Approach to Oral and Enteral Nutrition (PN) in Adults

Topic 8

Module 8.4

Formulae for Enteral Nutrition

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Learning Objectives

- To know about the different types of “dietary foods for special medical purposes”;
- To understand what formulae should be used in what condition;
- To understand the metabolic effects of single special nutrients added to some formulae.

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   1.1 Nutritionally complete/incomplete formulae
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Key Messages

- Formulae for EN, so called “dietary foods for special medical purposes”, are defined in the European legal regulation of the commission directive 1999/21/EC of 25 March 1999;
- Standard enteral formulae have a composition which reflects the ideal values for macro- and micronutrients for a healthy population;
- Disease-specific enteral formulae are modified standard enteral formulae designed to meet the special metabolic demands of the diseased body;
- The energy components of enteral formulae are semi-natural in the sense that common high quality staple are used as basis (milk, soy, different kinds of plant oils, corn);
- The addition of nutrients to some formulae in amounts not regularly reached by normal food, for instance, glutamine, arginine, nucleotides, omega-3 fatty acids, antioxidants, adds a value as functional food, usually to modify immune functions and/or wound healing.
1. General Characteristics

Commercial formulae for EN comprise formulae for tube feeding and oral nutritional supplements (ONS). They are regulated by the EU commission directive 1999/21/EC (1), and officially denominated as “dietary foods for special medical purposes”.

The EU commission directive regulates compositional and labelling requirements. For instance, both minimum and maximum content for micronutrients per 100 kcal are defined, hereby guaranteeing that 1500 kcal of every (nutritionally complete) formula is enough to cover 100 % of RDA/AI. This is sufficient for the broad majority of patients, however, situations of increased requirements or loss of specific nutrients must be taken into account and supplementation instituted.

1.1 Nutritionally Complete/Incomplete Formulae
Nutritionally complete formulae are formulae that can be used as sole source of nourishment. Usually they are designed based on the concept of RDAs. That means, that their compositions reflect reference values for nutrient provision in a healthy population. Heterogeneity of general patient populations renders it impossible to provide accepted values for diseased individuals, at least up to now. However, some disease-specific formulae have macronutrient relations adapted to the disease-specific metabolism (e.g. diabetes formulae) or altered contents of single micronutrients, most often increases in antioxidant vitamins and trace elements.

Usually all formulae for tube feeding are nutritionally complete, whereas some ONS might be not. Mandatory labelling regulations (EU directive 1999/21/EC see above) require a statement that the product is suitable for use as the sole source of nourishment.

Nutritionally incomplete formulae are formulae that are not suitable to be used as sole source of nourishment. Most contain an incomplete array of nutrients but some have high amounts of single nutrients, e.g. antioxidants, which render them as possibly harmful if used as sole source of nutrition. Only products intended for supplementary oral use (ONS) may be nutritionally incomplete, products for tube feeding are usually nutritionally complete.

1.2 Low, Normal and High Energy Formulae
Normal energy formulae are defined as 0.9 -1.2 kcal/ml, high energy formulae are anything above this, low energy formulae anything below (2). In Figure 1 these numbers are transferred to products of normal food.

![ENERGY DENSITY](image)

Figure 1 Energy densities of enteral formulae compared to normal food

1.3 Whole Protein Formulae
Whole protein formulae contain intact proteins and usually lipids as long chain triglycerides (LCT), and carbohydrates predominately as maltodextrins. They require normal or near normal gastrointestinal function and can be used in as many as 95% of patients on enteral nutrition. Since nutrients are not hydrolysed, they have an osmolality reasonably close to the physiological level (about 200 to 350 mosmol). All standard and most of disease-specific formulae belong to this category.
1.3.1 Standard Formulae

Standard formulae are enteral formulae with a composition that reflects the RDA values for macro- and micronutrients of a healthy population (Fig. 2, Table 1).

**STANDARD FORMULAE contain**


- 15-20 energy% (E%) whole protein,
- 30 E% lipids, predominantly in form of LCT,
- about 50-55 E% carbohydrates
- 1 kcal/ml („normal energy“)
- about 85% water
- fiber*

* However, non-fiber containing formulae with otherwise similar composition also exist, but they should be used only when fibers are contraindicated.

