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Original Article

Profile and factors influencing resting energy expenditure in adult burn patients

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Abstract: The aims of this study are to determine characteristics and factors influencing REE in adult severe burn patients. A prospective study was conducted on 62 adult burn patients admitted during 72 h after burn to burn intensive care unit, National Burn Hospital, Vietnam. REE measurements and REE/BMR calculations were obtained on the 3rd, 7th, 14th, 21st and 28th day after burn. Collected data was analyzed to find out the influence of age, gender, burn extent, inhalation injury to REE. The results indicated that all measured REE was significantly higher than BMR at all time points (REE/BMR ratio > 1) with a peak value on the 7th day then steady decreased but still around 200% in compared with BMR on the 28th day after burn. In compared with females, REE of male patients were significantly higher during the first three weeks after burn. In addition, significantly greater REE were seen in the patients with burn surface area ≥ 60% TBSA or deep burn area ≥ 20% TBSA. Moreover, REE of nonsurvivors was significantly higher in compared with survivor group on the 7th and 14th day after burning. Meanwhile, increased age and presence of inhalation injury did not affect REE. In conclusion, in adult burn patients, increased REE is prolonged, burn size dependent and significantly higher in male and in nonsurvivor. This finding should be considered in nutritional caring for adult burn patients.

Keywords: Resting energy expenditure, adult burn patients, influencing factors

Introduction

Hypermetabolic response after burn has only been studied and known since World War II when Cope and colleagues proved that the increase in metabolic rate in burns was not due to Thyroid hormones and also not only due to increased secretion of adrenal hormones but depends on the burn size [1].

Currently, hypermetabolic response following burn injury is considered as the highest level in compared with any types of traumas and diseases [2, 3]. This state is associated with elevation in cardiac output, increased release of metabolic hormones, cytokines and others, resulting in increasing energy expenditure, muscle wasting and loss of lean body mass, impairing immune function, prolonging wound healing, increasing complications and mortality [4, 5]. It is well reported that hypermetabolic responses in pediatric burns start right after the burn shock, reach their peak on the 7th to 12th day after burns, then gradually decrease depending on the rate of wound healing and may return to normal levels when the healing process ends completely [6, 7].

Adequate nutritional support is essential in burned patients to prevent the detrimental consequences of overfeeding and underfeeding. Currently, resting energy expenditure (REE) is seen as basic and gold standard guiding for nutritional support. Because nutritional provision is essential in burned patients, it should be considered the factors influencing resting energy expenditure on major burn patients. To date, limited reports have been conducted with inconsistent results of REE state in adult burn patients [8]. In this study, we determined features and factors which influence REE in acute phase of major burn in adult patients.

Materials and methods

A prospective study was conducted on 62 severe adult burn patients admitted to inten-

Table 1. Patient characteristics

Criteria	Subgroup	Mean	Min-max
Gender, n (%)	Male	46 (74.2)	
	Female	16 (25.8)	
Age (year)	Mean	35.2 ± 10.9	19-58
	16-39	40 (64.5)	
	40-60	22 (35.5)	
Admission time after burn (h)		7.6 ± 8.4	1-50
Burn extent (%TBSA)	Mean	50.1 ± 17.4	20-95
	20-59	47 (75.8)	
	≥ 60	15 (24.2)	
Full thickness burn area (%)	Mean	19.3 ± 16.3	0-69
	< 20%	38 (61.3)	
	≥ 20%	24 (38.7)	
Inhalation injury, n (%)	Yes	8 (12.9)	
	No	39 (88.6)	
Death, n (%)	Yes	11 (17.7)	
	No	51 (82.3)	

TBSA: total body surface area.

Table 2. REE (Kcal/day) and REE/BMR along the time after burns

Time point	BMR	REE	REE/BMR
3rd day	1488.3 ± 166.2	2431.9 ± 502.2	1.6 ± 0.3
7th day	1481.6 ± 177.5	3071.9 ± 534.5	2.1 ± 0.3
14th day	1412.7 ± 170.4	2880.9 ± 581.3	2 ± 0.4
21st day	1354.6 ± 142.3	2581.8 ± 435.9	1.9 ± 0.3
28th day	1308.8 ± 100.8	2618 ± 513.5	2 ± 0.4

BMR: basal metabolic rate; REE: resting energy expenditure.

sive care unit, National Burn Hospital, Vietnam during a period from June 2016 to August 2018.

Inclusive criteria

Studied patients were selected with following criteria: admitted during 72 hours after burn, age from 16 to 60 year old, burn extent from and over 20% total body surface are (TBSA).

