Am J Transl Res 2021;13(6):6987-6993
www.ajtr.org /ISSN:1943-8141/AJTR0130003

Original Article

The applied research on the intra-abdominal pressure monitoring in early enteral nutrition in patients with severe pneumonia

Liqiang Du[1], Yuanyuan Zhao[2], Changheng Yin[1], Shuhong Liu[3], Zhaobo Cui[2], Min Zhang[4]

[1]Department of Gastrointestinal Surgery, The People's Hospital of Hengshui, Hengshui, Hebei, China; [2]Department of Intensive Care Unit, The People's Hospital of Hengshui, Hengshui, Hebei, China; [3]Department II of Geriatrics, The People's Hospital of Hengshui, Hengshui, Hebei, China; [4]Department of Orthopaedics, The Second People's Hospital of Hengshui, Hengshui, Hebei, China

Received January 12, 2021; Accepted February 20, 2021; Epub June 15, 2021; Published June 30, 2021

Abstract: Objective: To explore the applied value of intra-abdominal pressure (IAP) monitoring in early enteral nutrition (EEN) in patients with severe pneumonia. Methods: 96 patients with severe pneumonia who underwent EEN treatment in our hospital from June 2017 to June 2019 were selected. According to the random number table method, they were divided into a control group (48 patients) and an observation group (48 patients). The control group was treated using the conventional EN method, and the observation group was treated using the intra-abdominal pressure monitoring besides the conventional EN method. The incidence of EN intolerance, the acute physiology and chronic health evaluation (APECHEII) scores, the positive end expiratory pressure (PEEP) value, mechanical ventilation time, EN implementation days, length of stay in ICU, the incidence of ventilator-associated pneumonia, mortality, and the incidence of multiple organ dysfunction syndrome were compared between the two groups. Results: Compared with the control group, the incidence of EEN intolerance in the observation group was significantly reduced. The results of univariate analysis showed that, in the EN intolerance group, the IAP, the PEEP value and APACHEII scores after 3 days of EEN implementation were higher than the EEN tolerance group, indicating a influencing factor of EEN intolerance ($P<0.05$). The results of multivariate analysis showed that IAP value was a risk factor for EEN intolerance ($P<0.05$). The ROC curve analysis result for IAP to predict EEN tolerance showed that the area under the curve for IAP value to predict EN tolerance was 0.856, the optimal cut-off value was 10.73 mmHg, the sensitivity was 95.10%, and the specificity was 89.60%. Conclusion: The intra-abdominal pressure monitoring during the EEN in patients with severe pneumonia is a preferred method to guide the patients' EEN.

Keywords: Intra-abdominal pressure, severe pneumonia, EEN

Introduction

Severe pneumonia, a respiratory disease, is characterized by severe pulmonary infection, which is more common in the elderly, with high morbidity and mortality [1]. Its pathogenesis is a little more complicated, and it is often caused by microbial infections, malnutrition, other underlying diseases, etc. [2]. Studies have confirmed that the function of the intestinal mucosal barrier in patients with severe pneumonia is impaired, so the toxins and intestinal bacteria in the body are prone to translocation, and a large number of pro-inflammatory factors are released, resulting in the systemic inflammatory response and multiple organ dysfunctions sign (MODS), which poses a serious threat to the life and health of patients [3].

Early enteral nutrition (EEN) supportive treatment can protect a patient's intestinal mucosal barrier and improve the nutritional status of the body. EN treatment in time can reduce the occurrence of complications and reduce mortality. Studies have shown that during the EEN treatment via nasogastric tube, patients often have various intolerance reactions, mainly manifested by gastrointestinal reactions such as abdominal distension, diarrhea, etc. [4]. In order to reduce the intolerance rate of EEN in

Table 1. Comparison of general materials

Group	Gender/n (%)		Ages/($\bar{x}$ ± sd, years)	BMI indexes ($\bar{x}$ ± sd, $Kg{\cdot}m^{-2}$)	APACHEII scores within 24 hours of admission ($\bar{x}$ ± sd, Scores)	PEEP value before EN ($\bar{x}$ ± sd, cmH_2O)
	Male	Female				
Control Group (n = 48)	27 (56.25)	21 (43.75)	70.46±7.08	23.43±2.18	24.72±7.54	10.76±2.09
Observation Group (n = 48)	25 (52.08)	23 (47.92)	70.39±7.12	23.47±2.05	25.01±7.73	10.82±2.13
t/x^2	0.168		0.048	0.093	0.186	0.139
P	0.682		0.962	0.926	0.853	0.890

