

## Clinical Nutrition Guidelines

# Guidelines for parenteral and enteral nutrition support in geriatric patients in China

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The mortality and morbidity of geriatric patients is much higher than for younger patients, especially when critically ill. This may be attributed to a lower reserve capacity in most organs and systems, reduced ability to deal with physical stress and the presence of acute or chronic co-morbidities. Parenteral and enteral nutrition support can improve the clinical condition of the elderly patient and result in better outcomes, such as lower mortality, reduced hospital stay and reduced medical costs. There is a need to standardize nutrition screening and assessment, and the implementation of appropriate evidence based nutritional support of geriatric patients in China. The Chinese Medical Association's Group of Geriatric Nutrition Support has developed guidelines by researching the present situation in Chinese hospitals and by referring to the guidelines from both American Society for Parenteral and Enteral Nutrition (ASPEN) and the European Society for Clinical Nutrition and Metabolism (ESPEN).

**Key Words:** guidelines, parenteral nutrition, enteral nutrition, nutrition support, geriatric patients

## INTRODUCTION

The mortality and morbidity of geriatric patients is much higher than among younger patients, especially if critically ill. This may be attributed to a lower reserve capacity in most organs and systems, reduced ability to deal with physical stress and the presence of acute or chronic co-morbidities. Malnutrition in the elderly may lead to anaemia and immune deficiency. These conditions will give rise to the higher risk of Multiple Organ Dysfunction Syndrome (MODS) after surgery, trauma and infection.

In 2012, a nation-wide nutrition screening survey was conducted on 10161 elderly patients in hospital using the MNA-SF (Mini Nutrition Assessment – Short Form) by the Chinese Medical Association Nutrition Support Group for Geriatric Patients. The survey concluded that the risk of developing malnutrition by geriatric patients in hospital was high at 50.1% and the actual prevalence of malnutrition was 15.1%. Therefore, geriatric patients in hospitals in China need careful nutritional screening to reduce potential morbidity and mortality.

Parenteral and enteral nutrition play an important role in the medical treatment of geriatric patients. Therefore,

there is a need to standardize nutrition screening and assessment and the implementation of appropriate evidence based nutritional support of geriatric patients in China. The Chinese Medical Association's Nutrition Support Group for Geriatric Patients has developed guidelines by researching the present situation in Chinese hospitals and by referring to the guidelines from both ASPEN and ESPEN. Commonly used terms are defined in Table 1.

## THE ROLE OF THE NUTRITION SUPPORT TEAM

Elderly patients have multiple health problems which are treated with many medications. Therefore a comprehend-

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Manuscript received 10 August 2014. Initial review completed and accepted 19 August 2014.

doi: 10.6133/apjcn.2015.24.2.11

sive assessment is required in clinical practice along with the appropriate nutritional support. In order to achieve this, a nutrition support team (NST) is needed to facilitate the initiation and monitoring of enteral and parenteral nutrition. Interestingly, the inception of the NST coincided with the introduction of parenteral nutrition (PN) in hospitals.<sup>1</sup>

The NST for elderly patients is multidisciplinary where geriatricians play an important role in organizing and running the team. Dietitians, clinical pharmacists, physical therapists and nurses are also key members. Surgeons, dentists, neurologists, psychologists and other clinical specialists provide necessary professional support.<sup>2</sup>

The main aim of the NST for elderly patients is to provide timely nutrition support. This includes the identification of malnutrition or nutritional risk, the completion of nutrition assessment and development of a nutrition care plan with nutrition support protocols if warranted and the monitoring and evaluation of the nutrition support.<sup>3</sup>

### Evidence

It has been shown in several clinical trials that the NST can improve the cost: effectiveness ratio and play an important role in decreasing the complications of nutritional support, cost and length of hospital stay.<sup>4-7</sup>

According to the individual nutritional objectives for the elderly patient, PN and EN support has been shown to achieve the better outcomes.<sup>8-12</sup>

Klek et al compared the effects of family nutritional support, under the direction of the NST, among 203 elderly patients. They found that the incidence of pneumonia, respiratory failure, anaemia and urinary tract infection dropped along with the medical expenses (from \$764 to \$142 per person).<sup>12</sup>

Lee et al predicted the mortality of 401 elderly patients in 28 days by using the geriatric nutritional risk index (GNRI) and reported that the NST significantly reduced the mortality of the elderly patients.<sup>11</sup> Sriram et al com-

pared the rationality of PN among 600 cases and found that under the direction of the NST, the rationality of PN increased from 71% to 83%.<sup>8</sup>

To summarize, the panel agreed that the NST should be established progressively in China. Geriatricians should be at the centre of the team to make a comprehensive assessment of the elderly patient, to understand the causes of malnutrition and to organize dietitians, nurses and other specialists to provide specific services for the patient.