Exclusion criteria

All patients under 16 or over 60 year old and patients with concomitant trauma, comorbidity, pregnancy or admitted later 72 hours after burn or died before 72 hours post burn were excluded from this study.

All patients in this study received the same management regime. Standard treatment included early excision and grafting with auto and allo-skin grafts. Enteral feeding was applied within 24 hours of admission. Basal metabolic rate (BMR) was calculated by using Harris-Benedict equation [9]. REE measurements were obtained on the 3rd, 7th, 14th, 21st and 28th day after burn using Carescape R860 ventilator, GE Health Care, USA. Accordingly, REE measurements were performed before 6 a.m. while the patients were sleeping and receiving continuous enteral feeding. REE/BMR ratio was calculated for each time point of REE measurement. This study was approved by the hospital's Committee for human research ethics.

Statistical analysis

Data were collected, tabulated and analyzed with t test or Chi square to find out the influence of age, gender, burn extent and inhalation injury on REE. Relationship between death and REE was also analyzed. Stata software version 14.0 was used with p value < 05 regarded as the significant level.

Results

Patients demographic and outcomes

Amongst 62 studied patients, males were predominance and 64.5% of patients was less than 40 years old with average burn extent of 50.1 ± 17.4% total body surface area (TBSA) and deep burn area of 19.3 ± 16.3% TBSA. Inhalation injury was diagnosed in 8 (12.9%) patients and overall mortality rate was 17.7% (**Table 1**).

Measured REE along the time

All measured REEs were significantly higher than BMR at all time points (REE/BMR ratio > 1). REE/MBR was 1.6 ± 0.3 on the 3rd day and reached peak value on the 7th day (2.1 ± 0.3) which was 210% of basal metabolic rate. After three weeks, REE steady decreased but still around 200% in compared with BMR (**Table 2**).

Table 3. Relationship of REE (Kcal/day) and age, gender

Time point	Age (year)			Gender		
	16-39	40-60	P	Male	Female	P
3rd day	2507.5 ± 555.2	2294.4 ± 359.8	0.11	2548 ± 475.5	2098.1 ± 432.7	0.002
7th day	3140 ± 570.8	2946.2 ± 446.6	0.17	3226 ± 489.6	2626.4 ± 397.9	0.001
14th day	2892.4 ± 663.5	2860.1 ± 486.8	0.84	2950.8 ± 610.9	2776.1 ± 440	0.11
21st day	2537.4 ± 489.5	2654.7 ± 338.4	0.37	2682.4 ± 443.5	2344.6 ± 317	0.01
28th day	2656.4 ± 624.4	2574.1 ± 366.6	0.67	2696.5 ± 487.6	2434.9 ± 554.5	0.21

Table 4. Relationship of REE (Kcal/day) and inhalation injury

Time point	Inhalation injury	Non-inhalation injury	P
3rd day	2175.8 ± 567.4	2469.8 ± 486.2	0.12
7th day	3003.3 ± 343.1	3082.1 ± 558.9	0.70
14th day	3266 ± 726.9	2837.3 ± 549.5	0.09
21st day	2331.5 ± 366.9	2604.6 ± 432.2	0.23
28th day	2296.5 ± 201.5	2641 ± 523	0.36

Factors influencing measured REE

Among studied patients, younger group (16-39 years old) seemed to have REE higher in compared with older group (40-60 years old) but the difference was not significant ($P > 05$). Regarding to gender, REE of male patients was higher at all time points in compared with that of female patients and the difference reached significantly level on the 3rd, 7th and 21st day after burn (**Table 3**). Data from **Table 4** indicates that REE of patients with and without inhalation injury increased on the 3rd day after burn and reached peak level on the 14th day post burn then steady decreased by time. However, there were insignificant difference of REE between two groups ($p > 05$). REE increased proportionally with burn extent and deep burn area. Significantly greater REE was seen in the patients with burn surface area ≥ 60% TBSA or deep burn area ≥ 20% TBSA in compared with remain groups (**Table 5**). REE of both death and survivor increased and reached peak level on the 7th day after burn then steady decreased by time. In addition, REE of death group was only remarkably higher comparing to survivor group on the 7th and 14th day after burn (**Table 6**).

Discussion

Energy consumption in burn patients is the largest in compared with that of any other injuries or surgeries. The increased energy expenditure in major burn is considered as the result of the hypermetabolic and catabolic state occuring at both acute and chronic phase after burn [10-12]. REE increases immediately after the burn shock period, peaking up to 200% above basic energy expenditure after 2 weeks post-burn and maintaining a high level even after discharge [13]. Works by Hart and coworkers showed that increased REE in pediatric patients with burns greater than 40% TBSA last until the 9th month after injury [14]. Honeycutt et al. showed that, REE increased about 11,470 Kcal/m^2/kg for every 1% of burnt area [15].

