Research Paper

Preventive strategies for feeding intolerance among patients with severe traumatic brain injury: A cross-sectional survey

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A R T I C L E I N F O

A B S T R A C T

Objectives: This study aimed to investigate the application status of preventive measures for feeding intolerance in patients with severe traumatic brain injury (STBI) in China and analysis the differences and their causes.

Methods: A cross-sectional survey was conducted. From December 2019 to January 2020, ICU nurses and physicians of 89 hospitals in China were surveyed by using a questionnaire on preventive strategies for feeding intolerance in patients with STBI. The questionnaire included two parts: the general information of participants (10 items) and application of preventive measures for feeding intolerance in STBI patients (18 items).

Results: Totally 996 nurses and physicians completed the questionnaire. Among various methods, gastrointestinal symptoms(85.0%) and injury severity (71.4%) were mostly used to assess gastrointestinal functions and risk of feeding intolerance among STBI patients, respectively. Initiating enteral nutrition (EN) within 24–48 h (61.5%), nasogastric tubes (91.2%), 30°–45° of head-of-bed elevation (89.5%), continuous feeding by pump (72.9%), EN solution temperature of 38–40 °C (65.5%), <500 ml initial volume of EN solution (50.0%), monitoring gastric residual volume with a syringe (93.7%), and assessing gastric residual volume every 4 h (51.5%) were mostly applied for EN delivery among STBI patients. Prokinetic agents (73.3%), enema (73.6%), probiotics (79.0%), antacid agents (84.1%), and non-nutritional preparations as initial EN formula (65.6%) were commonly used for preventing feeding intolerance among STBI patients.

Conclusions: The survey showed that nurses and clinicians in China have a positive attitude towards preventive strategies for feeding intolerance. However, some effective new technologies and methods have not been timely applied in clinical practice. We suggest that managers, researchers, clinicians, nurses, and other health professionals should collaborate to explore effective and standard preventive strategies for feeding intolerance among patients with STBI.

What is known?

- Severe traumatic brain injury (STBI) patients suffer a high incidence of feeding intolerance during enteral nutrition.
- Variety of preventive and curative strategies for feeding intolerance were applied among STBI patients.
- Application of preventive strategies for feeding intolerance is discrepant among different hospitals and even different departments in the same hospital.

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What is new?

- Nurses and physicians prefer the combined use of several methods to assess gastrointestinal functions and the risk of feeding intolerance among STBI patients in China.
- The evidence-based strategies for enteral nutrition delivery were widely used in clinical practice, while more valid preventive methods still need to be explored.
- Managers, researchers, physicians, nurses, and dietitians should collaborate to explore more valuable and standard preventive strategies for feeding intolerance among patients with STBI.

1. Introduction

Severe traumatic brain injury (STBI) patients are susceptible to negative nitrogen balance, weight loss, and malnutrition, which lead to poor prognosis [1]. It has been reported that early enteral nutrition (EN) could reduce the inflammatory responses, prevent bacterial translocation, improve nutritional status, and promote gastrointestinal functions [2]. However, due to the damage to the central nervous system (CNS), gut-brain axis dysfunction, and secondary damage to the gastrointestinal tract, it is difficult to deliver early EN in STBI patients, which is usually interrupted by feeding intolerance [3]. Moreover, the application of some conventional therapeutic measures such as analgesia and sedation might also aggravate the occurrence of feeding intolerance [4]. Feeding intolerance is usually accompanied by several gastrointestinal disorders, such as diarrhea, vomiting, constipation, aspiration, etc., which could cause increased morbidity and mortality [5]. Studies have shown that the incidence of feeding intolerance can reach 60%–75% during EN among STBI patients [3,6], which is a huge challenge for medical staff.

In the past two decades, with increasing understanding of the therapeutic role and significance of EN for critically ill patients, experts and researchers have conducted a series of explorations on how to improve gastrointestinal dysfunctions and reduce the incidence of feeding intolerance in STBI patients [7,8]. A variety of preventive and curative strategies for feeding intolerance were applied in clinical practice. Feeding by nasointestinal tube, continuous feeding, prokinetic agents, probiotics, and other strategies could reduce the feeding intolerance rates among critically ill patients [9–11]. However, the application of preventive strategies for feeding intolerance is discrepant among different hospitals and even different departments in the same hospital. Furthermore, fewer relevant studies have large-scale cross-sectional survey exploring the application status of preventive strategies for feeding intolerance among STBI patients.