### Recommendations

1. Nutritional support for elderly patients should be under the direction of the NST with geriatricians at the core of the NST (B).
2. The NST can recommend the correct execution of nutritional support prescriptions resulting in a reduction of complications and in turn should have economic benefits (B).
3. Work Scope of the NST: standardize nutritional support protocol; take charge of nutritional consultations, follow-up and clinic work in the hospital; carry out quality control for nutritional support; undertake education and training programs; perform family nutritional support (D).

## NUTRITION SCREENING AND ASSESSMENT FOR ELDERLY PATIENTS

### Background

Nutritional support for hospitalized patients should be based on nutritional screening and assessment tools that are sensitive, specific and simple to implement. The American Dietetic Association's definition of nutrition screening is to identify nutrition-related indicators for elderly patients who are at risk of malnutrition or already have malnutrition. They suggest integrating nutritional screening and assessment into the national chronic disease management program to help improve overall health.<sup>13</sup> Nutritional status is not accurately reflected by

**Table 1.** Definitions

Term	Definitions
1 Recommendation	The four classes (A to D) in Oxford Evidence-based Medicine principle of Grading of Recommendations Assessment, Development and Evaluation have been used as the basis for the recommendations.
2 Nutrition support	The provision of nutrients and any necessary adjunctive therapeutic agents to patients orally and/or enterally by administration into the stomach or intestine and/or by intravenous infusion (parenterally) for the purpose of improving or maintaining a patient's nutrition status.
3 Enteral nutrition, EN	The provision of nutrients directly into the gut via a tube. Is indicated when the client cannot ingest, chew, or swallow food but can digest and absorb nutrients. According to nitrogen source, it is of three types: amino acid, short peptide and total protein.
4 Oral nutritional supplement, ONS	The provision of nutrients orally in order to supplement oral intake and to reach daily energy and nutrient targets which is different from daily diets.
5 Parenteral nutrition, PN	The provision of nutrition support through intravenous administration of nutrients such as amino acids, glucose, fat, electrolytes, vitamins and trace elements.
6 Geriatric patient	The elderly people suffering from loss or limitation of physical, mental and society function due to acute or chronic diseases.
7 Malnutrition	A state of nutrition in which a deficiency of energy, protein and/or other nutrients cause measurable adverse effects on tissue/body form, composition, function or clinical outcome.
8 Nutritional risk	The risk at which the nutrition factors will influence clinical outcomes (infection-related complications, hospital stay et al).

physiological changes associated with the aging process such as height decline, reduced food intake, body composition changes and liver and kidney function decline.<sup>14</sup> Therefore, it is better to use more comprehensive assessment methods such as MNA-SF, Nutrition Risk Screening (NRS 2002) or the Geriatric Nutritional Risk Index (GNRI). Nutrition screening tools should be simple, easy, and of cost/benefit principles. The results can be used to identify risk factors associated with malnutrition and decide whether a further nutritional assessment and intervention are needed. A nutrition and health scale called "Determine" is currently recommended by the American Association of Family Physicians and is filled out by patients themselves. The results from this scale are used to determine nutritional risks or the need to seek professional nutritional help.<sup>15</sup> In 2009, the European Society of Parenteral and Enteral Nutrition (ESPEN) recommended the use of the MNA-SF by health professionals. The MNA-SF is based on six simple questions regarding medical history, weight, diet assessment and a simple physical examination which together determine whether a patient has malnutrition or is at risk of malnutrition. A score of less than 7 indicates malnutrition and the need for nutritional intervention to obtain a better clinical outcome.<sup>16,17</sup> In 2008 the Chinese Medical Parenteral and Enteral Nutrition Association recommended NRS2002 as an inpatient nutritional risk screening method, also suitable for elderly hospitalized patients. An NRS  $\geq 3$  points was defined at nutritional risk.<sup>18</sup>

