

## A prospective observation on nutrition support in adult patients with severe burns

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### Abstract

Nutrition therapy is considered an important treatment of burn patients. The aim of the study was to delineate the nutritional support in severe burn patients and to investigate association between nutritional practice and clinical outcomes. Severe burn patients were enrolled ( $n$  100). In 90% of the cases, the burn injury covered above 70% of the total body surface area. Mean interval from injury to nutrition start was 2.4 (SD 1.1) d. Sixty-seven patients were initiated with enteral nutrition (EN) with a median time of 1 d from injury to first feed. Twenty-two patients began with parenteral nutrition (PN). During the study, thirty-two patients developed EN intolerance. Patients received an average of about 70% of prescribed energy and protein. Patients with EN providing <30% energy had significantly higher 28-d and in-hospital mortality than patients with EN providing more than 30% of energy. Mortality at 28 d was 11% and in-hospital mortality was 45%. Multiple regression analysis demonstrated that EN providing <30% energy and septic shock were independent risk factors for 28-d prognosis. EN could be initiated early in severe burn patients. Majority patients needed PN supplementation for energy requirement and EN feeding intolerance. Post-pyloric feeding is more efficient than gastric feeding in EN tolerance and energy supplement. It is difficult for severe burn patients to obtain enough feeding, especially in the early stage of the disease. More than 2 weeks of underfeeding is harmful to recovery.

**Key words:** Severe burns: Enteral nutrition: Parenteral nutrition: Clinical outcomes

Severe burn remains a major healthcare problem throughout the world<sup>(1,2)</sup>. It is accepted that patients with severe burn injuries are characterised by an intense inflammatory response, a strong oxidative stress and a prolonged hypermetabolism and catabolic response, and they are proportional to the depth and area of burn injury<sup>(3–6)</sup>. Nutrition therapy is recognised as one of the most significant treatment aspects for burn patients, on the grounds of physiological rationale; nutrition guideline was designed specifically for burn patients<sup>(7)</sup>. However, the guideline was largely based on studies with limited sample sizes, with variable qualities or expert opinions<sup>(8–10)</sup>.

Nutritional therapy is preferentially delivered via the enteral route, with a recommended early start in the critically ill<sup>(7)</sup>. However, enteral feeding is often poorly tolerated in critically ill

patients. The gastrointestinal tract intolerance syndrome seems to occur in 10–52% of patients who receive gastric feeding. Through previous studies over the past decade<sup>(11,12)</sup>, the prevalence of 'feeding intolerance' and fasting in severe burn patients may be the chief factors resulting in inadequate enteral nutrition (EN) in critically ill patients<sup>(13)</sup>. Both risk factors appear to be particularly prevalent in severe burn injury patients<sup>(14)</sup>, suggesting that energy and protein delivery may be insufficient in these patients.

There are limited data relating the actual nutritional practices in patients with severe burn injury. In this study, we aim to delineate the nutrition support in adult patients with severe burns in a massive explosion in China, thus to investigate the association between nutritional practice and clinical outcomes.

**Abbreviations:** EN, enteral nutrition; PN, parenteral nutrition.

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**Table 1.** Characteristics of the patients at baseline (*n* 100)\*  
(Mean values and standard deviations; medians and interquartile ranges (IQR); numbers and percentages)

Characteristics	Mean	SD
Male patients		
<i>n</i>	55	
%	55.0	
Age (years)		
Median	35.6	
IQR	28–43	
Height (cm)	165.0	6.2
Weight (kg)	65.8	21.5
BMI (kg/m <sup>2</sup> )	21.6	1.5
BMR (kJ/d)	5629.6	694.1
APACHE II score at admission to ICU	12.5	4.5
Burned BSA (%)		
Global		
Median	94.5	
IQR	90–98	
Third degree		
Median	88	
IQR	76–95	
Patients with inhalation injury		
<i>n</i>	100	
%	100	
Patients with malnutrition		
Admission value		
Mean prealbumin (mg/l)	119.0	25.6
Leucocytes (cells/m <sup>3</sup> )	10.3	3.6
Serum glucose (mmol/l)	9.1	1.6
Serum creatinine (μmol/l)	46.8	5.3

APACHE II, Acute Physiology and Chronic Health Evaluation II; ICU, intensive care unit; BSA, body surface area.

