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Characters of Nutrition Status and Energy-delivery Patterns of the University-based Surgical Intensive Care Units in Thailand (Multi-center THAI-SICU Study)

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ABSTRACT

Aim: The authors aimed to describe nutrition status and energy-delivery characters in multi-center THAI-SICU study. **Material and Methods:** Eligible patients admitted in SICU were 1,686 after excluding 563 of 2,249 participants owing to very short stay or non-alive within 24 hours after admission and missing data. The study was a posthoc analysis and multicenter descriptive design. The analytic methods described categorical data in percentage and the continuous data in the median with interquartile range. Variables divided into baseline characteristics and nutrition data before SICU admission, and the pattern of energy delivery in SICU. Statistical significance accepted as a p-value less than 0.05. **Results:** The average age was 64 (52-76) years with 57% male. The median of serum albumin level at admission (interquartile range, IQR) was 2.8 (2.2-3.4). There was 46 -47 percent of nutrition risk patient. Less than 10 percent of the patient had enteral (EN), parenteral (PN) or their combination before admission. History of weight loss and appetite loss was 27-31 percent. However, seventy percent of the patient could not define the duration of the symptom. EN was initiated early, but the tendency of full feeding was 7-10 days. At that period, supplemental PN was added around 30 percent of total calories. The composition of PN was quite low in these study which contains only 15-16 percent of total calories. The average energy delivery was 20 kcal/kg/day (the recommendation is 25-30 kcal/kg/day). **Conclusion:** The patient's nutrition status before SICU admission was at risk of 46-47% and weight loss and appetite loss might unreliable in ICU setting. EN is started early with gradually increase up to 7-10 days. The average total calories requirement is lower than a recommendation.

Keywords: Multicenter studies, Critically ill, Nutrition status, Energy intake, Enteral nutrition.

1. INTRODUCTION

The surgical critically-ill patients in surgical intensive care units (SICU) had many factors affecting their energy requirement, e.g., level of illness severity, extended of traumatic injuries, and type of surgical procedures. There are many causes of negative energy delivery (or energy deficit) such as inadequate energy intake owing to appetite loss or gut physiology change, as well as an increase in energy demand by stress factors (1, 2). Also, some patient does not allow for oral intake during peri-operative periods due to post-operation of major surgeries or getting the postoperative complications. Moreover, the additional cause was an inaccurate calculation of the energy requirement (3). These lead to negative energy balance; which had an enormous impact on lean body tissue wasting, delayed wound healing and immune dysfunction (4, 5).

Although indirect calorimetry is introduced for estimation of energy expenditure, the instrument is mostly unavailable on ICU in Thailand (6). Therefore, the weight-based estimation is more popularized methods in surgical practice and the current use for the accuracy of energy requirement (3, 7, 8).

2. AIMS

In Thailand, there is an increased concern of nutrition issue in practice. However, there was no description of the scope of nutrition status or energy delivery in ICU, especially in SICU. Therefore, the study objective is to describe nutrition characteristics and patterns of energy delivery in SICU of University based-tertiary hospitals in Thailand.

3. MATERIAL AND METHODS

We retrieved data from THAI-SICU study which prospectively recruited and post-hoc analyzed from three Thai university-based surgical intensive care units (SICU), two settings located in Bangkok and one in Chiang Mai. The study protocol and data collection were described in the previous report (9). We excluded the patient who is having incomplete nutrition data owing to very short stay or non-alive patients within 24 hours after admission, as well as the missing data record. The completely nutrition data and energy delivery obtained 1,686 subjects after exclusion of 563 (25%). (Figure 1).