Nutritional assessment explains and expands on information obtained from nutrition screening. This in turn helps nutrition professionals to analyze and evaluate clinical information such as the medical and dietary history, digestion and absorption capacity, physical examination, body measurement and body composition analysis, biochemical indicators, and other nutrition-related clinical manifestations. This data is then used to make the nutritional diagnosis which will direct recommendations for fluid and nutrient needs, nutritional support route and nutrition monitoring indicators and ultimately improved clinical patient outcomes.<sup>19</sup>

### **Evidence**

In 2012, the Chinese Society for Parenteral and Enteral Nutrition Support Group for Geriatric Patients used MNA-SF and NRS2002 to conduct a nutritional screening survey in 30 hospitals in 14 cities in China. More than 40% of the elderly patients were found to be at risk of nutritional deficiencies. These findings highlight the poor nutritional status of hospitalized elderly patients in China and the need for this problem to be addressed.<sup>20</sup> In 2011, Skipper et al published an evidence-based analysis of the sensitivity and specificity of MNA-SF, NRS2002, SGA and other tools and found that MNA-SF was more useful in elderly patients.<sup>21</sup> In 2010, Kaiser analyzed the incidence and risk of malnutrition in 4,500 elderly in hospitals, communities and pensioner institutions; they were 22.8% and 46.2% respectively. They found that NRS2002 was more suitable for assessing hospitalized elderly patients with acute diseases and MNA-SF was more suitable for elderly with other conditions.<sup>22</sup> Based on a summary of several RCT studies, Elia et al concluded that elderly

patients are more prone to malnutrition and thus need regular nutritional screening to prevent malnutrition.<sup>23</sup> The Joint Commission on Accreditation of Health-care Organizations (JCAHO) requires that all patients have nutritional screening and assessment within 48 hours of hospital admission. There are several studies in support of the MNA-SF as a tool for nutritional screening in elderly patients.<sup>24-29</sup> In 2009 ESPEN recommended MNA-SF as the preferred tool for assessing a variety of elderly patients.

To date there is no single test which can completely assess one's nutritional status; sensitivity and specificity can be improved through an integrated assessment, combined with subjective and objective indicators. For example, by using tools such as GNRI, combined with objective indicators like albumin and weight, one can detect and diagnose malnutrition early, provide appropriate nutrition intervention, and ultimately predict the 28 day mortality risk.<sup>30,31</sup> In contrast, MNA is usually recommended as a tool for nutrition assessment and prediction of clinical outcomes.<sup>32,33</sup>

### **Recommendation**

1. Elderly patients should receive regular nutritional screening/assessment (A).
2. MNA-SF is the first tool of choice for nutritional screening in elderly patients (B); for hospitalized patients NRS2002 is also useful (C).
3. Elderly patients with risk factors for malnutrition should have a comprehensive nutritional assessment with a nutrition intervention plan in place according to the assessment (B).
4. A comprehensive nutritional assessment combined with clinical objective data can provide additional information regarding the extent of treatment benefit in elderly patients (D).

## **TUBE FEEDING FOR ELDERLY PATIENTS**

### **Background**

Enteral nutrition (EN) is the delivery of nutrients directly into the stomach, duodenum or jejunum via a tube, catheter, or stoma. EN formulas can be divided into three types by nitrogen source: amino acid formula, short peptide formula, and total protein formula. These formulas can be further divided in two types: balance formula and disease-specific formula. However, there are other types of formulas such as those rich in amino acids, short peptide or total protein, carbohydrate formula, MCT/LCT formula and vitamin formula.<sup>29</sup> Tube feeding can be provided via two routes: 1) non-invasive: the nasogastric tube (tip of the tube) inserting into stomach, duodenum or jejunum; 2) Invasive: gastrostomy and PEG.<sup>29,34</sup>

### **Evidence**

According to the ESPEN guidelines, NRS2002 is also appropriate for elderly patients and when the score is more than or equal to 3, the patient is at nutritional risk.<sup>28,29,35</sup> MNA is another comprehensive tool for nutritional screening and assessment. ESPEN recommends that MNA can be applied to elderly people at home, in institutions and in hospital.<sup>36</sup> A randomized trial using MNA showed weight gain in the EN group. This study

confirmed, along with other studies,<sup>37</sup> the viability of EN in improving clinical outcomes. Nutritional risk and malnutrition are both indicators for nutritional support.