\* Continuous variances complying with normal distribution are presented as means and standard deviations, otherwise as medians and IQR, category variances are presented as numbers and percentages.

## Methods

### Data sources and study patients

On 2 August 2014, a provincial network was set up in Jiangsu by the provincial government, to organise, coordinate and guide the management of the burn patients. The clinical treatment group included the Jiangsu Provincial Health Department and an expert panel from the departments of burn and critical care medicine.

This prospective, observational, multicentre trial was conducted in intensive care unit (ICU) of seven hospitals. Burn patients in a massive explore in Kunshan, Jiangsu Province, China, on 2 August 2014 were included. Patient inclusion criteria were admission on day 1 of burn injury, older than 18 years of age and expected to survive more than 48 h. Feeding protocol recommended by the expert panel was based on the European Society for Clinical Nutrition and Metabolism (ESPEN) guideline, and according to the guideline EN should be started as early as possible, gastric feeding via a nasogastric tube was the first choice, post-pyloric feeding was performed in patients developing gastric feeding intolerance, parenteral nutrition (PN) was suggested when EN was not available or EN intolerance happened. The correct gastric position of the feeding tube was checked by radiography. Energy target was set according to Toronto equation, and the protein intake had been considered to be around 2 g/kg per d based on the ESPEN

guideline. The above feeding strategy was implemented by the attending physician based on the specific circumstances of the patients. Daily data were recorded for a maximum of 28 d for each patient. Patients survived in hospital at the 28th day or being discharged before 28 d were considered to be survivors. The study was approved by the Ethics Committee of Southeast University affiliated Zhongda Hospital (reference number: 2014ZDSYLL116.1). All participating hospitals accepted the central ethics committee review. The study complied with the Declaration of Helsinki regarding ethical principles of human subject research and the relevant ethical requirements of the International Conference on Harmonisation/Good Clinical Practice guidance and national regulations. Written informed consents were provided by the participants or their legal representatives.

Burn wounds of all the patients were treated in a uniform fashion with regard to excisional and grafting therapy. Patients received urgent and periodic surgeries to remove all charred tissues and graft which involves a combination of autograft, homograft or artificial skin.

A case report form (CRF) was completed for each patient by his/her physician as soon as possible after inclusion in the study. The CRF included the following items: Acute Physiology and Chronic Health Evaluation (APACHE II) scores based on the worst values obtained within 24 h after the onset of the injury; laboratory test values including blood leucocytes, prealbumin, serum glucose and serum creatinine at admission, burn size and depth of burn; the route, timing and amount of nutrition support; the daily energy and protein intake, and energy requirement at the same time according to the Toronto equation<sup>(7)</sup> feeding intolerance or other adverse events in feeding; the occurrence of infection or septic shock; and clinical outcomes. Feeding intolerance was defined as gastric residual volume (GRV) from 150 to 500 ml in two occasions between 6 h, or GRV >500 ml in one measurement or when vomiting, abdominal distention or diarrhoea occurred. Postpyloric feeding was performed in patients developing gastric feeding intolerance. Septic shock was defined as persistent hypotension induced by infection, despite adequate fluid resuscitation. Infection was diagnosed by positive culture of pathogenic microorganisms in suspected infection sites. The main infection sites were burn wound, blood and lung. All the septic shock patients were treated with targeted antibiotics. Attributable mortality rate was evaluated using the definition of Montgomery *et al.*<sup>(15)</sup> for irreversible organ dysfunction.