In summary, the baseline variables were age, gender, current body weight (at admission), usual body weight (before admission), height, diagnosis categories, acute physiologic and chronic health evaluation II score

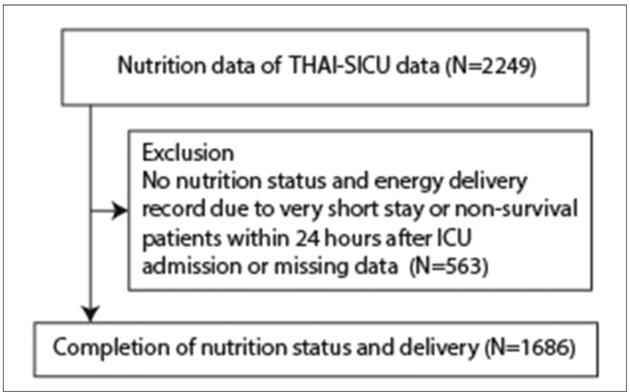

Figure 1 Study flow

Variables	All (%)
Age (years), median (IQR a)	64(52-76)
Male, n (%)	959(56.98)
Current BW (kg.), median(IQR)	58(50-66.7)
Usual BW (kg.), median(IQR)	56.5(48-66)
Height (cm.), median(IQR)	160(154-165)
Diagnosis categories, n (%)	
Cardiovascular	301(17.86)
Respiratory	217(12.88)
Abdominal (GI-HBP)	593(35.19)
Neuro – head – neck	59(3.50)
Sepsis	39(2.31)
Trauma	91(5.40)
Metabolic	37(2.20)
Hematological	1(0.06)
Renal – GU	139(8.25)
Obstetrics – Gynecology	56(3.32)
Musculoskeletal – skin	115(6.82)
Others	38(2.20)
APACHE II score, median(IQR)	12(8-17)
Albumin at admission (g/dL), median(IQR)	2.8(2.2-3.4)

Table 1. Baseline characteristics. a Interquartile range
Abbreviation: APACHE II score, acute physiologic and chronic health evaluation II score

Variables	All (%)
Weight loss	469(27.82)
Not sure	66(3.91)
Appetite loss	518(30.72)
Not sure	103(6.11)
Timing of weight loss	
≤1 week	36(2.14)
2-3 weeks	59(3.50)
1-2 months	175(10.38)
3-5 months	142(8.42)
≥ six months	86(5.10)
Uncertain time	1188(70.46)
Energy delivery before ICU admission	
Route of delivery	
Oral	1540(91.34)
Tube feed	58(3.44)
Intravenous (IV)	17(1.01)
Combine	54(3.20)
No	17(1.01)
Time of delivery	
<7 days	60(3.56)
7-14 days	62(3.68)
> 14 days	1227(72.78)
Uncertain time	337(19.99)
Estimate average energy intake before admission, n (%)	
No any energy intake	23(1.36)
Receive energy (any route),	1319(78.23)
Not sure of estimate energy intake	344 (20.40)
Subjective estimated of energy intake in percent	90(70-100)
Nutrition status assessment	
Subjective global assessment (SGA)	
A	927(54.98)
B	513(30.43)
C	246(14.59)
Nutrition risk screening (NRS2002)	
No risk (score 0 – 2)	903 (53.56)
At risk (score 3 – 7)	783 (46.44)

Table 2. Nutrition assessment variables

(APACHE II score), and albumin at admission. (Table 1). We assessed the nutrition status with a history of weight loss, the timing of weight loss, and Subjective global assessment (SGA)/Nutrition risk screening 2002 (NRS2002). Also, the energy delivery was recorded before SICU admission; such as route, duration of delivery, and the proportion of received energy to estimated energy (Table 2). The pattern of energy delivery demonstrated by calculation of energy per day and averaged by week interval, both enteral nutrition (EN) and parental nutrition (PN). The energy from PN further categorized into carbohydrate, protein, and fat. Then, all categories and subcategories compared the first week to the other week. However, the energy from propofol did not be added to the fat source (Table 3 and 4). Total energy and energy from EN and PN per day were plotted together, and the energy deficit was demonstrated compared to fixed target weight based estimation per day as the daily energy requirement as 20 kcal/kg, 25 kcal/kg, and 30 kcal/kg