Before nutritional support is implemented, electrolyte and acid-base balance disorders must be corrected. Nutrition formulas and the best route for EN should be tailored to each patient by taking into account age, nutritional risk, comorbidities and so on. During EN, monitoring is important to assess effectiveness and organ function and whether the nutritional plan needs adjustment. EN is the first choice for the elderly patients with normal gastrointestinal function. PN is the alternative route when facing gastrointestinal function deficiency and intolerance of the GI tract.<sup>38-40</sup>

Indications and contraindications of EN in elderly patients are the same as that of adults.<sup>29</sup> Standard total protein formulas are suitable for most patients, and amino acid or short peptide formulas are used for patients with gastrointestinal function deficiency (such as pancreatitis).<sup>29,36</sup> Older patients are liable to suffer from lactose intolerance because of lactase deficiency. Formulas without lactose can be used for these patients. It is recommended in elderly patients to reduce the use of formulas rich in saturated fatty acids, and increase the amount of medium-chain fatty acid and monounsaturated fatty acid, all of which can supply energy rapidly and reduce the metabolic burden to the liver. Such formulas can also reduce the risk of cardiovascular disease in long term management.<sup>41,42</sup> Studies have also shown that formulas containing dietary fibre can improve the function of the colon and reduce the risk of diarrhea.<sup>43,44</sup>

EN may be tolerated by approximately 50% of elderly critical hospital patients in the early stages but only 20% of them can tolerate Total EN (TEN).<sup>45,46</sup> A study of 2946 patients on mechanical ventilation showed that EN was initiated in 36% of the sample within the first 48 hours with 45.3% reaching the target dose.<sup>47</sup> If 30%-60% of energy demand is supplied by EN, the GI barrier is probably functioning well. However, if it is lower than 60%, supplemented PN should be considered.<sup>29,36</sup> Studies have shown that EN combined with PN can increase infection complication morbidity (OR=1.66, 95% CI: 1.09-2.51,  $p=0.02$ ), but reduce the mortality rate (OR=1.66, 95% CI: 1.09-2.51,  $p=0.02$ ).<sup>48</sup> Cui's research showed that EN combined with PN can decrease endotoxaemia (originating from the GI) and post-operative infective complications, and improve liver function after Whipple procedure.<sup>49</sup>

Tube feeding can meet energy and nutrient requirements and improve nutritional status.<sup>50,51</sup> The tube should be suitable for EN; the inserting procedure should also be easy with no risk of injury. Potential complications include nasal and throat irritation and ulceration and susceptibility to aspiration pneumonia.<sup>29,34</sup> It is better to choose EN for short-term therapy (2-3 weeks). Elevating the head to 30-45 degrees can prevent aspiration pneumonia. Jejunostomy or nasogastric tube during abdominal surgery is recommended for patients who need EN post-operatively.<sup>29,34</sup> The tip of the tube must be placed beyond the anastomosis. These years, Percutaneous Endoscopic Gastrostomy (PEG) is promoted and used widely. Research has shown that PEG is superior to nasogastric

feeding because it can provide more energy, is better at maintaining or improving nutritional status and is not involved in tube displacements and reinsertions.<sup>50,52</sup> Dwolatzky et al<sup>53</sup> reported a lower incidence of aspiration pneumonia in patients fed by PEG than by NGT. In three RCT studies, tolerance and safety were equal, irrespective of whether nutrition support was initiated 3 or 24 hours after PEG placement.<sup>54,55</sup> So for the elderly patients, if EN is anticipated for longer than 4 weeks, PEG is recommended.<sup>29,34-36</sup> Skilled endoscopic ability can reduce the complications of PEG.