Figure 2 General characteristics of standard formulae

Table 1 The almost identical compositions of normal energy, fibre containing standard formulae on the market

<table>
<thead>
<tr>
<th>Per 100 ml</th>
<th>Osmolite Fibre</th>
<th>Nutricomp Standard Fibre</th>
<th>Fresubin Original Fibre</th>
<th>Isosource Fibre</th>
<th>Nutrison Multi Fibre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prot g</td>
<td>4.0</td>
<td>3.8</td>
<td>3.8</td>
<td>3.8</td>
<td>4.0</td>
</tr>
<tr>
<td>Fat g</td>
<td>3.5</td>
<td>3.3</td>
<td>3.4</td>
<td>3.4</td>
<td>3.9</td>
</tr>
<tr>
<td>Carbohydrates g</td>
<td>12.4</td>
<td>13.8</td>
<td>13.8</td>
<td>13.6</td>
<td>12.3</td>
</tr>
<tr>
<td>E - density kcal/ml</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Osmolality mosm/l</td>
<td>237</td>
<td>260</td>
<td>250</td>
<td>232</td>
<td>210</td>
</tr>
<tr>
<td>Fibres g</td>
<td>1.4</td>
<td>1.5</td>
<td>2</td>
<td>1.4</td>
<td>1.5</td>
</tr>
</tbody>
</table>

Standard formulae, incl. high-energy and high-protein formulae, can be used for a broad array of disease states, see list of indications according to the ESPEN Guidelines below.

1.3.2. High Energy Formulae (syn. energy dense diets)

High energy formulae are modifications of standard formulae containing more than 1.2 kcal/ml. Usually this is reached by removing water from a standard formula accompanied by a slight increase in the lipid fraction. Thereby an energy density up to 1.5 kcal/ml can be attained. To achieve an energy density of more than 1.5 kcal/ml the lipid fraction has be increased considerably (up to 50%), and this is why those formulae are also called high-lipid ones. High energy formulae have a lower water content than standard formulae (70-77% vs. 85%) and care should be taken to substitute additional water to meet the daily fluid requirements.
General indications for high energy formulae are fluid restrictions in cardiac and kidney disease and electrolyte imbalances. However, they can also be used, in patients who tolerate them, to provide adequate nutrition in a smaller volume in order to reduce feeding time, improve compliance and increase mobility.

1.3.3. High Protein Formulae

High protein formulae are also modifications of standard formulae containing 20% or more of total energy from protein. **General indications** for high protein formulae are enforcement of the protein-anabolic reactions (e.g. catabolic states, severe malnutrition) and wound healing. **Indications** for standard formulae including high-energy and high protein formulae according to ESPEN Guidelines on Enteral Nutrition (3) are:

<table>
<thead>
<tr>
<th>Grade of recommendation</th>
<th>Indication</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>In most surgery patients (4)</td>
</tr>
<tr>
<td>B</td>
<td>In HIV patients (5)</td>
</tr>
<tr>
<td>A</td>
<td>Most Crohn's disease patients with active disease (6)</td>
</tr>
<tr>
<td>C</td>
<td>Oncology patients except perioperatively (7)</td>
</tr>
<tr>
<td>C</td>
<td>Alcoholic steatohepatitis and liver cirrhosis (8)</td>
</tr>
<tr>
<td>C</td>
<td>Postoperatively in liver transplantation (8)</td>
</tr>
<tr>
<td>C</td>
<td>Most patients with acute renal failure (9)</td>
</tr>
<tr>
<td>C</td>
<td>For short term use in undernourished patients in chronic renal failure (9)</td>
</tr>
<tr>
<td>C</td>
<td>For oral supplementation in haemodialysis therapy (9)</td>
</tr>
</tbody>
</table>

1.4 Peptide-based Formulae

(syn: oligomeric, low-molecular weight, chemically defined formulae)

Peptide-based formulae are partially “predigested” and more easily absorbed than whole protein formulae. They contain protein predominantly in peptide form (2 - 50 amino acid chains). A major part of lipids is provided as MCTs, since impaired digestion and malabsorption are main reasons for their use.

Only few patients need peptide-based formulae. Indications according to the recommendations of the Austrian Society of Clinical Nutrition (AKE) see Fig.3 (10). According to the ESPEN guidelines peptide-based formulae can also be used in patients with acute pancreatitis, but standard formulae can be tried when they are tolerated (11).

