme
  - Adaptation Apports / besoins nutritionnels