### Statistics

Continuous variables were summarised as either mean and standard deviations or medians with interquartile ranges. For categorical variables, the frequency and percentage of patients in each category were calculated. *T* test,  $\chi^2$  test or Fisher exact test was used to compare the categorical variables. Means between groups were compared via Mann–Whitney *U* test. The differences in prognostic factors in surviving and non-surviving patients were evaluated with Fisher exact tests. Multiple logistic regression analysis was used to identify independent predictors of mortality. All tests were two tailed, and *P* < 0.05 in the final

**Table 2.** Clinical management, feeding adverse events and outcomes in the 100 patients (Number and percentage; median and interquartile range (IQR); mean value and standard deviation)

Characteristics	<i>n</i>	%
No. of days to initiation of nutritional support		
Median	2	
IQR	1–3	
Nutritional support within 72 h after burn injury	89	89
Feeding initiated by the enteral route only	26	29.2
Days to starting nutrition		
Median	1	
IQR	1–3	
Feeding initiated by the parenteral route only	22	24.7
Days to starting nutrition		
Median	2	
IQR	2–3	
Feeding initiated by the enteral and parenteral route	41	46.1
Days to starting nutrition		
Median	2	
IQR	2–3	
Initiated exclusive oral feeding during 30 d after injury	4	4
Mean time to starting exclusive oral feeding (d)	25	
Nutritional route		
Only a gastric tube for the duration of admission	72	72
Gastric followed by placement of a post-pyloric tube	21	21
Gastric tube and post-pyloric tube when had feeding initiated	7	7
Patients receiving prokinetic drug during intervention period	90	90
Prealbumin (mg/l)		
Day 14		
Mean	162.4	
SD	52.1	
Day 28		
Mean	158.3	
SD	39.8	
Blood glucose during intervention period (mmol/l)		
Daily lowest		
Mean	5.3	
SD	3.2	
Daily highest		
Mean	12.5	
SD	7.8	
Patients receiving sustained insulin therapy — no./total no. (%)	18	18
No. of days on mechanical ventilation		
Median	12	
IQR	8–18	
Feeding adverse events		
Gastric residual volumes or vomiting	21	21
Abdominal distention	9	9
Diarrhoea	6	6
Regurgitation or aspiration	13	13
Elevated liver enzymes	12	12
Jaundice	8	8
Electrolyte disturbance	16	16
Upper gastrointestinal haemorrhage	6	6
Interruptions to nutritional delivery		
Interruptions to nutritional delivery	95	95
Days of interruption		
Median	3	
IQR	2–5	
Number of operations in the first month		
Median	3	
IQR	2–4	

**Table 2.** *Continued*

Characteristics	<i>n</i>	%
Use of growth hormone	36	36
Use of <i>n</i> -3 fatty acids	33	33
Use of glutamine	72	72
Acid-suppressive medication	91	91
Outcomes		
Days between illness onset and death		
Median	21	
IQR	4–26	
Mortality in the ICU, no./total no.	11/100	11
Mortality at 14 d, no./total no.	6/100	6
Mortality at 28 d, no./total no.	11/100	11
Mortality in-hospital, no./total no.	45/100	45
Attributable mortality		
Severe burn injury, no./total no.	3/45	6.7
Septic shock, no./total no.	42/45	93.3

ICU, intensive care unit.

analysis was considered statistically significant. All analyses were carried out using SPSS software for Windows (release 16.0).

## Results

### *Demographic and clinical characteristics*

One hundred patients from seven hospitals were enrolled, contributing a total of 945 study days. All the patients were admitted to ICU. Most of the patients had extremely severe burns. In all, ninety patients had burn injuries above 70% of the total body surface area (TBSA), and seventy-seven patients had above 90% TBSA burn. Ninety-two patients had a third-degree burn covering more than 50% TBSA. All the patients had smoke inhalation injuries and received mechanical ventilation. The median number of days on mechanical ventilation was 12. Mean APACHE II score at admission was 12.5 (SD 4.5). The level of prealbumin decreased significantly at admission. None had co-morbidities and all were healthy before injury. Baseline characteristics of the patients are shown in Table 1.

### *Nutrition delivery*

Overall, eighty-nine patients received nutritional support within 72 h after burn injury. Of these, sixty-seven patients initiated with EN and twenty-two patients started with PN. For all patients, median to initiation of nutritional support was 2 d, and for patients feeding was initiated only through the enteral route, the median time was 1 d. Ten patients received oral nutrition within 28 d of observation. Patients with EN were more likely than those with PN to initiate early oral nutrition. Four patients took oral nutrition exclusively with a mean starting time for exclusive oral nutrition of 24.8 (SD 4.6) d. Prealbumin levels were lower than normal at days 14 and 28 (Table 2).