The use of indirect calorimetry is considered to be useful method to make certain the safety of nutritional support of burn patients. In addition, regular measurements permit adjustment of nutritional support, and is very useful for early identification of nutritional status [16]. The measured value of REE is lower than that of Curreri formula and higher than the result calculated by the Harris-Benedict equation [17]. It is recommended that regular measurement of REE should be conducted in patient with open burn wound greater than 10% TBSA for properly adjusting nutritional support [18]. However, in clinical practice, REE cannot be measured routinely in burn patients so it is important to find factors that influence REE for setting the appropriate supply.

Gender difference can influenced REE at acute phase of burn injury. Males have higher REE in compared with female with the same burn size and severity [19]. In our study, REE of male patients was higher at all time points as compared to that of female patients and the difference reached significantly level on the 3rd, 7th and 21st day after burn.

Table 5. Relationship of REE (Kcal/day) and burn size, deep burn area

Time point	Burn extent			Deep burn area		
	20-59%	≥ 60%	p	< 20%	≥ 20%	P
3rd day	2416.1 ± 488.5	2481.3 ± 558	0.67	2439.4 ± 453.8	2420 ± 580.9	0.81
7th day	2994.3 ± 504.6	3312.3 ± 571.1	0.04	2984 ± 444	3209.4 ± 638.8	0.11
14th day	2755.7 ± 539.9	3324 ± 517.5	0.01	2726.6 ± 517.2	3140.6 ± 601.8	0.01
21st day	2545.4 ± 382.7	2776.1 ± 639.4	0.17	2519.2 ± 350.3	2713.2 ± 561.2	0.15
28th day	2585.6 ± 403.1	2780 ± 947.2	0.44	2533.6 ± 310.1	2714.5 ± 677.1	0.34

Table 6. Relationship of REE (Kcal/day) and death

Time point	Death	Survivor	P
3rd day	2562.3 ± 688.3	2403.8 ± 456.5	0.34
7th day	3384.9 ± 576.1	3004.4 ± 505.8	0.03
14th day	3354 ± 672	2806.7 ± 536.1	0.01
21st day	3045.3 ± 846.1	2551 ± 387.1	0.06
28th day	4365	2557.79 ± 400.4	0.12

Regarding to the influence of age on REE, in 2009, Kim and colleagues analyzed the factors influencing resting energy expenditure on 199 adult burn patients with burn extent ≥ 20% TBSA indicated that the measured REE and REE/body mass index (BMI) were the highest in group of patients from 18-40 years old, followed by REE in group of patients from 41-60 and over 60 years old [20]. In our study, age did not significantly influence REE.

Most studies indicated REE was burn size dependent. Staonjcic et al. studied in 1288 adult burn patients showed that patients with medium-size (20% to 40% TBSA) burn demonstrated a strong response similar to large burns [21]. In our study significantly greater REE was seen in the patients with burn surface area ≥ 60% TBSA or deep burn area ≥ 20% TBSA. The same situation was reported by Kim and colleagues [20]. The same rent was also reported by Masuda and colleagues [18].

Influence of inhalation injury on metabolic state post burn is still debated. Przkora and coworkers reported that no differences were detected in resting energy expenditure or percent of the predicted basal metabolic rate between pediatric burn patients with and without inhalation injury [22]. In our study, REE of patients with inhalation injury and non-inhalation injury at the same time was not statistically significant difference. Meanwhile in the study by Kim et al. The measured REE and REE/BMI showed significantly higher in inhalation injury group. Beside age, gender, burn severity, other studies indicated that metabolic rate was also significantly increased with procedures such as dressing and surgery [17].

Relationship between REE and survival was also reported [23]. A study by Jeschke and coworkers on 230 severely burned children with burns greater than 30% TBSA, requiring at least 1 surgical procedure showed that nonsurvivors exhibited a vastly increased hypermetabolic response that was associated with increases in organ dysfunction and sepsis when compared with survivors. In compared with survivors, nonsurvivors have different courses in inflammatory, metabolic, and acute phase responses [24]. In our study, REE of death group was greater but only significantly higher comparing to survivor group on the 7th and 14th day after burn.

Conclusion

We have shown that in adult burn patients, increased REE is prolonged and burn size dependent. Moreover, REE is remarkably higher in males and nonsurvivors but is not affected by increased age and the presence of inhalation injury. This finding should be considered in nutritional caring for adult burn patients.

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Disclosure of conflict of interest

None.

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