	1st week	2nd week	3rd week	4th week	P value
Enteral, kcal					
Median (IQR a)	0(0 – 180)	540(0-1200)	710 (0-1440)	720 (0-1440)	<0.001
Mean (SD)	228(470)	681(692)	786 (749)	823 (791)	
Parenteral (PN), kcal					
Median (IQR)	125(0-272)	163 (0 – 612)	132(0 – 543)	95(0 – 469)	<0.001
Mean (SD b)	231(360)	368 (475)	352 (496)	351(530)	
PN carbohydrate, kcal					
Median (IQR)	119 (0 – 255)	133(0 – 364)	96 (0 – 319)	34(0 – 305)	<0.001
Mean (SD)	176(237)	234(279)	212 (295)	201 (290)	
PN protein, kcal					
Median (IQR)	0(0 – 0)	0(0 – 112)	0(0 – 100)	0(0 – 100)	<0.001
Mean (SD)	23(68)	56 (94)	55(97)	60(112)	
PN fat, kcal					
Median (IQR)	0(0 – 0)	0(0 – 0)	0(0 – 0)	0(0 – 0)	<0.001
Mean (SD)	32(116)	78(170)	84(183)	90(194)	
All calories, kcal					
Median (IQR)	238(31 – 700)	1034(593 – 1481)	1126(642 – 1570)	1200(651 – 1161)	<0.001
Mean (SD)	459(552)	1048(625)	1137(680)	1174(708)	

Table 3. Pattern of energy delivery per day of enteral and parenteral nutrition. a Interquartile range b Standard deviation

(Figure 2 and 3). We used STATA software version 12.0 (STATA Inc., College Station, TX) in this statistical analysis. Results of the descriptive analysis showed as a percentage of the categorical data and median with interquartile range (IQR) for continuous data. We tested the hypothesis by Chi-square for categorical data and t-test for continuous parametric data and Mann-Whitney U test for continuous nonparametric data. We determined the statistical significance at the 0.05 level.

4. RESULTS

After exclusion, the nutrition data recruited 1,686 participants from the THAI-SICU study. Age of the study population was 64 (52-76) years, and the male was 959 (57%). The median (IQR) body weight (BW, kilograms) were 58 (50-67) in current BW and 56.5 (48-66) in usual BW. The frequency of each diagnosis were abdominal causes (gastrointestinal and hepatobiliary) (593/1686 = 35%), cardiovascular causes (301/1686 = 18%) and respiratory causes (217/1686 = 13%), respectively. Additionally, the median (IQR) of APACHE II and albumin at admission were 12 (8-17) and 2.8 (2.2-3.4), respectively (Table 1). This study assessed their nutrition status before ICU admission by the extent of weight loss, appetite loss, average energy intake and route of energy delivery, and SGA and NRS 2002. The study had shown that they lost weight and appetite of 469/1686 (27.8%) and 518/1686 (30.7%), respectively. Which weight loss occurred during 1-2, 3-5 and 6 months, but uncertain time found (1188/1686 = 70.5%). The energy delivered through oral (1540/1686 = 91%), tube feed (58/1686 = 3%), and combine (54/1686 = 3%), while the intravenous route was the least. Duration of delivery mainly took more than two weeks (1227/1686 = 73%). Most participants received energy (1319/1686 = 78%), and the median (IQR) of the proportion of intake amount to usual total intake was 90% (70-100%). However, one-fifth could not remember duration and amount of intake change. More than half of study population were in good nutrition status or no risk (SGA-A = 927/1686 (55%), NRS2002-no risk= 903/1686 (54%)), respectively (Table 2).

The energy delivery in SICU had an upward trend and steeply increased at the second week (added 397, 406 and 450 kcal/day, $p < 0.001$ for 2nd-4th weeks respectively). The enteral route almost responded to this trend

	Week	intake	(95% CI a)	P value
Enteral	1st		Reference	
	2nd	324	(295 to 352)	<0.001
	3rd	365	(327 to 402)	<0.001
	4th	440	(391 to 490)	<0.001
Parenteral	1st		Reference	
	2nd	73	(52 to 93)	<0.001
	3rd	41	(13 to 68)	0.003
	4th	8	(-27 to 44)	0.656
PN Carbohydrate	1st		Reference	
	2nd	25	(12 to 38)	<0.001
	3rd	0.7	(-16 to 18)	0.938
	4th	-20	(-43 to 2)	0.079
PN Protein	1st		Reference	
	2nd	19	(15 to 23)	<0.001
	3rd	10	(4 to 15)	<0.001
	4th	9	(2 to 16)	0.009
PN Fat	1st		Reference	
	2nd	31	(23 to 38)	<0.001
	3rd	33	(23 to 43)	<0.001
	4th	23	(10 to 36)	<0.001
All calories (IQR)	1st		Reference	
	2nd	397	(366 to 428)	<0.001
	3rd	406	(365 to 448)	<0.001
	4th	450	(396 to 504)	<0.001

