Clinical Nutrition 36 (2017) 818–824

Contents lists available at ScienceDirect

Clinical Nutrition

journal homepage: http://www.elsevier.com/locate/clnu

Original article

Impact of decreasing energy intakes in major burn patients: A 15-year retrospective cohort study

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A R T I C L E I N F O

Article history:
Received 8 February 2016
Accepted 10 May 2016

Keywords:
Critical care
Energy requirement
Indirect calorimetry
Guidelines

S U M M A R Y

Background & aims: Nutritional therapy is particularly important after major burn injury and specific nutritional guidelines have been developed. The study aimed at evaluating the impact of the changes in our nutritional practice, general compliance with the guidelines and potential consequences.
Methods: Retrospective analysis of prospectively collected data in burn patients requiring intensive care (ICU) between 1999 and 2014. Inclusion criteria: admission on day 1, full treatment and length of ICU stay >7 days. Four periods (P) were defined by protocol changes (P1: 1999–2001, P2: 2002–2005, P3: 2006–2010, P4: 2011–2014). Collected data: demographic and nutritional data, infectious complications, weights, CRP and prealbumin concentrations during the first 21 days.
Results: 240 patients were included (median age 43 years, burned area 25%). Measured energy expenditure (MEE) was stable through all periods but the prescribed caloric target decreased significantly, and below MEE (P1: 33 kcal/kg, IQR 7, P4: 28 kcal/kg, IQR 8, $p < 0.001$). Energy delivery ended decreasing below 30 kcal/kg/day (P1: 30 kcal/kg, IQR 23, P4: 25 kcal/kg, IQR 12, p < 0.001). Protein intakes increased due the use of high protein solutions and glutamine (P1: 1.04 g/kg, IQR 0.90, P4: 1.26, IQR 0.99, $p < 0.001$). Weight loss by day 21 increased significantly according to area under the curve (P1: 701, IQR 38, P2: 722, IQR 51, P4: 689 IQR 63, $p = 0.02$). Prealbumin levels decreased with energy decrease (P1: 150 mg/L, IQR 110, P4: 80 mg/L, IQR 70, $p = 0.003$).
Conclusions: The observed reduction of the energy delivery <30 kcal/kg was associated with a supplemental weight loss and lower prealbumin concentrations.

1. Introduction

Among critical care conditions, major burn is the one in which nutrition therapy has repeatedly been shown to contribute to outcome. Nutrition therapy constitutes an integral part of care and even of resuscitation, participating in resuscitation of the gastrointestinal tract [1].

Burns, with oncology, were the conditions for which the concept of hyperalimentation was developed in the 80s and publications reported about energy deliveries of 4000–5000 kcal/day based on energy targets calculated with the Curreri equation [2]. Tracer metabolic studies did support the high requirements. It became soon obvious though that increasing delivery with combined parenteral nutrition might lead to severe complications, including infections and deaths [3], but the reasons for these complications were not well understood. Complications were observed that were compatible with overfeeding such as severe hyperglycemia, fatty liver, ventilator weaning problems, and septic complications. Despite these observations, “aggressive” nutrition support to fight the loss of lean body mass and the related poor outcome remained the recommended concept until recently [4].

The recent European recommendations for burn patients [1] reflect all the changes that have occurred in the management of critically ill burn patients: the energy targets have been reduced and are now based on the Toronto equation in absence of indirect calorimetry, while the protein recommendations are elevated compared to other pathologies (1.5–3 g/kg/day).

Our burn centre, computerized since 1999 [5], has been following the recommendations and their evolution over time: the feeding protocol has been adjusted by steps, as have the

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http://dx.doi.org/10.1016/j.clnu.2016.05.007
0261-5614/

resuscitation recommendations. We recently observed increasing complications such as weight loss, infectious complications and delayed wound healing. All of them being potentially nutrition related, we decided to conduct a quality control study of our feeding procedures aiming at detecting undue changes.

2. Methods

2.1. Setting

The Lausanne University Hospital (Centre Hospitalier Universitaire Vaudois) is a 1'100 bed quaternary care hospital. The multidisciplinary intensive care unit (ICU) has 33 beds including 5 dedicated to burns patients. The Lausanne burns centre, is one of two specialized facilities in Switzerland, and admits approximately 150–200 burns patients each year, including 30–50 ICU admissions.

2.2. Study design and data

A retrospective cohort study, based on prospectively collected data, was performed on all consecutive burns admissions to the ICU, between June 1st, 1999 and December 31st, 2014. Patients admitted to the burns facility for other indications were excluded (e.g., Lyell syndrome, readmissions). Inclusion criteria were: admission on day 1, full treatment and length of ICU stay more than 7 days. Data were recorded until day 21. The study was approved by the Institutional Research Ethics Committee (Commission cantonale d'éthique de la recherche sur l'être humain). Informed consent was waived.