ICU patients, the gastric residual volume monitoring method is often used in clinic to confirm patients' EEN tolerance. However, it has been proved by many practices that, with the method of the gastric residual volume monitoring, more patients still show symptoms such as abdominal distension, diarrhea, vomiting, etc. The time of EEN treatment cannot be determined, and patients' intolerance cannot be improved [5].

Intra-abdominal pressure (IAP) refers to the internal pressure that exists in the abdominal cavity. In recent years, people have paid more and more attention to the monitoring and research of IAP, and the changes of IAP are closely related to the EEN tolerance [6]. At present, there is no research on the application of intra-abdominal pressure monitoring to EEN in patients with severe pneumonia. Therefore, this study aimed to monitor the intra-abdominal pressure of patients with severe pneumonia to guide patients with EEN, hoping to show certain significance in the improvement of EEN tolerance.

Materials and methods

General materials

96 patients with severe pneumonia who underwent EEN treatment in our hospital from June 2017 to June 2019 were selected. According to the random number table method, they were divided into a control group (48 patients) and an observation group (48 patients). Inclusion criteria: ① Patients who met the diagnosis criteria of "severe pneumonia" in the "Guidelines for the Diagnosis and Treatment of Chinese Adult Hospital-acquired Pneumonia and Ventilator-associated Pneumonia (2018 version)" [7]; ② Patients whose nutrition risk screening scores were ≥3 points and needed enteral nutrition support [8]; ③ Patients whose anatomy of the gastrointestinal tract was complete; ④ Patients who needed the mechanical ventilation; ⑤ Patients whose families and themselves gave informed consent. Exclusion criteria: ① Patients with the gastrointestinal tract, cardiovascular, cerebrovascular, liver, kidney and other serious organ diseases; ② Patients with metabolic and wasting diseases such as cancer; ③ Patients who were in the acute phase or the perioperative period after trauma; ④ Patients with history of digestive tract surgery and the digestive tract dysfunction; ⑤ Patients with severe infections in other parts; ⑥ Patients with contraindications to enteral nutrition. This study was approved by the medical ethics committee of our hospital. There was no statistically significant difference in the general information between the two groups (P>0.05), and they were comparable. See **Table 1**.

Research methods

Control group: The specific measures of routine EN support were as follows: ① Placed a gastric tube: The depth of the gastric tube was placed in the range of 45-55 cm. After the position of the gastric tube was confirmed, the gastric tube was properly fixed with the pressure tape. ② EN support: The nutrient solution was pumped in through the silicone rubber nasogastric tube at a constant speed, and the target calorie intakes of patients were calculated to be 25 kcal/(kg·d) [9]. The initial pumping speed of the nutrient solution was 20 mL/h. If patients didn't show any discomfort after 3 to 5 hours of EN pumping, the pumping speed could be adjusted to 40-60 mL/h. Nutrient solution and tube were replaced every 24 hours. ③ Position: If patients had no special contraindications, in order to prevent the reflux and aspiration of the nutrient solution, the head of the bed could be raised appropriately. ④ Nurses transferred the scale of the stomach tube each shift and accurately recorded the data.

Observation group: IAP monitoring was performed while regular EN support was implemented. (1) IAP monitoring: ① Monitoring time: Before EN, that is, after admitted to the department, patients were immediately conducted intra-abdominal pressure monitoring which was measured three times, and the average value was taken; the dynamic monitoring of intra-abdominal pressure was conducted within 3 days of EN implementation [10]; ② Monitoring method: With the method of indirect cystometry, IAP measurement was performed after the pressure sensor was connected to the monitor. The enteral nutrient solution was pumped in at an initial speed of 20 mL/h and monitored once every 6 hours. The specific measurement method: A three-way switch was connected between the drainage bag and the catheter, and the 3 ports were respectively connected with the catheter, the urine bag and the pressure sensor.