The daily energy content, fat, carbohydrate and amino acid intake up to day 28 are delineated in Fig. 1. The mean energy intake was 11.4 kcal/kg (47.7 kJ/kg) of actual body weight on the 1st day, which gradually increased to 33.8 kcal/kg (141.4 kJ/kg) of actual body weight per d within the first week. After 2 weeks,

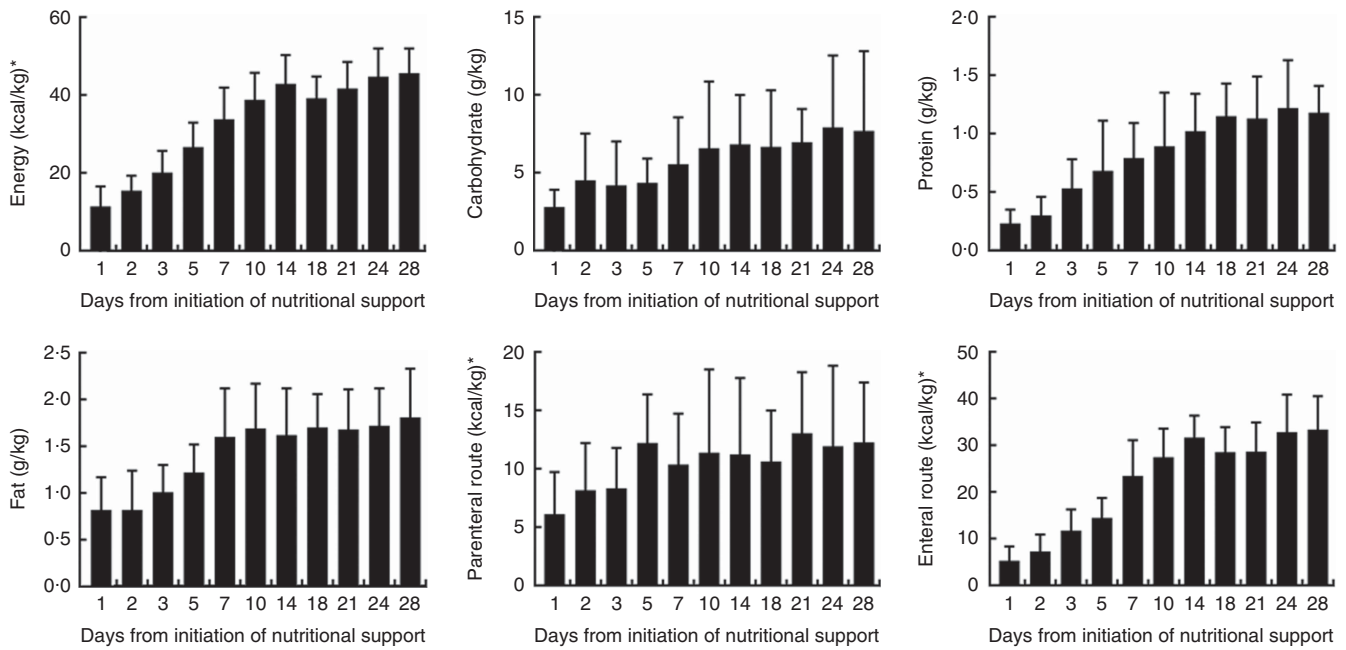


Fig. 1. Energy and protein delivered as a percentage of prescribed values regardless of the route. \* To convert kcal to kJ, multiply by 4.184.

