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Review

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Artificial Nutrition in Therapeutic Approach of Acute Caustic Poisonings

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Abstract

Acutes corrosive poisonings can cause serious chemical injuries of the upper gastrointestinal tract, and they are localized most frequently in the esophagus and the stomach because the poison remains there a long time. Treatment of the acute corrosive intoxications include: neutralization of corrosive agents, antibiotics, corticosteroids, anti-secretory therapy, nutritional support, collagen synthesis inhibitors, esophageal dilation and stent placement, and surgery.

The damaged mucosa, submucosa and muscle layer regenerate with great difficulty because of the surrounding inflammation, necrosis and secondary complications. Tissue fibrosis, adhesions or circular stenosis appear, which greatly disturb the normal functioning (impeded peristaltic, impeded passage). All these complicate the entire general condition of the patient, including inadequate normal food intake, loss of body weight, prostration, cachexia. These patients are also into a severe general condition due to hypercatabolic state and negative alkali balance. Therefore, early nutritional support is of substantial importance in treatment of these patients. Nutritional support can be given by parenteral way in peripheral or central vein and by enteral way through specially designed tubes inserted in the stomach or intestines, prepyloric or postpyloric.

The type of artificial nutritional support will depend on the grade of esophageal or gastric damage determined by endoscopy.

Introduction

Acute corrosive poisonings appear as a result of ingestion of acids, bases, oxidants, heavy metal salts and other chemical substances. They cause chemical injuries of the upper gastrointestinal track and they pose a serious medical and social problem, both by their clinical presentation and therapeutic approach [1, 2].

Today the incidence of acute corrosive poisonings is increasing. The important fact is that acute corrosive poisonings constitute 8-10% of the total number of poisonings, 18-80% of the complications and 10-38% of the mortality [3, 4]. The data for our country show incidence of 15-18% of the total number of poisonings, 14-40% of the complications, and 4-6% of the mortality [5].

Severity of the post-corrosive lesions depends on the nature of the corrosive substance, its quantity and concentration, and the duration of exposure [6].

In establishing the diagnosis and therapeutic approach of acute corrosive poisonings, the severity of the post-corrosive changes of the esophagus, stomach and duodenum detected by esophagogastroduodenoscopy is of great importance.

In the world literature there are several classifications of endoscopic post-corrosive injuries in the upper gastrointestinal tract (Holinger's, Fridman's, Zargar's, Kikendall's classifications) [7-9].

We usually use the classification of endoscopic post-corrosive injuries in the upper GIT suggested by Kikendall:

1. First grade: erythema and edema of the mucosa;
2. Second (A) grade: erosions, blisters, superficial ulcers (transversal and linear), exudation, hemorrhage;
3. Second (B) grade: circumferential lesions;
4. Third grade: multiple deep brownish-black or grey ulcerations and necrosis;
5. Fourth grade: perforation.

Extensive damages of the gastrointestinal tract hinder normal nutrition in these patients. They are in a severe general condition due to disorders of the nutritional status associated with hypercatabolic state and negative alkali balance. Thus, early nutritional support is of major importance in the treatment of these patients.

Artificial nutrition is a life-maintaining therapy in patients who cannot take food by mouth and are disposed to a risk of malnutrition. The effects of artificial nutrition in patients with life-threatening diseases, such as: reducing the possibility of infections and bacterial translocation, reducing the predisposition to onset of aspiration pneumonia and pulmonary embolism are of substantial importance for the treatment outcome in these patients. Thus, early nutritional support is very important in treatment of these patients [10].

Nutritional support

FOOD IS MEDICINE – hence, let your medicine be your food (Hippocrates, ca 400 years BC).

For a long time nutritional support has been one of the most controversial procedures that have been discussed in modern medicine. More than 20 years ago Koretz commented on the nutritional support and emphasized that there were no sufficient relevant information to deduce evidence-based conclusions for indication and need of nutritional support. However, since then, the situation has completely changed and today there are solid proofs confirming that undernutrition is an independent risk factor that leads to higher morbidity rate, poorer quality of life, longer hospital stay, delayed healing time, higher hospital costs [9]. Nutritional support may be given by parenteral feeding through peripheral or central vein and by enteral feeding through specially designed tubes inserted in the stomach or intestines, pre-pyloric or post-pyloric [11].

History

The first attempts of administering intravenous infusion were made by Sir Christopher Wren in 1656, who injected nutrients in a dog's vein. He used goose feathers and canine blood with addition of opium and wine for the intravenous injection. Numerous complications and lethal outcomes in those experiments were a result of the absolute lack of knowledge about sterility, microorganisms, immunologic incompatibility, osmolality and pyrogenic substances.