A patient was in the supine position and his/her urinary bladder was emptied. Then 20 mL of sterile saline was injected into the catheter by rotating the three-way switch. The patient's mid-axillary line was used as the zero point, and his bladder pressure was measured by the end of expiration. (2) Adjusted the EN speed as the IAP value. ① According to the recommendations in the *Guidelines for the Diagnosis and Treatment of Abdominal Hypertension and Abdominal Compartment Syndrome (2013 version)* and *Clinical Practices for Parenteral and Enteral Nutrition of the Chinese Society of Parenteral and Enteral Nutrition*, the intra-abdominal pressure was divided into four levels, and the EN dripping speed was adjusted as the change of IAP value. Specifically, the EN dripping speed was adjusted according to the following grades of IAP: Level I when the IAP value was 12-15 mmHg (1 mmHg = 0.133 kPa); Level II when the IAP value was 16-20 mmHg; Level III when the IAP value was 21-25 mmHg; Level IV when the IAP value >25 mmHg. ② The pumping speed of the nutrient solution was adjusted according to the IAP levels. For the IAP level I, the pumping method of EN was the same as that of the control group until the target feeding amount of the patient was reached. For the IAP level II, the pumping speed was adjusted to 40-60 mL/h. For the IAP level III or IV, the EN support for the patient was suspend. The reason for the increase in IAP must be found out while the corresponding treatment was given. EN treatment would not be resumed until the IAP value returned to level I or II.

Outcome measures

① Intestinal tolerance: After 3 days of EN, intestinal tolerance was defined based on the gastrointestinal symptoms that patients showed during the EN stage, including abdominal distension, diarrhea, and vomiting. If patients showed any one or two or more of the symptoms, it indicated the intestinal intolerance. If no one appeared, it indicated the intestinal tolerance [11]. ② Positive end expiratory pressure value (PEEP): After the mechanical ventilation had been stable for 2 hours, recorded the average value respectively before EN and after 3 days of EN. ③ Acute physiology and chronic health evaluation score (APACHEII): APACHEII score consisted of three parts, namely acute physiology score (APS), age score (AS), and chronic health evaluation score (CHES). The total score of its theory was 71 points. The higher the total score was, the higher the degree of criticality was [12]; recorded the lowest value respectively within 24 hours of admission and after 3 days of EN. ④ Time of mechanical ventilation. ⑤ EN implementation days. ⑥ Length of stay in ICU.

Statistical analysis

SPSS22.0 was used for the statistical analysis of the data in this study. Measurement data were expressed by $\bar{x} \pm sd$ and comparison was conducted using the t test. Enumeration data were expressed by n (%) and compared using chi-square test. $P<0.05$ was considered statistically significant.

Results

Comparison of intolerance

Compared with the control group, the incidence of abdominal distension, diarrhea, vomiting and two or more symptoms in the observation group were smaller ($P<0.05$). See **Table 2**.

Comparison of hospitalization

Compared with the control group, patients in the observation group spent less mechanical ventilation time, hospitalization time in ICU

Table 2. Comparison of intolerance rates [n (%)]

Group	Abdominal distension	Diarrhea	Vomiting	Two or more symptoms	Intolerance rate
Control Group (n = 48)	14 (29.17)	16 (33.33)	18 (37.50)	13 (27.08)	26 (54.17)
Observation Group (n = 48)	6 (12.50)	7 (14.58)	4 (8.33)	5 (10.42)	13 (27.08)
x^2	4.042	4.631	11.558	4.376	7.298
P	0.044	0.031	0.001	0.036	0.007

Table 3. Comparison of hospitalization ($\bar{x} \pm sd$, d)

Group	Mechanical ventilation time	Hospitalization time in ICU	EN implementation time
Control Group (n = 48)	10.79±2.51	12.18±2.39	10.94±2.57
Observation Group (n = 48)	6.32±1.48	7.96±1.53	6.83±1.85
t	4.042	4.631	11.558
P	0.044	0.031	0.001