### Recommendations

1. Malnutrition and high nutrition risk are indications for EN in geriatric patients (A). EN is the first choice if gastrointestinal function is normal (A).
2. In frail elderly, tube feeding is recommended in order to improve or maintain nutritional status (A).
3. Total protein EN formulas are suitable for most elderly patients. Long-term use of optimized fatty acid EN formulas can reduce the risk of cardiovascular events (A). Dietary fibre added to formula can contribute to the normalization of bowel functions in tube-fed elderly (A).
4. When energy intake is insufficiently provided by EN (less than 60% for more than 7 d), PN is recommended in combination with EN (B).
5. NG tube feeding is recommended for short-term enteral nutrition (2-3 weeks); elevating head to 30-45 degrees can reduce the occurrence of aspiration pneumonia (C).
6. Jejunostomy during abdominal surgery is recommended for patients who need long-term EN post-operatively (C). The tip of tube must be placed beyond the GI tract anastomosis (B).
7. PEG is recommended for long-term nutritional support (A). Use PEG if EN is anticipated for longer than 4 weeks (B). Initiate enteral nutrition 3 hours after PEG placement (A).
8. The feeding tube should be inserted into the jejunum in geriatric patients at high risk of aspiration pneumonia (such as nanojejunal tube, jejunostomy or PEJ) (C).

## ORAL NUTRITIONAL SUPPLEMENT (ONS) FOR ELDERLY PATIENTS

### Background

According to recent research, after the age of 30, muscle mass drops by 3% to 5% every 10 years, especially after 60 years of age.<sup>56</sup> The aging process is associated with a decline in organ function, muscle wasting and dysfunction, osteopenia, immune dysfunction, a decrease in hormone levels, fluid and electrolyte imbalance, delayed recovery after surgery, chronic comorbidities, and mental conditions and cognitive impairment. Moreover, elderly patients are usually taking a plethora of drugs to treat several chronic diseases which can have adverse side effects. Also, aging is linked to reduced mobility and activities of daily living. All of these factors may lead to anorexia, decreased food intake and malnutrition (inadequate nutrient intake) which can adversely affect bodily functions and clinical outcomes. Thus, because of the accelerated aging process, it is important to take simple steps to

ensure adequate nutrient intake to reduce nutritional risk and maintain good quality of life in the elderly.

### **Evidence**

Commercialized ONS products have been used in clinical practice since the 1970s. These products were mainly enteral nutrition agents containing a variety of nutrients with liquid, semi-solid or powder form, which can provide macronutrients and micronutrients in complete or modular (component) formula and are usually taken orally. The ONS agents can also be used as the sole source of nutrition to meet the daily metabolic demands.<sup>57,58</sup>

Intervention studies of ONS in elderly patients found that in the group of patients with malnutrition or in patients at high risk of malnutrition, ONS increased the intake of nitrogen and energy, reduced muscle loss, increased weight gain, improved nutritional status and quality of life.<sup>59-62</sup>

In a multi-centre study including 19 wards, 672 critical cases over the age of 65 years were given ONS (providing 200 kcal per serving) twice a day for 15 days. The patients with hypoalbuminemia were found to be at higher risk of pressure sores. However, pressure ulcers were significantly lower in the group receiving ONS due to higher intake of energy and protein compared to the control group.<sup>63</sup>

Perioperative ONS may reduce nutritional risk and postoperative complications in elderly patients undergoing orthopedic operations.<sup>64</sup> Compared with dietary consultation and guidance, ONS has been shown to improve the nutritional status of patients with Alzheimer's disease. For the patients suffering from early and moderate dementia, ONS should be supplied in order to provide adequate energy and nutrients to prevent malnutrition.<sup>65</sup>

In a meta-analysis including 3,790 elderly cases from 36 randomized controlled trials, a higher protein ONS formula (>20% total energy derived from protein) was compared to: a) a standard diet b) standard diet with diet consultation or 3) standard ONS. The higher protein ONS formula was found to be more beneficial because it significantly reduced complications and re-admission rates; it improved grip strength and increased the intake of energy and protein without affecting the normal daily diet.<sup>58,66</sup>

### **Recommendations:**

1. For elderly patients with malnutrition or at risk of malnutrition, ONS supplemented to the normal daily diet may improve nutritional status without affecting normal food intake (A).
2. ONS can reduce nutrition risk and postoperative complication rates after a hip fracture and other orthopedic surgery in elderly patients (A).
3. A higher protein ONS formula may reduce the risk of pressure ulcers in elderly patients (A).
4. For dementia patients, ONS is better at improving nutritional status than nutrition education. For patients with early but moderate dementia, ONS is recommended to provide adequate energy and nutrients to prevent malnutrition (B).