In spite of the rapid development of medicine, the first therapeutic application of fluids was done in the beginning of the 19th century during the large epidemics of cholera when it was applied subcutaneously. At the end of the 19th century, after the investigations of asepsis made by Sir Joseph Lister (1870) and detection of microbial infections by Louis Paster (1877), the application of intravenous infusions gained objective chances for success and diminishing complications. Entire intravenous nutrition with sufficient number of calories, amino acids, minerals and vitamins for more rapid healing of damaged tissues and return of the organism in the normal pre-traumatic conditions in patients with cachexia has become apparent in the sixties of the last century with the development of special application techniques and reducing the number of fatal complications [12].

In the beginning of the 70-ties this therapeutic method was improved with the development of the application techniques. The advent of parenteral nutritional support in critically-ill patients had initiated investigations for obtaining specific nutrient formula intended for regulation of pathologic changes in renal, cardiac, hepatic and gastroenteral diseases. In the eighties, not only new technologies in this field were presented, but also gigantic steps were made by replacement of protein hydrolysates as a source for proteins with crystalloid solutions of amino acids. This enabled production of solution for different clinical conditions, better control of protein metabolism were provided and complications were avoided from auminium excess associated with application of casein hydrolysates [13].

Throughout history enteral nutrition has been administered in several ways: rectal nutrition, nasoenteral nutrition, oral-enteral nutrition, nutrition by enterostomas.

The beginnings of enteral nutrition date back in 1958 when Caprivaceus for the first time succeeded to enter food directly in the esophagus. In 1617 Fabricius fed his patients who could not swallow by a silver tube inserted nasopharyngeally. For the first time, food was entered directly in the stomach by Boerhaave in 1646. In 1850 for the first time gastrostoma was inserted for nutritional needs in a child with severe esophageal burns caused by a caustic agent. In 1952 for the first time jejunostoma was inserted for nutritional needs in a patient with esophageal carcinoma. Modern enteral nutrition started in 1982 when the first percutaneous endoscopic gastrostoma and the first endoscopic jejunostoma were inserted [14].

Parenteral nutrition

Parenteral nutrition is administered in two modes: in peripheral vein and in central vein.

Cubital veins (in the elbow fossa) are the most commonly used peripheral veins for administration of infusions and duration of application cannot last more than 7-10 days. The most commonly used central vein is v. subcalavia and the administration might last more than 30 days [15].

Parenteral application of nutritional solutions is associated with complications that sometimes impede the feeding of the patient and cause difficulties to the medical doctor in planning and conveying nutritional support. The most common complications in parenteral support are: complications related to central and peripheral vein catheter; needle injuries (injuries of pleura, neighboring artery or vein, d. thoracicus, v. cava, right atrium); air embolism; thrombosis; infectious complications (sepsis, endocarditis); metabolic complications (hypoglycemia and hyperglycemia with hyperosmolar coma and ketoacidosis); deficit of intracellular ions (K, Mg, PO_4); lack of oligoelements, vitamins and essential amino acids; metabolic bone disease (osteomalatia, hypercalciuria, decrease of skeleton calcium and decrease of circulating parathormone); and disorders of acid and alkali status (metabolic acidosis or metabolic alkalosis).

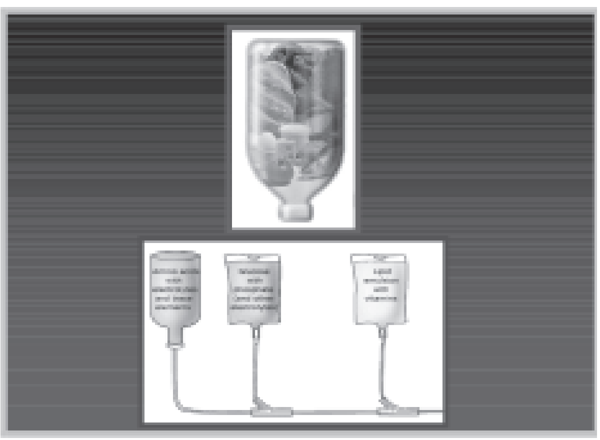

Figure 1: Solutions applied parenterally.

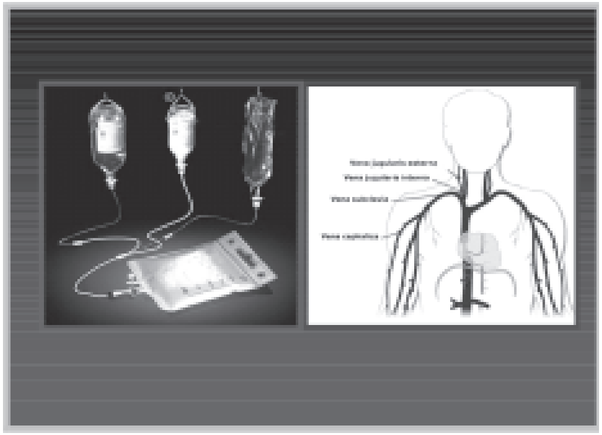

Figure 2: Presentation of veins where nutritional solutions are applied.