Total body surface area (TBSA) burned and depth were estimated by plastic surgeons according to the Wallace Rule of Nine. Inhalation injury was documented by intensivists. The cohort was divided into four groups according to the period defined by the changes in our protocol: Period 1 (P1): 1999–2001 ($n = 32$), Period 2 (P2): 2002–2005 ($n = 57$), Period 3 (P3): 2006–2010 ($n = 85$), Period 4 (P4): 2011–2014 ($n = 66$) (Table 1). These changes followed international recommendations and related essentially to nutritional management. The evolution of the feeding protocol is detailed in Table 1. The principal changes concerned energy prescription and protein targets: energy target decreased from 1.3 times measured energy expenditure (MEE) in P1 to crude measurement in P3 and P4. No protein target was specified during P1 and P2. The protein delivery depended directly on prescribed calories. Specific protein targets, protein enriched feeding and glutamine were all introduced since P3.

The nurse driven feeding protocol itself did not change over time. Enteral nutrition was started at 20 or 30 ml/h (normal or slow progression depending on clinical condition), and increased stepwise (resp. +10 or +15 ml/h), every 12–24 h according to tolerance. Feeding tolerance was assessed using gastric residues (< or >300 ml). Used prokinetics agents were erythromycin and metoclopramide. Parenteral nutrition was suggested after day 4 if energy delivery was below 60% of target for more than 3 days. Through all periods, the intensivists were in charge of prescribing energy target, the nutritive solution and the route. The nurses were in charge of adapting caloric intake by modifying the feed delivery rates, taking into account non-nutritive sources (e.g.: propofol, dextrose infusions). The exact daily intakes of lipid, glucose, protein and calories were real time calculated by our computerized information system (Metavision®, iMDSoft, Tel Aviv Israel) and this information was available for clinicians (but frequently not considered). Energy expenditure was measured by indirect calorimetry, using a Deltatrac II® (Datex-Ohmeda, Helsinki, Finland), until 2014 when it was replaced by a Quark RMR® (Cosmed, Roma, Italy). Due to manpower issues and technical problems, indirect calorimetry was not always available. During these periods the Toronto equation was used for guidance, as it is an equation based on indirect calorimetry.

Study variables were extracted from the computerized information system and included severity variables (SAPS II: Simplified Acute Physiology Score, ABSI: abbreviated burn severity index, and Ryan score), length of mechanical ventilation and ICU stay, measured energy expenditure (MEE), energy targets, energy delivery and substrates (including glutamine), administered amounts of propranolol, laboratory data (prealbumin and C-reactive protein values), as well as admission and actual weights.

Infectious complications were retrieved, based on discharge reports, antibiotherapy introduction or rotation and microbiological findings. Infections were defined according to the Center for Disease Control (CDC) criteria [6], American Burn Association (ABA) consensus criteria [7] and Calandra et al. criteria [8]. Multiple positive cultures were considered only once when they were related to a unique episode of infection. Concomitant sites of infection, including primary bloodstream infections, were considered as separate episodes of infections. Episodes of infections due to several microorganisms were considered only once.

2.3. Statistical analysis

Descriptive statistics are presented as medians with interquartile ranges (IQR = p25–p75) or as mean (standard deviation) for continuous variables and as frequencies and percentages for categorical variables. Study periods were compared using the χ^2 test, Fisher's exact test, one-way-ANOVA or Kruskal–Wallis test

Table 1
Evolution of the ICU's nutritional recommendations.

Variable	Period 1 (1999–2001)	Period 2 (2002–2005)	Period 3 (2006–2010)	Period 4 (2011–2014)
Initial resuscitation	4 ml/kg/% TBSA burned	4 ml/kg/% TBSA burned	2 ml/kg/% TBSA burned	2 ml/kg/% TBSA burned
Energy target	MEE[a] × 1.3	MEE[a] × 1.2	MEE[a] (or Toronto) ≥30 kcal/kg	MEE[a] (or Toronto) ≥30 kcal/kg
Nutritive solution	Standard	Standard	Protein-enriched Low fat	Protein-enriched Low fat
Recommended Feeding route	Enteral	Enteral	Enteral	Enteral
Protein target	Not explicit	Not explicit	1.3–2.0	1.3–2.0
Glutamine	None	None	30 g/day for 10 days	30 g/day for 10 days
Micronutrients	Repletion of losses: Cu, Se, Zn, vitamin C, Mg, P	Repletion of losses: Cu, Se, Zn, vitamin C, Mg, P	Repletion of losses: Cu, Se, Zn, vitamin C, Mg, P	Repletion of losses: Cu, Se, Zn, vitamin C, Mg, P
Glucose control	No recommendation	Doctor driven tight: 4.0–6.0 mmol/l	Nurse driven tight: 4.0–6.0 mmol/l	Nurse driven moderate: 6.0–8.0 mmol/l
Propranolol	None	After 72 h, if stable	After 72 h, if stable	After 72 h, if stable

[a] MEE = indirect calorimetry measured energy expenditure.