Table 4. Energy-delivery change by week interval. [a]95% Confidence interval

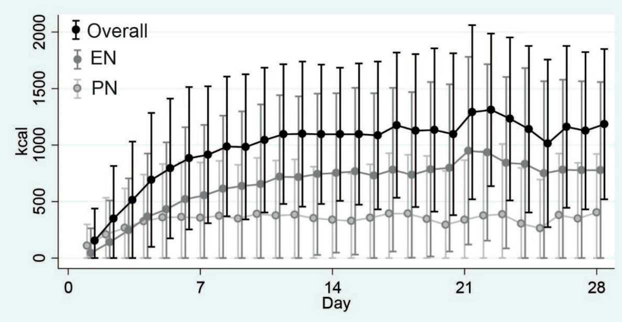

Figure 2. Daily overall energy and EN & PN intake. EN = enteral nutrition; PN = parenteral nutrition; oval points = mean; the vertical lines = standard deviation

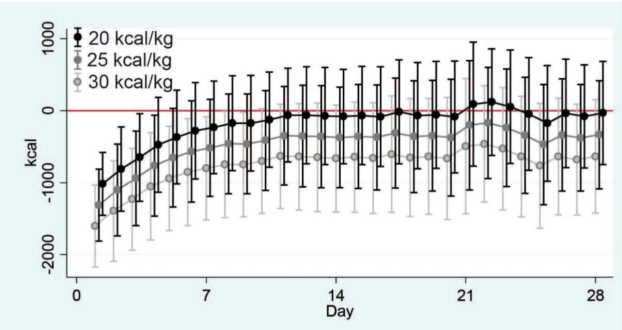

Figure 3. Energy deficit defined by different weight based estimation of 20, 25 and 30 kcal/kg Horizontal zero line = energy target per day; oval points = mean; the vertical lines = standard deviation

(added 324, 365 and 440 kcal/day, p < 0.001 for 2nd-4th weeks respectively). While parenteral route had more role for few days than the enteral route before it gradually decelerated provided calories (added 73, 41 and 8 kcal/day in 2nd-4th weeks, p < 0.001 at second week). For parenteral nutrition, the carbohydrate was the main energy source for four weeks (significant change at first week, p < 0.001) and the protein-fat supplied top-up energy (significant change at 2nd-4th weeks, p < 0.001 and 0.009) (Table 3 and 4). Both enteral and parenteral nutrition (EN and PN) started when they admitted to SICU. The energy supply from EN accelerated increased in the first week and provided more energy than PN on the third day. EN grew at a lower rate in the second week and steady afterward. The total energy supply after a 2nd week had a range of 1,100-1,300 kcal/day (Table 3, Figure 2). The energy supply entered the constant level on the 10th day. Moreover, the status of the energy balance depended on which formula used for calculation; this study showed that 20 kcal/kg had an optimal energy balance (Figure 3).