### INDICATIONS

**Peptide-based formulae**

Druml W, Roth E, Jadma K, AKE recommendations for enteral and parenteral nutritional support, 2004

- When whole protein formulae are not tolerated
- Severely impaired resorption capacity
- After prolonged starvation
- In ICU patients with jejunal tip placement *
- In severe acute pancreatitis with jejunal tip placement **
- Short bowel syndrome
- Crohn’s disease with fistula a.s.o*

* only if whole protein formulae are not tolerated  ** but standard formulae can be tried if tolerated (ESPEN Guidelines, Clin Nutr, 2006)

Figure 3 Indications for peptide-based formulae
1.5 Free Amino Acid Formulae
(syn: elemental, monomeric, low molecular weight, chemically defined formulae)

Free amino acid formulae contain single amino acids as protein source. There is hardly a real indication for them, since oligopeptides are better absorbed than free amino acids and have a lower osmolality. The main indications being for congenital metabolic disease, severe protein allergies, short bowel syndrome, if other formulae are not tolerated.

1.6 Ingredients of Enteral Formulae

Protein sources for the whole protein formulae are mostly milk proteins, often together with soy proteins. In peptide-based formulae hydrolysates of soy, lactalbumin, gelatine and/or whey are used. Amino acids based formulae contain free amino acids, which imply that they do not even contain the basal amounts of glutamine, because this amino acid is not stable in the free form.

Fat sources in whole protein formulae are predominately mixtures of oils that are high in polyunsaturated ω-6 fatty acids, like sunflower, soy, safflower and corn oils. Recently, with increasing awareness of the positive effects of ω-3 fatty acids, canola oils got part of most formulæ and sometimes even fish oils are added. Medium chain triglycerides (MCT) derived from coconut oil are also part of several solutions. Peptide-based and elemental formulæ often contain dominant amounts of MCTs, because they do not require bile salts or pancreatic lipase, bypassing the lymphatic system and being absorbed directly into the portal circulation. However, MCTs do not contain any essential fatty acids. Therefore, to prevent essential fatty acid deficiency a minimum of 5% polyunsaturated fatty acids have to be provided in each nutritionally complete formula.

Carbohydrates sources are predominantly partial enzymatic hydrolysates of corn starch (maltodextrin, > 10 glucose molecules). Some formulæ, especially for oral use, may contain sucrose in small amounts to increase palatability. Some whole protein formulæ may also contain starch.

Minerals, vitamins and trace elements are added usually to meet 100% of RDA in 1500 kcal of a formula.

EN formulæ do usually not contain lactose, cholesterol, purin and gluten in relevant amounts. That is not due to technical elimination processes but rather through a smart choice of base materials. They do not contain cholesterol because mostly plant oils are used lipid as source (and cholesterol is part of the animal fat). They do not contain purin, because milk and soy do not contain any. And carbohydrates are usually derived from corn, which does not contain any gluten (gluten is found in wheat, oats, rye and barley). Protein powders used in enteral products are of high biological value, and highly concentrated, usually with a protein fraction of about 85%, and thereby containing only negligible amounts of lactose. Therefore, enteral formulæ are safe products for patients with primary or secondary lactose intolerance, celiac disease, symptoms of gout and hypercholesterolemia.

Enteral formulæ obviously are designed foods. Still, their energy components are natural, in the sense that common high quality staple are used as basis. Talking about their artificiality is more or less a philosophical question. Most of them are as artificial or as natural as designed products we usually buy in supermarkets (like certain milk desserts, drinks etc.). Therefore, wordings suggesting the negative connotation of artificiality, like astronaut food or artificial nutrition, should be possibly avoided in daily clinical practice.

2. Disease-specific Formulae

Disease-specific formulæ include those with macro- and micronutrient composition adapted to the needs of a specific disease and/or digestive or metabolic disorder (2).