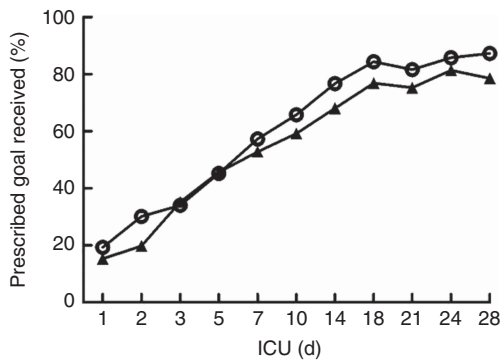


Fig. 2. Energy (—○—) and protein (—▲—) delivered as a percentage of prescribed values regardless of the route. ICU, intensive care unit.

the mean energy supply reached about 40.0 kcal/kg (167.4 kJ/kg) of actual body weight per d until the fourth week. It was the same as the protein supply. Compared with energy requirement calculated by the Toronto formula at the same time, the patients received about 70% of their prescribed energy and protein requirements by nutrition therapy after 2 weeks during our observation (Fig. 2). The mean energy deficit up to day 28 for all patients was 1173 kcal/d (4908 kJ/kg), with a mean protein deficit up to day 28 of 57 g/d. Higher energy and protein deficiency were found in patients with gastric feeding (*n* 72) compared with those with post-pyloric feeding (*n* 28) (1368 *v.* 979 kcal/d (5724 *v.* 4096 kJ/d), *P*=0.034; 68.3 *v.* 46.1 g/d, *P*=0.026) (Fig. 3(a)).

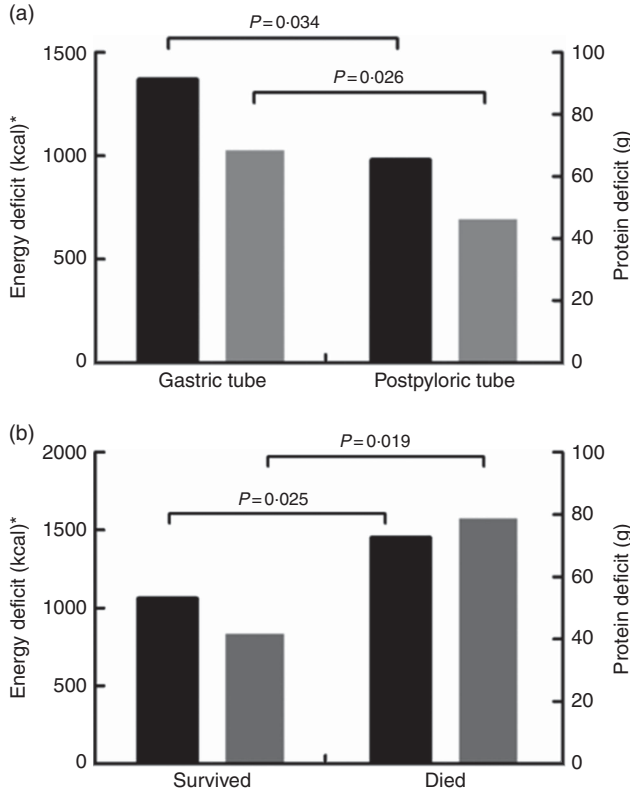
Eleven patients received only total EN feeding in the study, the remaining eighty-nine patients were fed by EN combined with PN. Of all the patients, forty-seven patients received total protein formula, while fifty-three were fed by short polypeptide formula. No difference was seen in total energy and protein intake between patients with EN and patients with EN

combined with PN. Compared with the EN feeding, patients in the EN combined with PN group were more severely injured. No differences could be noted in the severity of injury or energy and protein intake among patients with different EN:PN ratio; higher incidence of nutrition intolerance was found in patients with EN providing <60% of the prescribed energy content compared to those with EN providing more than 60% prescribed energy content. The patients with EN providing more than 30% of energy content had lower incidence of haemodynamic instability (27.3 *v.* 72.7%) and 28-d mortality (7.3 *v.* 36.4%), and in-hospital mortality (38.8 *v.* 86.3%) compared with patients with EN providing energy content <30% (Table 3).

The majority of patients (*n* 95) had interruptions to their feeding during the 28 d. The median duration of interruption was 3 d. Sixteen patients had interruptions even more than 5 d. Fasting for procedures resulted in feeding interruption. The other main contributing factors included haemodynamic abnormality, gastrointestinal access displaced and EN feeding intolerance.