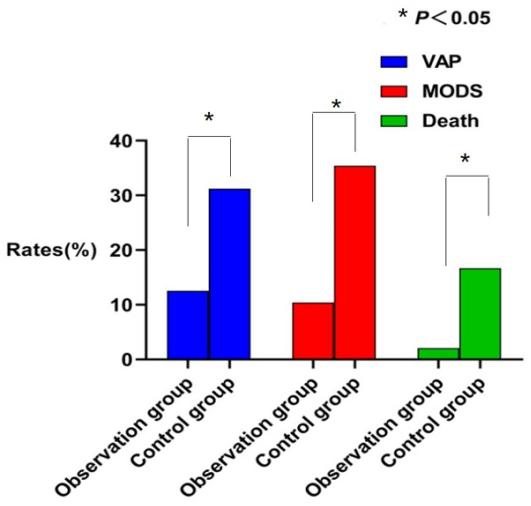

Figure 1. Comparison of prognosis between the two groups pf patients.

and EN implementation time (P<0.05). See **Table 3**.

Comparison of prognosis

The ventilator-associated pneumonia (VAP), MODS and the incidence of death in hospital were compared between the two groups. The result showed that the incidences of VAP, MODS and death in hospital in the observation group were respectively 12.50%, 10.42%, and 2.08%. The incidence of VAP, MODS and death in hospital in the control group were respectively 31.25%, 35.42%, 16.67%. The incidences in the observation group were significantly lower than those of the control group (P<0.05). See **Figure 1**.

Univariate analysis of EEN intolerance

According to the EN tolerance, patients were divided into EN tolerance group (57 people) and EN intolerance group (39 people). Through comparing the gender, age, body mass index (BMI) and APACHEII score after 3 days of EN, IAP value within 3 days of EN, and PEEP value within 3 days of EN, the result showed that the IAP value within 3 days of EN, the PEEP value after 3 days of EN and the APACHEII value after 3 days of EN in the EN intolerance group were all higher than those in the EN tolerance group, which were the influencing factors of EEN intolerance (P<0.05). See **Table 4**.

Multivariate analysis of EEN intolerance

The IAP within 3 days of EN, PEEP value after 3 days of EN, and APACHEII score after 3 days of EN were independent variables, and the EN tolerance was dependent variable (assignment: tolerance = 0, intolerance = 1). The Logistic multivariate analysis showed that the IAP value was a risk factor for EEN intolerance (P<0.05). See **Table 5**.

The ROC curve analysis for IAP to predict EEN tolerance

The ROC curve analysis results for IAP to predict EEN tolerance showed that the area under the curve for IAP value to predict EN tolerance was 0.856, the optimal cut-off value was 10.73 mmHg, the sensitivity was 95.10%, and the specificity was 89.60%. The 95% CI was 0.732-0.917. See **Figure 2**.

Table 4. Univariate analysis of EEN intolerance

Variable	EN tolerance group (n = 57)	EN intolerance group (n = 39)	t/x^2	*P*
Gender	25/32	19/20	0.220	0.639
Age ($\bar{x}$ ± sd, years)	70.46±7.27	70.39±7.12	0.047	0.963
BMI ($\bar{x}$ ± sd, $Kg{\cdot}m^{-2}$)	23.43±2.18	23.47±2.36	0.085	0.932
APACHEII score ($\bar{x}$ ± sd, score)	17.05±4.15	19.96±5.84	2.856	0.005
IAP ($\bar{x}$ ± sd, mmHg)	9.04±2.73	10.82±2.96	3.032	0.003
PEEP value ($\bar{x}$ ± sd, cmH_2O)	6.13±1.21	11.05±2.13	14.390	<0.001

Table 5. Multivariate analysis of EEN intolerance

Variables	B	Wald x^2	*P*	OR (95% CI)
APACHEII	-0.062	0.083	0.159	0.940 (0.596, 4.811)
IAP	2.136	0.724	<0.001	8.466 (2.734, 13.152)
PEEP	-0.146	0.215	0.572	0.864 (0.425, 4.736)

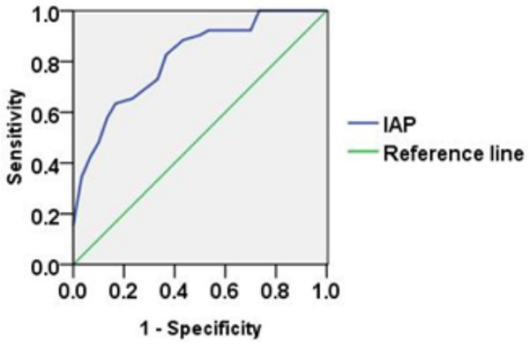

Figure 2. ROC curve for IAP to predict EEN tolerance.