To better apply the preventive strategies for feeding intolerance among STBI patients, the application status of these strategies needs to be known first. Thus, this study aimed to further reveal the current application status of preventive measures for feeding intolerance in China by a cross-sectional survey to provide a basis for nurses and physicians to make more rational medical decisions for STBI patients and reveal the research directions that need further exploration.

2. Methods

2.1. Study design and participants

The cross-sectional survey was performed among nurses and physicians in general ICU or neurological ICU (NICU) from December 2019 to January 2020 in 89 hospitals of China. All participants were required to meet the following inclusion criteria: registered physicians and nurses; have worked in ICU or NICU at least for 1 year; willing and able to give informed consent.

2.2. Instrument

We conducted a cross-sectional study by a self-completed questionnaire among ICU physicians and nurses of Class A secondary to Class A tertiary hospitals in China. The questionnaire was developed via a multi-step co-design process in collaboration with medical staff and experts. First, a literature review was conducted by searching the following keywords on PubMed, Information Sciences Institute (ISI), Web of Science, China National Knowledge Infrastructure (CNKI), Wanfang, and Weipu databases: "severe craniocerebral injury," "severe traumatic brain injury," "severe head injury," "enteral nutrition," "gastrointestinal dysfunction," and "feeding intolerance". After further summary and refining, the initial questionnaire themes and items were formed, including basic characteristics of participants (sex, age, educational background, department, types of employment, position, work experience, hospital classification), and clinical treatments for preventing the occurrence of feeding intolerance among STBI patients (methods for assessment of gastrointestinal functions, methods for EN delivery, and preventive strategies of feeding intolerance in STBI patients). Twenty-five ICU medical staff from two Class A tertiary hospitals were chosen to advise on the initial questionnaire. Then six ICU experts were invited to test the validity of the questionnaire(one of them was deleted because of the large number of empty items in the questionnaire). The item-level content validity index (I-CVI) of the survey ranged from 0.83 to 1.00, except for the "initiation speed of enteral nutrition" (I-CVI = 0.67), which has been revised as "initiation volume of enteral nutrition" according to experts' suggestions. .

The final version of the questionnaire included 10 items of general information and 18 items of clinical treatments for preventing the occurrence of feeding intolerance in STBI patients. According to the principle that the sample size is 5—10 times the number of items, and accounting for the possibility of 20% invalid questionnaires, the sample size was estimated to be at least 168—336 participants. Then the questionnaire was put on a Chinese online survey platform called "Questionnaire Star" (https://www.wjx.cn/), for further large-scale investigation.

2.3. Data collection

The survey distribution and data collection were conducted between December 2019 and January 2020 in 89 hospitals of China. Non-probability sampling methods (convenience sampling and snowball sampling) were used to select participants. According to the 7 geographic regions of China (including East China, South China, North China, Central China, Southwest China, Northwest China, and Northeast China), at least one Class A tertiary hospital was selected in each region for the survey. After obtaining consent and support from the surveyed hospitals, the link to the questionnaire was sent to participants by WeChat. Meanwhile, we also distributed the questionnaire to the nearby hospitals and through academic groups in a snowballing manner. A total of 1,109 eligible participants were identified, and 996 returned a completed survey (response rate of 89.8%).

2.4. Statistical analysis

All the data collected in this study were analyzed using the SPSSAU platform. The statistical description of participants' general data and answers for each item are expressed in frequency and percentages. For multiple-choice items, both percentages of

responses and respondents are reported. The percentage of responses was calculated based on the frequency of response selecting an option divided by the total number of responses to an item. The percentage of respondents was calculated based on the frequency of response selecting an option divided by the total number of respondents.

2.5. Ethical considerations

The study was conducted following the Declaration of Helsinki and approved by the Ethics Committee of the Army Medical Center of People's Liberation Army (2019-04). Informed consent was obtained from all participants included in the study.

3. Results

3.1. Demographics of the participants

The majority of the respondents were female (84.8%), 18–35 years old (81.8%), and with a Bachelor's degree (68.5%). Besides, 89.1% of the respondents were nurses, and 72.5% of the respondents were from Class A tertiary hospitals (Table 1).