## **PARENTERAL NUTRITION IN GERIATRIC PATIENTS**

### **Background**

Slow recovery is an important characteristic of geriatric patients. The nutritional status of geriatric patients is negatively correlated with mortality, incidence of infection or stress ulcer, and length of hospital stay.<sup>67</sup> Establishing a careful nutrition support plan should be a key component of the entire treatment plan of geriatric patients. When oral or enteral nutrition has failed, and the patient has not eaten for more than 3 days or undernutrition lasts 7-10 days, parenteral nutrition should be administered to geriatric patients. Strictly monitored parenteral nutrition is safe and effective.<sup>68</sup>

### **Evidence**

The nutrient supply for geriatric patients should meet the needs for this age group.<sup>69</sup> Because of a low basal metabolic rate, the macronutrient supply for elders over 75 years of age should decrease by 30% of that for adults aged 30 years. Therefore, the PN prescription should be based on the adult prescription and adjusted according to the disease status, metabolic status, physiological characteristics, and recovery duration.<sup>69</sup>

Insulin sensitivity of geriatric patients decreases by 43%, and their risk of developing diabetes mellitus increases by 16%.<sup>70,71</sup> Lung volume and capacity decrease gradually, with obvious weakened lung function. Extra glucose supply during PN not only causes blood sugar disorders but can increase pulmonary burden, induces respiratory failure, cause fatty liver, cholestasis, and even liver dysfunction. Fatty acid oxidation ability of geriatric patients is similar to that of young patients, therefore strictly controlled glucose supply is recommended and an increased lipid supply in PN may be beneficial in geriatric patients.<sup>72</sup> A clinical study involving 66 patients over 75 years old showed that a daily non-protein calorie intake of 46.0-125.5 kJ/(kg·d), 75.3 kJ/(kg·d), with glucose supply of 2.5 g/(kg·d) accounting for 50%-55% of total energy, could meet the basic physiological need without causing blood sugar disorders, respiratory failure, and liver or renal dysfunction.<sup>73</sup> Bruno et al observed the outcomes of 304 patients over 70 years old who had PN. They found that the 10-year mortality and morbidity of patients with a calorie intake of 25-30 kcal/(kg/d) were significantly lower than those with higher or lower calorie intake. Also, the 10-year morbidity of patients with a protein intake of 0.8-1.2 g/kg was lower than those with a protein intake of <0.8 g/(kg·d).<sup>74</sup>

A study on 2066 community elderly people showed that daily protein intake is highly related with the maintenance of body muscle level in geriatric patients.<sup>75</sup> Staun et al<sup>76</sup> found that the fractional synthetic rate (FSR) of muscle proteins in healthy old people was increased by about 2.25 fold after a 3-hour continuous intravenous infusion of amino acid solution 1.35 mL/(kg·h), 100 mg amino acid/mL. This suggested that a high blood level of amino acids could effectively stimulate the synthesis of muscle proteins in older people. This effect was more obvious when combined with appropriate endurance exercises.<sup>77</sup> Therefore, a daily protein supply of 1.2-1.5 g/kg with

simple physical activity was recommended to older patients with normal renal function.<sup>78,79</sup>

The n-3 polyunsaturated fatty acids have unique anti-inflammatory and immuno-regulatory functions. A recent prospective, randomized, double-blinded clinical trial involving 57 geriatric patients who underwent surgical resection of colon cancer showed that TPN with fish oil (0.2 g/(kg·d)), as compared with TPN with nutriliplid (1.2 g/(kg·d)), significantly decreased serum levels of IL-6, TNF- $\alpha$  and CD8. The former also reduced infection rates, SIRS incidence after surgery, and shortened hospital stay.<sup>80</sup>

The inadequate intake of vitamins and minerals in geriatric patients should also draw our attention. In the 1990s, a study on geriatric patients in the US showed an insufficient intake of multiple vitamins and minerals (such as vitamins C, B<sub>1</sub>, B<sub>2</sub>, magnesium, iron, and zinc) in more than 40% of patients over 65 years of age.<sup>81</sup> Necessary vitamins and minerals should be considered as additives in PN for geriatric patients.<sup>82</sup>