#### Adverse events

Thirty-two patients developed feeding intolerance during the study, with the mean duration of 4.7 (sd 3.5) d. The most common clinical manifestations were higher GRV or vomiting (*n* 21), abdominal distension occurred (*n* 9) and diarrhoea (*n* 6). Enteral refeeding was performed in twenty-one patients with post-pyloric tube. Features of nutrition support with or without feeding intolerance were summarised in Table 4. Overfeeding, total protein formula and haemodynamic instability seemed to be the main reasons for feeding intolerance. In patients with EN intolerance, more patients had hyperglycaemia. There was no significant difference in feeding route and



**Fig. 3.** (a) Energy (■) and protein (▒) deficits in relation to nutrition routes from days 1 to 28. (b) Energy and protein deficits in relation to prognosis from days 1 to 28. \* To convert kcal to kJ, multiply by 4.184.

feeding type between patients with EN tolerance and intolerance. Other main adverse events included blood glucose fluctuations and hepatic enzyme elevation. Forty-eight patients had at least once a fasting blood glucose >10 mmol/l, six patients experienced hypoglycaemic episodes (blood glucose <3.5 mmol/l), twelve patients had elevated liver enzymes and eight patients had jaundice.

**Clinical outcomes**

Eleven patients died, and no patients were discharged 28 d after admission. The clinical outcomes are summarised in Table 2. Mortality rate at day 14 was 6% (6 of 100), which increased to 11% (11 of 100) at day 28, and in-hospital mortality was 45%. The cause of death was septic shock. Three patients died within 3 d after admission.

The patients who were fed by EN providing <30% of energy had significantly higher mortality than those who fed by EN providing more than 30% of energy ( $P=0.001$ ). Severity of burn injury, energy and protein intake were all similar in these patients. Higher energy and protein deficiency were found in survival patients compared to dead patients (Fig. 3(b)). Compared with survivors, non-survivors received more surgeries, with an energy intake lower than 30 kcal/kg (126 kJ/kg) of actual body weight per d at 14 d after injury. In addition to the incidence of energy and protein deficits, EN intolerance and septic shock were significantly more frequent in the non-survivors (Table 5). Considering all these prognostic factors

**Table 3.** Comparison of different ratios of enteral nutrition (EN) (Mean values and standard deviations; percentages)

	EN (n 11)		EN <30% (n 22)		30% < EN < 60% (n 41)		EN > 60% (n 26)		P
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
Age (years)	37.1	8.1	33.6	9.0	37.3	10.7	33.7	7.9	0.235
Male sex (%)	27.3		81.8*		51.2†		57.7†		0.001
APACHE II at admission to ICU	9.2	4.7	13.5	3.1	12.5	2.8	12.8	3.6	0.017
Global burned BSA (%)	52.0	15.7	96.4*	4.7	93.4*	6.9	93.5*	5.7	0.000
Third-degree burned BSA (%)	41.2	25.2	89.2*	8.0	84.7*	16.5	85.1*	9.4	0.000
Prealbumin at admission to ICU (mg/l)	127.2	23.4	122.7	21.5	120.0	28.1	116.6	18.9	0.520
Operations in the first month	2.2	1.0	2.8	1.1	3.2	1.1	3.3	1.2	0.063
Energy intake (kcal/kg per d)†	36.2	7.1	32.1	7.5	34.6	5.1	34.9	6.8	0.118
Protein intake (g/kg per d)	1.0	0.5	1.2	0.5	1.2	0.6	1.1	0.6	0.233
Feeding intolerance (%)	0		72.7*		34.1*		7.7†		0.001
Patients receiving sustained insulin therapy (%)	0		40.9*		17.1		7.7†		0.000
Use of albumin (g/d)	20	11.5	44.1*	11.8	37.8*	11.4	35.0*	11.0	0.000
Haemodynamic instable (%)	0		72.7*		23.5†		3.8†		0.001
Mortality at day 28 (%)	0		36.4*		7.3†		0†		0.001
Mortality in-hospital (%)	0		86.3*		58.5†		7.7†		0.001

PN, parenteral nutrition; APACHE II, Acute Physiology and Chronic Health Evaluation II; ICU, intensive care unit; BSA, body surface area.