3.2. Methods of gastrointestinal function assessment

According to Table 2, the physicians and nurses assessed gastrointestinal functions in patients with STBI commonly based on gastrointestinal symptoms (constipation, bowel distension, etc.) (85.0%), while motility of gastric antrum (15.7%) was least used. Physicians and nurses predicted the risk of feeding intolerance in STBI patients mostly based on injury severity (Glasgow coma scale [GCS]; acute physiology and chronic health evaluation [APACHE-II], etc.) (71.4%), while personal experience (39.5%) was least used (Table 2).

Table 1
Characteristics of participants ($n = 996$).

Characteristics	n (%)
Sex	
Male	151 (15.2)
Female	845 (84.8)
Age (years)	
18−35	815 (81.8)
36−55	174 (17.5)
≥56	7 (0.7)
Education level	
Technical or vocational education	2 (0.2)
Junior college education	278 (27.9)
Bachelor	682 (68.5)
Master/Doctor/Ph.D	34 (3.4)
Department	
General ICU	657 (66.0)
Neurological ICU	339 (34.0)
Occupation	
Doctor	109 (10.9)
Nurse	887 (89.1)
Professional title level	
Junior	659 (66.2)
Intermediate	294 (29.5)
Senior	43 (4.3)
Work experience (years)	
≤2	189 (19.0)
3−5	281 (28.2)
6−10	373 (37.5)
≥11	153 (15.4)
Hospital classification	
Class A tertiary hospital	722 (72.5)
Class B tertiary hospital or below	274 (27.5)

3.3. Methods of enteral nutrition delivery

Table 3 shows that majority of the physicians and nurses usually used methods of EN included: initiated time within 24-48 h, nasogastric tube as the primary enteral nutrition catheterization option, continuous infusion by a pump, assessing gastric residual volume(GRV) every 4 h and by extracting gastric content with a sytinge, etc.

3.4. Preventive strategies for feeding intolerance in STBI patients

The majority of the respondents resported that they applied preventive strategies to promote gastrointestinal motility (81.2%), facilitate defecation (when patients had not defecated for less than three days) (84.1%), protect gastrointestinal mucosa (93.7%), etc. among STBI patients. The preventive strategies used included prokinctic agents (73.3%), enema (73.6%), probiotics (79.0%), antacid (84.1%), etc. (Table 4).

In the last two open-ended questions, 744 respondents (74.7%) reported that they believed combined use of preventive methods would reduce the occurrence of feeding intolerance in STBI patients. The answers from 5 respondents (0.5%) did not cover preventive measures.

4. Discussion

4.1. Combined use of several methods is conducted to assess gastrointestinal functions and risk of feeding intolerance in patients with STBI

The results of the study showed that more than a half of respondents chose at least three options to assess patients' gastrointestinal functions as well as predict the risk of feeding intolerance, which indicated that most of the medical staff use multiple methods to evaluate gastrointestinal functions and tolerability of EN in patients with STBI. Further analysis of the collected data suggested that the current assessment methods of gastrointestinal functions are mainly based on clinical symptoms related to gastrointestinal dysfunction, GRV, and bowel sounds. There was only 28.8% and 15.7% of the respondents took AGI grade and medical imaging methods (motility of gastric antrum), respectively, which showed that these two measures were not yet widely applied in clinical practice. In 2012, the European Society of Intensive Care Medicine (ESICM) proposed AGI grade to assess the degree of acute gastrointestinal impairment in critically ill patients [12]. The low usage of AGI grade in evaluating gastrointestinal functions might be due to two reasons: AGI grade lacks objective evaluation indexes, and it is hard to quantify the severity; as most respondents involved in the survey were nurses, we supposed that the use of AGI grade might not have been included in the scope of nurses' responsibility. Using imaging measures to evaluate gastrointestinal functions is an emerging technique in the field of intensive care in recent years, and it can visually reflect the gastric antrum movement [13]. The low prevalence of this imaging measure may be due to that it's a novel technique and has not yet been widely conducted among STBI patients. We suggest that timely comparative studies of emerging methods with traditional methods are urgently needed to confirm their effectiveness and feasibility in assessing gastrointestinal functions to make these newest techniques timely applied in critically ill patients.