The “all-in-one” PN infusion pattern is widely recommended at home and abroad.<sup>68</sup> However, prescription incompatibility, contamination, impurity formation, and poor stability are frequently observed during the preparation of the “all-in-one” nutrient solution. A high preparation error rate of 26% was observed during the mixture of PN solution, whereas the risks of prescription incompatibility and contamination for the industrialized “multi-chamber bag” solution are very low.<sup>83</sup> A study involving 68984 patients in the US showed that PN increased the risk of blood stream infection (BSI). The occurrence rate of BSI was significantly higher in patients who underwent PN with hospital self-made “all-in-one” solution than in those who underwent PN with industrialized “multi-chamber bag” solution (25.9% vs 19.6%, OR=1.54,  $p<0.001$ ).<sup>84</sup> Another study involving 44358 patients showed that “multi-chamber bag” solution decreased the occurrence rate of BSI and hospital expense as compared with hospital self-made “all-in-one” solution.<sup>85</sup> An investigation of PN application in adults in several European countries showed that various industrialized “multi-chamber bag” solutions had been used in more than 80% of the patients, whereas individualized solutions had been used in less than 20% of the patients.<sup>86</sup> A similar study in China showed that most individualized solutions were similar to industrialized “three-chamber bag” solutions and that “multi-chamber bag” solutions could meet the nutrient need of most patients.<sup>87</sup> PN solutions can be infused via the central vein. Along with the improvement of catheter materials and catheter insertion techniques, as well as the application of intravenous infusion pump, PN solutions have been increasingly infused via peripheral veins. Peripheral venous infusion can be applied when the duration of PN is shorter than 10-14 days, with a permeation pressure of the nutrient solution less than 900 mOsmol/L.<sup>68</sup> Peripheral venous infusion and PICC catheter insertion have been proven to effectively control the occurrence of catheter-related infection.<sup>88,89</sup>

### Recommendations

1. EN is the first choice of nutrition supportive therapy. However, when EN cannot provide 60% of the total

energy intake of the patient or when EN is contraindicated, PN should be applied (C).

2. Generally, a daily non-protein energy supply of 20-30 kcal/kg and a daily protein energy supply of 1.0-1.5 g/kg are recommended (B).
3. Double energy resources from glucose and lipid are recommended for PN prescription, with an increase in the proportion of lipid (no more than 50% of non-protein calories) (C). Pharmacological doses of fish oil lipid emulsion are suitable for postoperative patients, improving the clinical outcome (A). Fish oil lipid emulsion should be considered an ingredient of PN solutions for patients with CVD (B). Attention to the supply of micronutrients is also needed (B).
4. The selection of PN solutions for older patients is the same as those for younger adults: commercial hospital self-made “all-in-one” solutions are recommended for geriatric patients with critical illness or special metabolic needs; commercial “multi-chamber bag” solutions are recommended for geriatric patients with stable disease, especially those that have PN at home, to decrease the risk of BSI (C).
5. Peripheral intravenous infusion is recommended for PN shorter than one week; PICC is recommended for long-term PN infusion (C).

## MONITORING AND MANAGEMENT OF THE COMPLICATIONS OF EN AND PN

### Background

Complications of PN and EN in the elderly are similar to that of adults but with a relatively higher incidence. The complications of PN mainly consist of tube placement related complications, route-related complications and metabolic complications including dysglycemia, turbulence of electrolytes, hepatic complications, bone demineralization and refeeding syndrome. Although EN is safe to most of patients, some complications are still recorded such as mechanical, metabolic, infection, mental and gastrointestinal specific complications.