\* Value was significantly different from that for EN ( $P < 0.05$ ).

† Value was significantly different from that for EN <30% ( $P < 0.05$ ).

‡ To convert kcal to kJ, multiply by 4.184.

**Table 4.** Nutrition characteristics with and without enteral nutrition (EN) intolerance (n 100)

	EN intolerance	EN tolerance	P
Formula total protein/short polypeptide	20/12	27/41	0.033
Feeding route gastric/post-pyloric	25/7	47/21	0.349
Feeding type continuous feeding/bolus	8/24	29/39	0.088
EN intake per d (ml) >1500/<1500	25/7	39/29	0.044
Prokinetics, yes/no	27/5	63/5	0.198
Acid-suppressive medication, yes/no	29/3	62/6	0.928
Haemodynamic stable/instable	13/19	60/8	0.000
Mean blood glucose (mmol/l) >10/<10	19/13	26/42	0.047

**Table 5.** Prognostic factors in non-surviving and surviving burn injury patients (n 100)

	Non-survivor	Survivor	P
Age ≤40 years/>40 years	9/2	52/37	0.133
Sex (male/female)	7/4	48/41	0.542
Global burned BSA <40 %/≥ 40 %	0/11	2/87	0.616
Third-degree burned BSA <20 %/≥ 20 %	0/11	2/87	0.616
APACHE II on admission to ICU <15/≥15	9/2	64/25	0.485
Mean number of operations ≤2/>2	9/2	29/60	0.002
Initiation of nutritional support ≤24 h/>24 h	2/9	14/75	0.834
Initiation of nutritional support ≤48 h/>48 h	4/7	44/45	0.413
Initiation of EN ≤24 h/>24 h	2/9	14/75	0.834
Initiation of EN ≤48 h/>48 h	4/7	41/48	0.542
Energy content in the first week (kcal/kg per d) ≤30/>30*	5/6	51/38	0.455
Energy content within 2 weeks (kcal/kg per d) ≤30/>30*	8/3	31/58	0.015
Use of glutamine, yes/no	7/4	65/24	0.513
Use of n-3 fatty acids, yes/no	4/7	29/60	0.801
Use of growth hormone, yes/no	6/5	30/59	0.174
Septic shock, yes/no	9/2	18/71	0.000
Energy deficit (kcal/kg per d) >20/<20*	9/2	45/44	0.050
Protein deficit (g/kg per d) >0.8/<0.8	10/1	48/41	0.019
Feeding route gastric/post-pyloric	6/5	66/23	0.172
Nutrition tolerance, yes/no	3/8	65/24	0.002

BSA, body surface area; APACHE II, Acute Physiology and Chronic Health Evaluation II; ICU, intensive care unit; EN, enteral nutrition.  
\* To convert kcal to kJ, multiply by 4.184.

including severity of burn, the surgical amount, septic shock, energy and protein deficit, nutrition intolerance, initiation of nutritional support, initiation of EN and ratios of EN providing energy in nutrition multiple regression analysis, it was demonstrated that EN providing <30% energy in nutrition and septic shock were the independent risk factors for mortality (OR 5.2; 95% CI 1.026, 11.682; *P* = 0.042; OR 6.5; 95% CI 0.848, 32.156; *P* = 0.031).

### Discussion

Data on nutrition support and feeding practices in severe burn patients are scarce. This study, to our knowledge, is the largest in severe burns in China and possibly anywhere else as well. One hundred critically ill patients with severe burns were presented in this study. The consistence of the underlying medical conditions, including the aetiology, injury onset and treatment of all these patients reduced the influence of interference factors. The findings showed that EN can be initiated early in majority of severe burn patients, and post-pyloric feeding is more beneficial than gastric feeding in EN tolerance and energy supplement. Many patients developed EN feeding intolerance, and nearly 90% patients needed PN supplementation. It is

difficult for severe burn patients to obtain adequate feeding, especially in the early stage of the disease. More than 2 weeks of underfeeding may be harmful to recovery.