The present study found that 71.4% of respondents predict the risk of feeding intolerance in STBI patients based on injury severity (GCS, APACHE-II, etc.), 60.8% of the respondents based on assessment scales, and 60.6% of the respondents based on the patients' basic characteristics (age, sex, etc.). It is well known that disease

Table 2
Gastrointestinal function assessment methods for patients with severe traumatic brain injury carried out by nurses and physicians (n = 996).

Methods	n	Percentage of responses, %	Percentage of respondents, %
Method for assessment of gastrointestinal function			
Bowel sounds	780	27.0	78.3
Gastrointestinal symptoms (constipation, bowel distension, etc.)	847	29.3	85.0
Gastric residual volume	819	28.3	82.2
Motility of gastric antrum	156	5.4	15.7
AGI grade	277	9.6	27.8
Others (relying on dietitians' assessment and patients' nutritional status)[a]	13	0.5	1.3
Method for predicting feeding intolerance			
Assessment scale	606	21.5	60.8
Injury severity (GCS, APACHE-II, etc.)	711	25.2	71.4
AGI grade	485	17.2	48.7
Basic characteristics of patients (age, sex, etc.)	604	21.4	60.6
Personal experience	393	13.9	39.5
Others (gastrointestinal symptoms)[a]	21	0.7	2.1

Note: All items are multiple-choice questions.
[a] Supplementary answers from respondents. AGI = acute gastrointestinal injury grade. APACHE = acute physiology, and chronic health evaluation. GCS = Glasgow coma scale.

Table 3
Delivery of enteral nutrition to patients with severe traumatic brain injury (n = 996).

Characteristics	n	Percentage of responses, %	Percentage of respondents, %
Initiation time of enteral nutrition			
<24 h	171	14.4	17.2
Within 24–48 h	612	51.6	61.5
Within 48–72 h	322	27.2	32.3
Within 72–120 h	72	6.1	7.2
Others (according to patients' conditions)[a]	9	0.8	0.9
Primary enteral nutrition catheterization method			
Nasogastric tube	908	74.4	91.2
Nasointestinal tube	312	25.6	31.3
Degree of head-of-bed elevation during enteral nutrition			
<30°	76	7.0	7.6
30°–45°	891	82.6	89.5
>45°	108	10.0	10.8
Others (according to patients' intracranial pressure)[a]	4	0.4	0.4
Infusion method during early enteral nutrition			
Intermittent infusion (normal enteral nutrition solution)	475	32.3	47.7
Intermittent infusion (semi-solid enteral nutrition solution)	136	9.3	13.7
Continuous infusion by pump (normal enteral nutrition solution)	726	49.4	72.9
Continuous infusion by gravity (normal enteral nutrition solution)	133	9.1	13.4
The temperature of the enteral nutrition solution			
Near room temperature (22–25 °C)	382	36.9	38.4
Near body temperature (38–40 °C)	652	63.1	65.5
Initiation volume of enteral nutrition (ml)			
<500	498	45.0	50.0
500–1,000	456	41.2	45.8
1,000–1,500	132	11.9	13.3
>1,500	19	1.7	1.9
Others (1,000–2,000)[a]	3	0.3	0.3
GRV measurement			
By syringe	933	74.5	93.7
By vacuum drainager	220	17.6	22.1
Ultrasound	97	7.8	9.7
Others (do not monitor GRV)[a]	2	0.2	0.2
Frequency for monitoring GRV			
Every 2 h	163	12.5	16.4
Every 4 h	513	39.4	51.5
Every 6 h	142	10.9	14.3
Each time before giving enteral nutrition solution	482	37.0	48.4
Others (during shift changes)[a]	2	0.2	0.2
Definition of gastric retention			
GRV >500 ml every 6 h	368	32.5	37.0
GRV >200 ml each time within 24 h	575	50.8	57.7
GRV >400 ml each time within 24 h	180	15.9	18.1
Others (GRV>500 ml every 24 h, GRV>100 ml every 4 h, GRV>200 ml every 4 h, GRV>500 ml every 4 h or GRV>500 ml each time within 24 h)[a]	8	0.7	0.8

Note: All items are multiple-choice questions.
[a] Supplementary answers from respondents. GRV = gastric residual volume.