2.1 Diabetes Formulae

Two types of diabetes formulæ are available:

a: The “classic” diabetes formulæ

“Classic” diabetes formulæ are very similar to fibre containing standard formulæ. That is because recent guidelines for diabetic diets conform with the concept of RDAs on which standard formulæ are based. Classical diabetes formulæ may have some part of sucrose exchanged by fructose and contain a higher fraction of polysaccharides but the differences are minimal and do usually not
justify their higher price. Therefore, (fibre containing) standard formulae are usually adequate in uncomplicated and medically adequately treated diabetes mellitus.

b: The new generation “high MUFA” diabetes formulae:
The new generation diabetes formulae are whole protein formulae containing up to 35 energy% of mono-unsaturated fatty acids (MUFA), a higher amount of total fat and decreased carbohydrates (Fig. 4). In a recent systematic review and meta-analysis (12) high MUFA diabetes formulae were shown to significantly reduce postprandial rise in blood glucose, peak blood glucose and glucose area under curve (AUC) compared to standard formulae in short-term studies (most of them 1 day ONS for breakfast). Results of clinical benefits in long term use are still inconclusive. Several studies report lower mean, fasting and/or postprandial glucose levels (2;13-17) with however only trends towards decreased HbA1c and fructosamine (13;15;17) and insulin requirements (13;15;17) for high MUFA formulae compared to classical diabetes formulae. An appropriate pragmatic approach in clinically stable patients is to use such formulae if adequate glycaemic control with standard formulae is difficult to achieve. In the ICU setting, however, where strict glycaemic control with the use of exogenous insulin is achieved relatively easily when standard or ICU-specific formulae are used there is no reason to believe that such formulae would be required (2).

<table>
<thead>
<tr>
<th>High MUFA diabetic formulae vs standard formulae</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Elia M et al, Diabetes Care 2005, 28:2267)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Trial size (study length)</th>
<th>Effect (95% CI)</th>
<th>Change in blood glucose AUC (All trials RCT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Golev et al 1995</td>
<td>-1.38 (-2.67 to -0.1)</td>
<td></td>
</tr>
<tr>
<td>Printz et al 1997</td>
<td>-1.22 (-2.18 to -0.26)</td>
<td></td>
</tr>
<tr>
<td>Hoffman et al 2004</td>
<td>-0.89 (-1.73 to -0.05)</td>
<td></td>
</tr>
<tr>
<td>Hoffman et al 2004</td>
<td>-1.22 (-2.46 to -0.47)</td>
<td></td>
</tr>
<tr>
<td>Meta analysis diabetes specific vs. standard</td>
<td>-1.19 (-1.89 to -0.7)</td>
<td></td>
</tr>
</tbody>
</table>

Figure 4 High MUFA diabetic formulae versus standard formulae

2.2 Liver Formulae
Disease specific formulae for liver disease are whole protein formulae that contain higher proportions of branched-chain amino acids (valine, leucine, isoleucine) and lower levels of aromatic amino acids than standard formula to counteract the abnormal plasma levels of these amino acids. They usually contain high amounts of MCTs in the lipid fraction to prevent possible absorption problems for LCTs due to cholestases (Table 2). Total protein content varies but is often normal, and energy density is usually slightly increased to meet fluid restrictions. They have been used in attempts to prevent and/or treat hepatic encephalopathy, but results from studies using these formulae have been inconclusive (8). At the current time it is felt that standard high energy formulae are sufficient to meet the needs of patients with hepatic failure, and according to ESPEN guidelines liver formulae should only be used in alcoholic steatohepatitis, liver cirrhosis and postoperatively in liver transplantation and liver surgery when hepatic encephalopathy develops during enteral nutrition (grade of recommendation: A) (8).
2.3 Renal formulæ

The aim of enteral nutrition in renal failure is to minimize blood urea nitrogen and reduce accumulation of toxic products, while maintaining water and electrolyte balance as well as nutritional status. Renal formulæ are high energy formulæ (usually 2 kcal/ml) with a low content in potassium, phosphate and sodium, and adjusted in fat soluble vitamins (e.g. low amounts of vitamin A). Predialytic formulæ are low in proteins, which are often enriched with essential amino acids to increase the biological value. Dialytic formulæ are high protein formulæ to meet protein losses during haemodialysis. In most patients with acute renal failure standard formulæ can be used (9). Dialytic formulæ, but not predialytic formulæ can be used in acutely ill patients with either chronic or acute renal failure, in case of electrolyte derangements (9).