Discussion

Patients with severe pneumonia often suffer from malnutrition during the treatment, so the EN implementation time, mechanical ventilation time, and hospitalization time in ICU are prolonged. Meanwhile, the incidence of infectious complications and the mortality were increased [13]. EN support had been widely accepted in clinical practice, with many advantages in the maintenance of intestinal function and nutritional therapy. However, the effect of EEN in patients with severe pneumonia was still not ideal. The reason may be that patients with severe pneumonia were prone to having acute gastrointestinal dysfunction, which resulted in poor EN tolerance. Therefore, the decrease in the occurrence of EN intolerance had become an urgent problem to be solved [14]. In recent years, studies have shown that it could achieve better results when the intra-abdominal pressure monitoring was applied to the clinical treatment of enteral nutrition [15]. But there were no studies on the application of intra-abdominal pressure monitoring to EEN in patients with severe pneumonia and its effects still needed to be further explored.

In this study, the incidence of EN intolerance in the observation group was lower than that in the control group. It showed that the effective dynamic monitoring of intra-abdominal pressure, in the early stage of enteral nutrition therapy for patients with severe pneumonia, could help detect the increase in abdominal pressure as soon as possible. After the relevant causes of the increase in intra-abdominal pressure was found, measures could be taken in time as to prevent the continuous increase in intra-abdominal pressure, decrease or avoid the occurrence of EN intolerance in patients and improve the tolerance rate of EEN, achieve the value of EEN, and allow patients to better receive further treatment. In this study, compared with the control group, patients in the observation group had shorter EN implementation time, mechanical ventilation time, and hospitalization time in ICU. The result was consistent with previous studies, which further illustrated that the effective dynamic monitoring of intra-abdominal pressure in the early stage of enteral nutrition therapy for patients with severe pneumonia could shorten the treatment time, reduce the medical care cost, and reduce their economic burden to a certain extent. Compared with the control group, the incidences of VAP, MODS, and mortality were lower, suggesting that the early EN treatment under the IAP dynamic monitoring effectively improved the nutritional status while the occurrence of vomiting was reduced [16]. Thereby the aspiration risk was reduced, the mechanical ventilation time was shortened, the incidences of VAP, MODS and mortality were reduced, and the prognosis was improved. Patients in ICU were more likely to have abdominal hypertension. Once abdominal hypertension appeared, it would further lead

to the occurrence of MODS. The treatment of MODS was more difficult, with the poor prognosis [17]. Therefore, it was very important to detect the increase in IAP as soon as possible and to deal with the prevention and treatment of MODS in time. The univariate analysis result showed that the IAP within 3 days of EN, the PEEP value and the APACHEII score after 3 days of EN in the EN intolerance group were all higher than those in the EN tolerance group. And the difference was statistically significant, which was the influencing factors of EEN intolerance. The multivariate analysis result showed that the IAP value within 3 days of EN implementation was a risk factor for EEN intolerance. Studies had discovered that the EEN intolerance of patients mechanically ventilated in ICU was related to the PEEP level of mechanical ventilation [18]. Mechanical ventilation was an extremely important treatment for patients with severe pneumonia. After patients received mechanical ventilation, patients' lung volume increased accordingly as the PEEP level of mechanical ventilation increased. The pressure was gradually transferred to the abdomen, which caused the diaphragm to move down. The expansion of the abdominal cavity was still restricted, which resulted in an increase in IAP [19]. In addition, in the entire course that patients with severe pneumonia were treated, a large amount of inflammatory mediators were released, and the permeability of capillaries was increased, which led to the edema of the relevant organs and then cause an increase in IAP [20]. At the same time, the more severe the patients' conditions, the more common the symptoms such as hypoxia and ischemia, and the intestinal function were prone to more severe impairment. Therefore, the higher the APACHEII score was, the greater the intra-abdominal pressure was. The intestinal tract was very sensitive, under the influence of the intra-abdominal pressure in the human body. The IAP value could reflect the gastrointestinal function in time. The normal IAP of critically ill patients usually fluctuates from 5 to 7 mmHg (1 mmHg = 0.133 kPa). When IAP pathologically increased continuously or repeatedly >12 mmHg, intra-abdominal hypertension (IAH) will occur. When IAP develops to >20 mmHg, coupled with new organ dysfunction or failure, abdominal compartment syndrome (ACS) may occur. Therefore, IAP monitoring plays a positive role in guiding the rational development of EEN in critically ill patients. IAP monitoring combined with corresponding treatment and nursing measures can improve the monitoring level and improve patient prognosis [21]. When the IAP was higher, EN intolerance was more likely to appear, so IAP could affect the EN implementation for patients with severe pneumonia. The monitoring method was relatively simple to operate, and the effective IAP monitoring for patients with severe pneumonia played an extremely important role in the treatment of patients. Studies had found that the tolerance of enteral nutrition therapy in ICU patients was related to IAP [21]. The ROC curve analysis results for IAP to predict EEN tolerance in this study showed that the AUC was 0.856, the best critical value of IAP for predicting tolerance in enteral nutrition therapy was 10.73 mmHg, and the sensitivity and specificity were respectively 95.10% and 89.60%, verifying the previous research findings. It also showed that the IAP value was able to better predict the tolerance of enteral nutrition, which was of great significance for patients with severe pneumonia to better receive the EEN therapy. The sample size included in this study is small, and long-term follow-up has not been performed. In the future, trials with larger sample size and long-term follow-up are needed to yield more accurate data.