Table 4
Preventive strategies of feeding intolerance among patients with severe traumatic brain injury ($n = 996$).

Characteristics	n	Percentage of responses, %	Percentage of respondents, %
Gastrointestinal motility promotion			
In use ($n = 809$)			
Traditional Chinese medicine (Dahuang, acupuncture, Dachengqi Tang, etc.)	225	12.7	22.6
Prokinetic agents (mosapride, metoclopramide, etc.)	730	41.1	73.3
Nursing strategy (abdominal massage, passive limb movement, etc.)	584	32.9	58.6
Others (regulation of gut microbiota)[a]	5	0.3	0.5
Not use and reasons ($n = 187$)			
No preventive effects	48	2.7	4.8
Unclear preventive effects	137	7.7	13.8
Side effects	38	2.1	3.8
Others (lack of awareness, health insurance restrictions, and no medical advice)[a]	8	0.5	0.8
Defection facilitation			
In use ($n = 838$)			
Enema (glycerol, paraffin oil, etc.)	733	41.6	73.6
Laxative (polyethylene glycol, lactulose, etc.)	548	31.1	55.0
Nursing strategy (rectal stimulation, acupoint massage, etc.)	283	16.1	28.4
Others (herbs)[a]	7	0.4	0.7
Not use and reasons ($n = 158$)			
No preventive effects	45	2.6	4.5
Unclear preventive effects	111	6.3	11.1
Side effects	25	1.4	2.5
Others (no medical advice, no necessary to use)	11	0.6	1.1
Gut microbiota modulation			
In use ($n = 806$)			
Probiotics (live combined *Bifidobacterium*, live combined *Bacillus Subtilis* and *Enterococcus Faecium*, etc.)	787	58.9	79.0
Prebiotics (inulin, polydextrose, etc.)	134	10.0	13.5
Synbiotics	189	14.2	19.0
Not use and reasons ($n = 190$)			
No preventive effects	46	3.4	4.6
Unclear preventive effects	141	10.6	14.2
Side effects	26	2.0	2.6
Others (health insurance restrictions)[a]	13	1.0	1.3
Gastrointestinal mucosa protection			
In use ($n = 933$)			
Gastric mucosa protective agent (sucralfate, bismuth potassium citrate, etc.)	529	29.4	53.1
Antacid (lansoprazole, omeprazole, etc.)	838	46.6	84.1
Immune-enhancing agent (glutamine, ω-3 polyunsaturated fatty acid, etc.)	352	19.6	35.3
Not use and reasons ($n = 63$)			
No preventive effects	11	0.6	1.1
Unclear preventive effects	41	2.3	4.1
Side effects	16	0. 9	1.6
Others (health insurance restrictions)	10	0.6	1.0
Initial enteral nutrition solution			
Short peptide EN solution (Peptison Liquid, Peptisorb, etc.)	410	25.1	41.2
Intact protein EN solution (Enteral Nutritional Emulsion, Pepti son, etc.)	553	33.9	55.5
Non-nutritional preparation (glucose, warm water, etc.)	653	40.0	65. 6
Others (rice broth, milk, rice flour, or dependent on the decision of the nutrition department)[a]	18	1.1	1.8

Note: All items are multiple-choice questions.
[a] Supplementary answers from respondents. EN = enteral nutrition.

severity is closely related to the occurrence of feeding intolerance [14]. GCS and APACHE II scores are applied to STBI patients within 24 h after admission to assess the injury severity [15]. The risk of gastrointestinal dysfunctions is predicted based on these assessments. As these scores are the classic assessment methods for STBI patients, they have been widely used in clinical practice. Studies have shown that basic characteristics of patients, such as age and sex, are risk factors for disease severity [16,17]. For example, atrophy of intestinal mucosa can occur in the older people, affecting the absorption and transportation of water and electrolytes [18]. Therefore, nurses and physicians should pay attention to the basic characteristics of patients, such as age and sex, when considering EN delivery. In recent years, researchers in China have developed risk assessment scales to facilitate the assessment and prediction of feeding intolerance in critically ill patients [19]. These results of the present survey showed that the assessment scales for feeding intolerance are used widely among STBI patients, indicating that clinical staffs prone to use methods that are based on objective indexes and clear grading. However, considering the heavy workload and various assessment scales needed to complete in ICU, we suggest that it is necessary to further optimize the assessment scales and procedure to improve the effectiveness of evaluation of feeding intolerance and reduce the workload of medical staff.