For indications of renal formulæ see Figure 5. For indications of standard formulæ in kidney disease see above.

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**Indications for RENAL FORMULÆ**


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**Prädialytic Formulae**

- In conservatively treated chronic renal failure for EN > 5 days (C).
- Essential amino acids and ketoanalogues, in association with very low protein formulæ, are proposed to preserve renal function (B).

**Dialytic Formulae**

- For tube feeding in patients on maintenance haemodialysis therapy (C).
- In acute renal failure in case of electrolyte derangements (B).

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Figure 5 Indications for renal formulæ
2.4 Pulmonary formulae
Disease-specific pulmonary formulae contain a higher percentage of total energy from fat to decrease the formation of carbondioxide. In stable COPD EN is usually given in amounts of 300-600 kcal/d to supplement normal food orally and thereby increase daily energy intake. Therefore, the impact of modulation of the respiratory quotient (RQ) by modulating the carbohydrate/fat ratio of the ONS is minor because the composition and amount of normal food will have more effects on the RQ. According to the ESPEN guidelines there is no additional advantage of a disease specific pulmonary formulae compared to standard, high protein or high energy ONS in patients with stable COPD (Grade of recommendation: B) (18). However, in acute respiratory deficiency syndrome, where total enteral nutrition has to be instituted, pulmonary formulae enriched with ω-3-fatty acids and antioxidants are recommended (Grad of recommendation B, also see immune-modulating formulae) (19).

3. Immune-modulating formulae
(syn: immunonutrition, immune-enhancing diets)

Immune modulating formulae contain substrates to modulate (enhance or attenuate) immune functions. Immune-modulating nutrients are given in supranormal amounts to achieve a “pharmacological” effect on the response of the body to surgery, trauma or infection (20). Many nutrients have potentially immune-modulating properties, however, so far, omega-3 fatty acids, nucleotides, arginine and glutamine have mainly been used.

For indications of immune-modulating formulae see Figure 6. According to ESPEN guidelines immune-modulating formulae are NOT indicated in severe sepsis, where it might be harmful (19), in burned patients due to insufficient data (19) and in HIV patients due to conflicting results (5). During stem cell transplantation enteral administration of glutamine and eicosapentanoic acid is not recommended due to inconclusive results (7).

![Indications for IMMUNE-MODULATING FORMULAE](table)

<table>
<thead>
<tr>
<th>Indications for IMMUNE-MODULATING FORMULAE</th>
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<table>
<thead>
<tr>
<th>Perioperatively independent of nutritional status in (4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Major neck surgery for cancer</td>
</tr>
<tr>
<td>Major upper abdominal cancer surgery</td>
</tr>
<tr>
<td>After severe trauma</td>
</tr>
<tr>
<td>In intensive care patients with (19)</td>
</tr>
<tr>
<td>mild sepsis (APACHE II &lt; 15)</td>
</tr>
<tr>
<td>ARDS (formulae containing ω-3 fatty acids)</td>
</tr>
</tbody>
</table>

Figure 6 Indication for immune-modulating formulae

4. The individual effects of single special nutrients

4.1 ω-3 fatty acids
Fats may have effects on immune function. Oils traditionally used in enteral formulae, like soybean, sunflower and safflowers, are rich in ω-6-fatty acids. ω-6-fatty acids are precursors of the eicosanoids series 2 prostanooids, series 2 thromboxanes and series 4 leucotrienes. Series 2 prostanooids induce inflammation and increase immunosuppression. In contrast, ω-linoleic acid, an ω-3-fatty acid, is the parent of eicosapentanoic acid (EPA). EPA is the precursor of the eicosanoids series 3 prostanooids, series 3 thromboxanes and series 5 leucotrienes. Series 3 prostanooids and series 5 leucotrienes have been shown to have anti-inflammatory and immune-enhancing properties.
Furthermore, thromboxane A2 produced in platelets is a potent platelet aggregator and vasoconstrictor, whereas thromboxane A3 is a moderate vasoconstrictor and does not aggregate platelets. The $\omega$-3 products have also been shown to inhibit the formation of the $\omega$-6 products. The optimum ratio for $\omega$-6: $\omega$-3 fatty acids is considered to be 5:1, although this ratio is not confirmed by any clinical studies. This ratio is far from being met by the Western diet and, therefore, exchange of part of conventional oils with fish oils are necessary to achieve this immunomodulatory effect. In addition to the anti-inflammatory effects (Fig. 7), $\omega$-3--fatty acids increase the fluidity of cell membranes (20;21).