In summary, the IAP monitoring for patients with severe pneumonia can guide the treatment of EEN, reduce the incidence of intolerance and improve the prognosis. And the results of IAP monitoring predicted the occurrence of EN intolerance, which was worthy of clinical application.

Disclosure of conflict of interest

None.

Address correspondence to: Yuanyuan Zhao, Department of Intensive Care Unit, The People's Hospital of Hengshui, 180 East Renmin Road, Hengshui 053000, Hebei, China. Tel: +86-158328-28256; E-mail: yuanyuanzhao07@126.com

References

[1] Li PF, Wang YL, Fang YL, Nan L, Zhou J and Zhang D. Effect of early enteral nutrition on outcomes of trauma patients requiring intensive care. Chin J Traumatol 2020; 23: 163-7.

[2] Lin A, Ye J, Wang Z and Li P. Analysis of postoperative efficacy and pharyngeal fistula healing in patients with laryngeal cancer treated with post-operative enteral nutrition support nursing combined with early oral feeding. Oncol Lett 2020; 19: 3964-70.

[3] Srinivasan V, Hasbani NR, Mehta NM, Irving SY, Kandil SB, Allen HC, Typpo KV, Cvijanovich NZ, Faustino EVS, Wypij D, Agus MSD and Nadkarni VM; Heart and Lung Failure-Pediatric Insulin Titration (HALF-PINT) Study Investigators. Early enteral nutrition is associated with improved clinical outcomes in critically Ill children: a secondary analysis of nutrition support in the heart and lung failure-pediatric insulin titration trial. Pediatr Crit Care Med 2020; 21: 213-21.

[4] Chang YR, Yun JH, Choi SH and Jee YS. Effect of early enteral nutrition on the incidence of acute acalculous cholecystitis among trauma patients. Asia Pac J Clin Nutr 2020; 29: 35-40.

[5] Liu H, Zhu J, Ni HB and Hu XX. Transcutaneous electrical acupoint stimulation for early enteral nutrition tolerance in patients with sepsis of gastrointestinal dysfunction: a multi-center randomized controlled trial. Zhongguo Zhen Jiu 2020; 40: 229-33.

[6] Goenka MK, Goenka U, Afzalpurkar S, Tiwari SC, Agarwal R and Tiwary IK. Role of static and dynamic intra-abdominal pressure monitoring in acute pancreatitis: a prospective study on its impact. Pancreas 2020; 49: 663-7.

[7] Shi Y, Huang Y, Zhang TT, Cao B, Wang H, Zhuo C, Ye F, Su X, Fan H, Xu JF, Zhang J, Lai GX, She DY, Zhang XY, He B, He LX, Liu YN and Qu JM. Chinese guidelines for the diagnosis and treatment of hospital-acquired pneumonia and ventilator-associated pneumonia in adults (2018 Edition). J Thorac Dis 2019; 11: 2581-616.