4.2. Evidence-based strategies for EN delivery have been widely used

We found the following feeding strategies were mostly applied in China: using the nasogastric tube, 30°—45° of head-of-bed elevation during EN, continuous infusion method, 38—40 °C of EN solution, and initiating EN within 24—48 h after admission with <500 ml EN solution. Some of these strategies were following several guidelines and expert consensus on nutritional support for critically ill patients [20,21], which indicates that most nurses and physicians can apply evidence-based strategies during EN delivery. In recent years, it has been reported that administration of low-

temperature EN solutions (22–25 °C) [22] and intermittent infusion of semi-solid solutions [23,24] can reduce the risks of gastric ulcer and aspiration, while these two strategies were only used among 13.7% and 38.4% of the respondents, respectively. The low utility rates might be due to the related research being limited, causing insufficient popularization and application. Thus, for these effective methods found in clinical practice, we should summarize and spread them timely and carry out multicenter and multidisciplinary studies to confirm their effectiveness.

The amount of GRV is positively correlated with the incidence of reflux and aspiration [25]. Therefore, monitoring GRV is an important part of EN. The collected data in our survey presented that retraction of gastric content by syringe is still the main method for monitoring GRV. However, it has been reported that the accuracy of the use of syringe withdrawal is influenced by various factors, such as the patient's position and gastric tube diameter [26]. In recent years, more accurate and feasible methods for monitoring GRV have been explored, including ultrasound. Some studies have shown that GRV could be calculated accurately using 3-dimensional morphology by ultrasound, which would not be affected by other factors [27,28]. However, only 9.7% of the respondents chose to apply ultrasound to monitor GRV. The reason for this result may be related to the fact that the use of ultrasound for EN is still in its early phase, and the ultrasound instrument is a highly specialized technique that requires systematic learning and training. We suggest that we should focus on the timely training of new methods or techniques to make them applied in clinical practice better and faster.

The results also showed that gastric retention in China is mainly defined by GRV >200 ml/time within 24 h. However, GRV >500 ml every 6 h was recommended by ESICM in 2017 [29] and has been only used in 37.0% of respondents. The definition of gastric retention can directly influence the EN delivery, as well as preventive and curative measures. If the definition is too conservative, it may lead to more feeding interruptions and clinical interventions during EN; if the threshold of the definition is too strict, it might increase the risk of feeding intolerance. Therefore, how defining the threshold of gastric retention still needs further scientific exploration.

4.3. The prevention of feeding intolerance has been paid more attention in clinical practice

Strategies for promoting gastrointestinal motility and defection, protecting the mucosa, and modulating gut microbiota have been widely used before the occurrence of feeding intolerance. We found that antacid agents are still important treatments for preventing stress-related gastrointestinal bleeding among STBI patients. The antacid is a double-edged sword. It can protect the gastrointestinal mucosa, while it will also increase the gastric pH and aggravate the risk of feeding intolerance. Expert consensus has stated that we should discontinue the application of proton pump inhibitors as soon as possible when TBI patients can take adequate energy by oral feeding [30]. Thus, how to use the antacid properly still needs further exploration.

The current survey also found that physicians have paid attention to the effects of gut microbiota on STBI patients, and probiotics were mainly used in clinical practice. With the increasing understanding of the interaction of the gut microbiota-brain axis, it has been found that regulating the gut microbiota after TBI can not only improve gut dysbiosis but also promote the recovery of neurological functions [31].

For measures to improve gastrointestinal motility in STBI patients, most respondents chose prokinetic agents other than traditional Chinese medicine. However, several studies in China have confirmed that measures such as Chinese medicine rhubarb [32], Da Cheng Qi Tang [33], and acupuncture [34] can significantly improve gastrointestinal motility in STBI. However, the applications of these effective methods of traditional Chinese medicine are still very limited. We suggest that the collaborative working model of the Traditional Chinese Medicine department and physiotherapy department could be established to promote the applications of effective traditional Chinese medicine measures.