<table>
<thead>
<tr>
<th>Effects of $\omega$-3 FATTY ACIDS</th>
</tr>
</thead>
<tbody>
<tr>
<td>▪ Anti-inflammatory by reversing pro-inflammatory cytokine production</td>
</tr>
<tr>
<td>▪ Reverse immunosuppression</td>
</tr>
<tr>
<td>▪ Decrease coagulation capacity</td>
</tr>
<tr>
<td>▪ Cave: decrease wound strength in wound healing</td>
</tr>
</tbody>
</table>

Figure 7 Effects of $\omega$-3 fatty acids

4.2 Arginine
Although not a traditional “essential” amino acid, arginine has been shown to be “semi-essential” under a variety of stress situations, including burns, trauma, and rapid growth (22-24). On a biochemical level, arginine supports protein synthesis, biosynthesis of other amino acids and urea formation. On an immunological level, arginine stimulates lymphocyte function and improves wound healing. Arginine has multiple and potent secretagogue activities, including the increase of human pituitary growth hormone, increased releases of insulin, glucagon and somatostatin. The possibility of deleterious effects of the amino acid, from its action as a precursor for nitric oxid production, has been raised. Excessive production has been linked with mortality in septic shock (20).

4.3 Glutamine
Glutamine is the most abundant amino acid in the body and classically has been considered a non-essential amino acid. Recent studies, however, indicate that it may be conditionally essential in stress and starvation (20). Glutamine is important for rapidly dividing immune cells, for maintaining gut barrier function and for synthesis of the endogenous antioxidant, glutathione. The potential clinical benefits of enteral supplementation of glutamine have been systematically reviewed (25): In chemotherapy patients mucositis was ameliorated. In bone marrow patients, a trend toward reduced mortality was noted. In short bowel syndrome there was no evidence of beneficial effects of glutamine on gut function. In Crohn’s disease a small improvement in gut permeability was found. In critically ill patients a reduction in infections and inflammation were noted with no improvement in length of stay.

Basic requirements of glutamine can be satisfied with conventional whole protein formulae (see Figure 8). But if it is indicated to cover disease-associated additional requirements, about 20 g /d of glutamine should be added to the formula. Some formulae, especially immune-modulating ones, already contain the additional requirements of glutamine. According to ESPEN guidelines, glutamine should be added to a standard formulae in burned and trauma patients (A) (19). But there are not sufficient data to support a routine glutamine supplementation in surgical or heterogenous critically ill patients (19).
**Summary**

Formulae for enteral nutrition offer a variety of opportunities to prevent and treat malnutrition during the course of a disease. Some have the additional value of being adapted to the metabolism of a specific disease, and some others add components of functional food to the pure feeding aspect of nutrition.

**References**


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**GLUTAMINE**

**Natural glutamine content in commercial formulae (2000 ml) (26)**

<table>
<thead>
<tr>
<th>Formulae</th>
<th>Glutamine Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whole protein formulae, normal</td>
<td>4-6 g</td>
</tr>
<tr>
<td>Whole protein formulae, high</td>
<td>6-8 g</td>
</tr>
<tr>
<td>Peptide-based formulae</td>
<td>2-3 g</td>
</tr>
<tr>
<td>Amino-acid based formula</td>
<td>0 g</td>
</tr>
<tr>
<td>Impact (Novartis Nutrition)</td>
<td>6.3 g</td>
</tr>
</tbody>
</table>

**Immune-modulating formulae enriched with glutamine (2000 ml) (16)**

<table>
<thead>
<tr>
<th>Formulae</th>
<th>Glutamine Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Impact Glutamine (Novartis Nutrition)</td>
<td>20 g</td>
</tr>
<tr>
<td>Nutricomp Immun (B. Braun)</td>
<td>21 g</td>
</tr>
<tr>
<td>Fresenius Reconvan (Fresenius-Kabi)</td>
<td>20 g</td>
</tr>
</tbody>
</table>

Figure 8 Glutamine content in commercial formulae (26)