### Evidence

According to recent research, glucose injection speed over 4-5 mg/(kg/min) or daily administration over 30 kcal/kg may exceed oxygenation ability and lead to hyperglycemia, fat accumulation and infiltration of fat into the liver.<sup>90</sup> About 50% of elderly patients can tolerate peripheral injection of “all-in-one” PN, but there are strict limitations of osmotic pressure (below 900 mOsmol/L) and duration (less than 14 days), otherwise phlebitis may occur.<sup>91</sup> Femoral and internal jugular venous catheterization is not recommended because of high risk of infection and thrombosis.<sup>92</sup> A meta analysis from SiegmanIgra and his colleagues demonstrated that it was only necessary to do a catheter culture when a bloodstream infection was suspected.<sup>93</sup> Many studies have shown that local or intravenous antibiotics did not prevent catheter-related infections.<sup>94,95</sup> Also, three meta analyses concluded that there was no difference between heparin-contained saline and normal saline in tube flushing to prevent relative complications.<sup>96-98</sup>

Most complications occur at the commencement of EN tube feeding due to tube displacement. Stable fixation and

intensive care must be implemented. If displacement is suspected, radiologic examination should be utilized.<sup>99-102</sup> Tube blockage is common when using high-energy formula or fibre-containing formulas. It can also occur in tubes with a thin inner diameter, due to improper administration through tube, and due to protein solidification caused by regurgitation of gastric juice.<sup>103</sup> A prospective study on severe critically ill patients used 30 mL normal saline to flush out the tube - this was effective at preventing tube blockage.<sup>104</sup> Buried bumper syndrome after PEG implantation can occur and should be removed immediately.<sup>105,106</sup> Elevating the head of the bed to high Fowler's position, at least 30-45 degrees can reduce the morbidity of inspiratory pneumonia.<sup>107,108</sup> Stomach residual volume monitoring is related to the prevention of inspiratory pneumonia. If the residual volume exceeds 250 mL in four hours after feeding, several factors of EN should be reconsidered, including regulating the location of the tube, decreasing the feeding speed, using PEG/PEJ or stopping EN.<sup>109-111</sup>

Patients at risk of refeeding syndrome can have abnormal serum levels of potassium, phosphorus, magnesium and vitamin B<sub>1</sub> and retention of water and sodium, which should be corrected before EN.<sup>112</sup> Nutrition support should be staged i.e. 25% of the total amount given at the beginning and the balance reached 3-5 days later.<sup>113</sup>

### Recommendations

1. The peripheral injection of "all-in-one" PN should be used first, but there are strict limitations of osmotic pressure (below 900 mOsmol/L) and duration (less than 14 days) (B).
2. A catheter culture is recommended only when bloodstream infection is suspected (B). Local or intravenous antibiotics do not prevent catheter-related infection (A).
3. Routinely monitor liver and renal function, blood lipid, blood sugar and other metabolic profiles (C).
4. Before EN feeding, location of the nasogastric or nasointestinal tube should be determined. If displacement is suspected, radiologic examination should be referred to (B).
5. Gastric residual volume should be monitored every 4 hours in the first 48 hours of EN (B). Elevate head of bed to high Fowler's position, at least 30 - 45 degrees; this can reduce the morbidity of inspiratory pneumonia (A).
6. Before EN for patients who have the risk of refeeding syndrome, routine examination of electrolytes and metabolic products should be carried out and corrected if found (B).

### ACKNOWLEDGMENTS

We would like to thank Dr Bing Hua, Zhigang Chang, Hongyuan Cui, Zhe Li, Puxian Tang from Department of General Surgery, Beijing Hospital for their language support of this manuscript.

### AUTHOR DISCLOSURES

There is no conflict of interest.

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## Clinical Nutrition Guidelines

# Guidelines for parenteral and enteral nutrition support in geriatric patients in China

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## 中国老年患者肠内肠外营养支持指南

老年患者的疾病发病率及死亡率较年轻患者明显升高，特别是危重症老年患者。这与老年人机体储备功能差，抵抗应激能力下降以及合并有多种急慢性疾病有关。肠外与肠内营养支持可以有效的改善老年患者的疾病状态及临床结局，包括降低死亡率、减少住院时间和总体住院费用。因此，在中国亟需针对老年患者的基于循证医学规范的营养筛查、评估及支持的指南性纲领。中华医学会肠外肠内营养学分会老年学组参考美国肠外肠内营养学会（ASPEN）和欧洲肠外肠内营养学会（ESPEN）发表的临床指南，结合中国的研究进展，制定了本指南。

**关键词：**指南、肠外营养、肠内营养、营养支持、老年患者