[8] Arslan M, Soylu M, Kaner G, İnanç N and Başmısırlı E. Evaluation of malnutrition detected with the Nutritional Risk Screening 2002 (NRS-2002) and the quality of life in hospitalized patients with chronic obstructive pulmonary disease. Hippokratia 2016; 20: 147-52.

[9] Oláh A and Romics L Jr. Enteral nutrition in acute pancreatitis: a review of the current evidence. World J Gastroenterol 2014; 20: 16123-31.

[10] Kirkpatrick AW, Roberts DJ, De Waele J, Jaeschke R, Malbrain ML, De Keulenaer B, Duchesne J, Bjorck M, Leppaniemi A, Ejike JC, Sugrue M, Cheatham M, Ivatury R, Ball CG, Reintam Blaser A, Regli A, Balogh ZJ, D'Amours S, Debergh D, Kaplan M, Kimball E and Olvera C; Pediatric Guidelines Sub-Committee for the World Society of the Abdominal Compartment Syndrome. Intra-abdominal hypertension and the abdominal compartment syndrome: updated consensus definitions and clinical practice guidelines from the world society of the abdominal compartment syndrome. Intensive Care Med 2013; 39: 1190-206.

[11] Wang C, Wang J, Wang B, Jing X and Huang Y. Effect of enteral nutrition tolerance assessment standardized process management on ventilator associated pneumonia and prognosis in patients with tracheotomy and long-term mechanical ventilation in intensive care unit. Zhonghua Wei Zhong Bing Ji Jiu Yi Xue 2018; 30: 1173-7.

[12] Bahtouee M, Eghbali SS, Maleki N, Rastgou V and Motamed N. Acute physiology and chronic health evaluation II score for the assessment of mortality prediction in the intensive care unit: a single-centre study from Iran. Nurs Crit Care 2019; 24: 375-80.

[13] Artinian V, Krayem H and DiGiovine B. Effects of early enteral feeding on the outcome of critically ill mechanically ventilated medical patients. Chest 2006; 129: 960-7.

[14] Zhang J, Dou Q, Chen J, Liang Y and Huang Z. Analysis of clinical effects of early enteral nutrition standardized treatment process management on patients with acute exacerbation of chronic obstructive pulmonary disease on invasive mechanical ventilation. Zhonghua Wei Zhong Bing Ji Jiu Yi Xue 2020; 32: 67-71.

[15] Reintam Blaser A, Regli A, De Keulenaer B, Kimball EJ, Starkopf L, Davis WA, Greiffenstein P and Starkopf J; Incidence, Risk Factors, and Outcomes of Intra-Abdominal (IROI) Study Investigators. Incidence, risk factors, and outcomes of intra-abdominal hypertension in critically Ill patients-A prospective multicenter study (IROI Study). Crit Care Med 2019; 47: 535-42.

[16] Asrani VM, Brown A, Bissett I and Windsor JA. Impact of intravenous fluids and enteral nutrition on the severity of gastrointestinal dysfunction: a systematic review and meta-analysis. J Crit Care Med (Targu Mures) 2020; 6: 5-24.

[17] Napolitano LM. Intra-abdominal hypertension in the ICU: who to measure? How to prevent? Crit Care Med 2019; 47: 608-9.

[18] Kreymann KG. Early nutrition support in critical care: a European perspective. Curr Opin Clin Nutr Metab Care 2008; 11: 156-9.

[19] Papavramidis TS, Marinis AD, Pliakos I, Kesisoglou I and Papavramidou N. Abdominal compartment syndrome - Intra-abdominal hypertension: defining, diagnosing, and managing. J Emerg Trauma Shock 2011; 4: 279-91.

[20] Malbrain ML, De Laet IE, De Waele JJ and Kirkpatrick AW. Intra-abdominal hypertension: definitions, monitoring, interpretation and management. Best Pract Res Clin Anaesthesiol 2013; 27: 249-70.

[21] Bejarano N, Navarro S, Rebasa P, García-Esquirol O and Hermoso J. Intra-abdominal pressure as a prognostic factor for tolerance of enteral nutrition in critical patients. JPEN J Parenter Enteral Nutr 2013; 37: 352-60.