The results of the survey indicated that enema is a commonly used strategy to assist defecation in STBI patients. While enema can only alleviate the symptoms, but not treat the primary cause of constipation. Studies suggested that nursing strategies such as rectal stimulation [35] and acupoint massage [36] are effective in stimulating gut motility and promoting defecation reflexes in patients. There were only 28.4% of the respondents chose nursing strategies, which might occur due to the that these methods are mild and takes a long time, and shows slower progress. Moreover, it may also relate to the limited manpower of ICU nurses who are unable to perform tasks other than those prescribed by physicians.

Most of the respondents gave STBI patients non-nutritional preparations (glucose, warm water, etc.) at the initiation of EN. Critically ill patients are commonly accompanied by gastrointestinal dysfunctions. Solutions such as glucose and water that can be easily digested and absorbed are given firstly in clinical practice, which will make the gastrointestinal tract adapt to the following EN solution. Research reported that giving non-nutritional preparations one day before giving EN solution could reduce the incidence of diarrhea in critically ill patients [37]. We also found that rice broth, milk, or other fluid food was also used as the initial type of EN formula. This result suggests that there is a need to further explore and standardize what, how much and how long to give at the beginning of EN in STBI patients so that EN can be delivered smoothly at the early stage.

4.4. Preventive measures for feeding intolerance need to be further explored

We provided an analysis of the reasons for not taking preventive measures. The survey found that the main reason why preventive measures are not used is "unclear preventive effects." The results suggest that comparative studies of various measures for preventing feeding intolerance are urgently needed, which are important to confirm the effectiveness of these treatments and provide the basis for clinical practice. Furthermore, medical staff should make an effort to learn the knowledge relevant to EN and the latest techniques, methods, and theories to reduce the risk of feeding intolerance as effectively as possible.

As a nationwide survey, this survey is expected to provide a more realistic picture of the clinical conditions regarding feeding intolerance in STBI patients. Because of the diversity and complexity of clinical measures in practice, the survey was designed with the option "others" as the final option to discover the points that the survey did not cover. We found that some nurses filled in "relying on dietitians' assessment or suggestion" or "no medical advice." This indicates that some nurses only act as "implementers" during the EN delivery period and lack initiative. A study has confirmed that nurse-led EN delivery protocols can help reduce feeding interruptions and improve the nutritional status of critically ill patients [38]. We suggest that it is important for nurses in ICU to improve their role awareness and skills in EN support for critically ill patients, which might significantly contribute to reducing the risk of feeding intolerance.

4.5. Limitations

This cross-sectional survey study provides a snapshot of medical staff's views on preventive strategies for feeding intolerance in STBI patients. The demographic of the participants and the fact that participants were mostly recruited from class A secondary or above hospitals which may limit the generalizability. The non-probability sampling methods (convenience sampling and snowball sampling) used to approach hospitals or participants for inclusion in this study signifies that the findings are likely to not be generalizable to the wider medical staff in China.

5. Conclusions

Through the cross-sectional survey of the ICU medical staff in 89 Class A secondary or above hospitals in China, we have gained the current application status of the preventive measures for feeding intolerance in patients with STBI. The results showed that nurses and physicians in China are closely concerned with the gastrointestinal functions of STBI patients and EN delivery procedures, and have a positive attitude toward preventive strategies for feeding intolerance among STBI. Meanwhile, there are still some points that need to be paid attention to and solved. For example, the effectiveness of many clinical measures still needs to be further clarified, and some effective new technologies and methods are required to be timely applied in clinical practice. We suggest that researchers, clinicians, and dietitians could strengthen cooperation to explore more valuable preventive strategies from feeding intolerance in STBI patients.

CRediT authorship contribution statement

Yuli Fang: Conceptualization, Investigation, Data curation, Writing- original draft. **Yuanyuan Ma:** Data curation, Writing- original draft. **Haiyan He**: Data curation, Validation. **Ting Chen:** Data curation, Validation. **Jingjing Fu:** Editing. **Jingci Zhu:** Conceptualization, Supervision, Editing.

Data availability statement

The datasets used and analyzed during the current study are available from the corresponding author on reasonable request.

Declaration of competing interest

The authors have declared no conflict of interest.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ijnss.2022.06.014.

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