5. DISCUSSION

The pre-SICU admission patient profiles in these settings were quite old with a nearly one-third history of appetite and weight loss. However, more than 70 percent could not identify the duration of weight loss. Regarding the patient declaring history, although the main route of intake of pre-admission was only oral (91%), and there was less than 10 percent to receive EN, PN or its combination. These routes were also self-report of more than 14 days of nutrition support duration. The admission nutrition risk also high as 45-46 percent in admission. These data might infer to the lacking of nutrition concern and nutrition preparation in high-risk surgical patients in these setting. Additionally, a barrier to food intake, loss of appetite, was quite low in comparing with other multi-center studies. Our patients reported only 30.7 percent of appetite loss compared with 63.9 percent on the report of the Canadian Malnutrition Task force as well as 48-59 percent in a prospective cohort study of hospitalized medical and surgical patients who admitted for seven days or more (10, 11). These results might be explained by the different eating habit in each country as well as the difference between the enrolled patients. Consequently, the weight loss history and appetite loss might be an unreliable history in the ICU patients. Furthermore, principal diagnoses in our study had the top ranking like; abdominal (gastrointestinal and hepato-biliary) (35.2%), cardiovascular (18%), respiratory (13%). The Canadian cohort study reported of the different proportion like 26%, 16%, and 21.7% respectively (12). As a result of nutrition status at admission, the proportion of SGA-B and C which was defined as nutrition risk before SICU admission showed slightly lower by comparison with the Canadian report (45% versus 51%) (11).

The acute body weight change during ICU admission and perioperative period associated the volume overload and related with poorer outcomes (13). In our setting, the body weight at admission in SICU was increased around 1.5 kilograms from their usual weight. In the opposite direction, the median serum albumin at admission is quite low (2.8 g/dL). This phenomenon of hypoalbuminemia and acute weight gain on admission might be associated with acute fluid retention in these patients (Table 1 and 2). APACHE II score disclosed the low risk of death during acute illness (median (IQR)=12 (8-17)) (14). A recent review of randomized trials by Kondrup mention that APACHE II was less useful to predict the benefit of nutrition support, unlike nutrition-risk scoring system (15). During SICU admission; early enteral feeding has been promoted (8, 16). The EN was started early at a similar amount of energy from PN at the first five days after admission which the energy from EN mostly was less than 500 kcal/day (Table 3 and Figure 2). However, the EN provision rapidly increased after day 5 with a constant level around the second week. From Figure 2, the trend of supplemental PN was given around 30 percent of the total received energy on day five after admission. The timing of supplemental PN in Thai was slightly later when compared with the previous randomized control study of supplemental PN by Heidegger et al. (17). In this study, the supplemental PN group was added at day four if the EN could not progressive increase to 60 percent of total calories. The results of this study showed that the supplemental PN group had lower nosocomial infections and suggested that this strategy might improve clinical outcome in patients in ICU for whom EN is insufficient (17). As the PN composition between the second to the fourth week, the proportion of carbohydrate: protein: fat was 55-64: 15-16: 21-24 percent of total PN energy. These results showed the proportion of protein delivery in Thai SICU is lower than the recommendation that should give the protein 1.5 -2 g/kg/day and account for 24-32 percent of the total received energy (8). Although the surgical ICU patients significantly received lipid-based sedation (or propofol) compared to the medical ward (18), it was the relatively small amount, and we did not include in the total energy calculation. On the total calories intake (Figure 3), the average of caloric intake in this study was 20 kcal/kg/day when the energy balance was nearly zero. Although the caloric goal was debatable (19), the weight base recommendation is 25 and 30 kcal/kg/day (8, 20). The average calories in our results were about 60-80 percent of recommendation. Besides, the TICACOS study revealed that the tendency of mortality outcome was lower by strictly control calories (21). The recent retrospective report by Zusman et al. including 1,171 patients who underwent indirect calorimetry for resting energy expenditure (22). They found that the administered calories to the resting energy expenditure ratio of 70 percent had a survival advantage in critically ill patients. Although we did not measure the energy expenditure in our study, the average administered energy might be adequate based on Zusman et al. results. The strength of the study was a largest prospective data collection setting in Thai-SICU. They might have some different protocol for nutrition management in each center. However, the trend of energy delivery and nutrition status at admission give us the guidance for quality improvement in the nutrition care.

6. CONCLUSION

SICU patients had nutrition at risk of 45-46 percent at admission (SGA-B and C or NRS2002). The patients had enteral or parenteral route before admission ten percent or less. After SICU admission, energy delivery early started with EN and progressive increase up to 7-10 days. The total amount of supplemental PN is around 30 percent and slightly lower proportion of protein. The average total received calories is 20 kcal/kg/day which accounted for 60-80 percent of weight base recommendation.

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- **Conflict of interest: none declared.**

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