Nutritional therapy plays an indisputable role for critically ill burn patients from the early start of the initial resuscitation<sup>(16)</sup>. It stimulates mucosal blood flow and maintains gut barrier function and mucosal integrity<sup>(17)</sup>. In our study, the enteral route was the first choice for feeding, in accordance with the guideline. Nevertheless, in our cohort, severe burn injury resulted in gastrointestinal dysfunction; so PN was an alternative or combined approach in almost 90% of the patients. The majority of our patients initiated nutrition within 72 h after burn injury, but only sixteen patients began to be fed within 24 h. It differs from some previous studies, in which the majority patients had been fed within 24 h<sup>(18,19)</sup>. Delayed feeding may due to inadequate medical staff, prolonged triage and transport, the severity of injury and haemodynamic instability.

Feeding intolerance is a common problem in critical burn patients<sup>(13)</sup>. A high rate (32%) of feeding intolerance was noted in our study, despite the early use of prokinetics in 90% of the patients. It was similar to Mentec's study<sup>(20)</sup>. Risk factors for enteral feeding intolerance in burn patients include severity scores (APACHE II, simplified acute physiology score II, sequential organ failure assessment), acidosis and electrolyte

disorders, sedation, use of catecholamines and prone position etc<sup>(21)</sup>. All the risk factors were particularly prevalent in our study patients. In our study, the mean duration of enteral feeding intolerance was 4.7 (SD 3.5) d which is longer than that in Lavrentieva's report<sup>(22)</sup>. Severity of injury therefore possibly may be associated with an increased prevalence of delayed gastric emptying and feeding intolerance. In addition, a significantly higher incidence of EN intolerance was observed in patients fed total protein formula, fed with a volume above 1500 ml/d and with septic shock. These observations indicate that both the type and the amount of the EN formula are worthy of attention.

The prevalence of feeding interruption mainly due to adverse events in feeding and perioperative fasting (median interval of 3 d) caused underfeeding in our study. PN was therefore supplemented, which led to hyperglycaemia and liver dysfunction in proportion to energy supply in most of the patients in the first month. Consequently, almost all the patients in our study were notably underfed at the early stage. This is comparable to the results in other non-burn critically ill patients.

Underfeeding should be avoided, considering the correlations between energy and protein deficits and the 28-d mortality. Potentially available strategies include continuous instead of bolus feeding, higher threshold of GRV for feeding reduction and post-pyloric feeding according to previous studies in cohorts of critically ill patients. Being consistent with the study by Deane *et al.*<sup>(23)</sup>, we found that the energy and protein deficits decreased after changing the intra-gastric feeding with post-pyloric delivery because of the gastric intolerance in some patients. Unfortunately, the timing of EN initiation did not affect the 28-d mortality in our study. The possible reasons were the delayed start of EN in most patients and the extreme severity of burn injury. These may also be the key factors affecting patient recovery.

This study has its limitations. Conditions did not allow us to measure the energy expenditure during the study, and the sample size is limited. Since the majority of the population were young to middle-age adults, sedated and analgesic, it may not be possible to exactly match the clinical characteristics of all the population. As a result, our observations may not be fully consistent with various institutional populations.

In conclusion, in our cohort, EN can be initiated early in severe burn patients. Majority of patients were fed by EN supplemented with PN. Post-pyloric feeding was beneficial to improving the tolerance of EN. It is difficult for severe burn patients to obtain adequate feeding, especially in the early stage of the disease. More than 2 weeks of underfeeding may be harmful to recovery.

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F. G., Y. X. and H. Q. had full access to all the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis. Study concept and design: F. G., H. Q. Acquisition of data: F. G., H. Z., J. W., Y. H., G. L., Y. W., H. Z., J. J., F. Z., L. L., W. L., Y. Y. Analysis and interpretation of data: F. G., H. Z. Statistical analysis and drafting of the manuscript: F. G., H. Z., Y. X. Critical revision of the manuscript for important intellectual content: Y. Y., Y. X., H. Q. Study supervision: H. Q.

The authors declare that there are no conflicts of interest.

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