Due to numerous complications and large financial expenses parenteral food intake has been replaced in everyday practice by enteral method of application since it is simple, safe and it costs less [16].

Enteral nutrition – feeding of patient when normal diet is not possible

Enteral nutrition is a way to provide food directly into the gastrointestinal tract through mouth, nose or percutaneously through a specially made and designed tube.

Definition

According to the current knowledge the term enteral nutrition comprises all forms of nutritional support that require use of dietetic feeding for specific medical aims, as has been defined in the European legal regulation of 25 March 1999. In line with the last consensually accepted concept enteral nutrition is a sophisticated nutritional regime of support practiced and conducted by professionals who work in trained nutritional teams [17].

Indications

Indications for enteral nutrition are in direct proportion to all conditions when patients are unable to ingest adequate nutrients although they have functional GIT. Major indications for enteral nutrition are: poor nutritional status, malnutrition, anorexia, chemical burns of the upper GIT, short bowel syndrome, inflammatory intestinal diseases, prolonged diarrhea, chronic hepatic diseases, encephalopathy, dysphagia of different etiology, CNS tumors, patients on chemotherapy, burns, support in patients in terminal conditions [18, 19].

Contraindications

Absolute contraindications for enteral nutrition

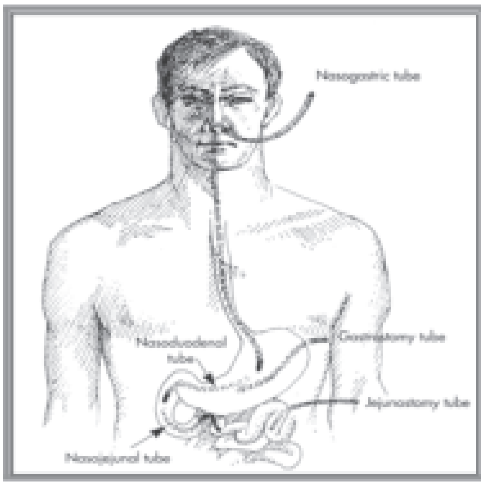

Figure 3: Presentation of possible sites of enteral application.

(and PN) are: shock conditions of any etiology, serum lactates (higher than 3-4 mmol/l), hypoxia (partial oxygen pressure less than 50 mm mercury column), and ethical issues.

Absolute contraindications for enteral nutrition when parenteral nutrition is possible are: intestinal ischemia, acute abdomen, acute abdomen, intestinal perforation, acute gastrointestinal bleeding, and mechanical obstruction.

Nutritional support in acute corrosive poisonings

Nutrition in the therapy of acute corrosive poisoning is one of the most important therapeutic procedures, which to a great extent contribute to more rapid healing of post-corrosive injuries in the upper gastrointestinal tract, stabilization of biological, immunological, and metabolic parameters, and reducing of hospital stay [20].

Some authors suggest intensive hyperalimentation of patients in the first 7 days after poisoning and do not recommend food intake by mouth during treatment since they think that it causes exacerbation of patients' condition. If the food is not taken, then food particles do not enter granulocytes of the esophageal wall and inflammation exacerbation is avoided [21, 22] (Table 1).

Table 1: Algorithm of post-corrosive damage in the wall of the injured organ (esophagus – stomach).

Injury	Time
Acute injury	Day 0
Inflamation, vascular thrombosis	1 to 7 days
Granular tissue	10 to 21 days
Fibrosis/stricture	3 weeks

Standardization of enteral nutrition in the treatment of acute caustic poisonings is imposed by the high incidence rate of acute suicidal poisonings with caustic agents and long-term therapy with unpredictable outcome. The entire treatment program of these patients is a significant burden for the medical and economic resources of our health care system, with concomitant impairment of the social security of the patients and their families. The actual problem with caustic poisonings in our country has shown that enteral supplementary or total nutrition is a method of choice in all patients with indication for nutrition and who have an active part of the gastrointestinal system. Data clearly yield advantages of enteral (EN) versus parenteral nutrition (PN) since EN enables natural (physiological) food utilization; it has a significantly smaller percentage of complications in comparison with PN; the economic effect is substantial; it is easily applied in domestic conditions thus leaving more free space in hospital capacities, and patients more easily re-socialize in their own families and neighborhood.

In October 2005 the European Society for Clinical Nutrition and Metabolism brought a consensual conclusion (ESPEN) for application of enteral nutrition, which comprised almost all indications for EN application. These conclusions can be also applied in treatment of patients with caustic poisonings. The small number of patients with caustic poisonings in the countries of the European Union is an obstacle for reaching complete conclusions.

Parenteral and enteral nutrition are indicated if normal food intake in patients is impossible.

Even 60% of patients who need nutritional support receive enteral nutrition [24]. Efficacy of enteral nutrition has been confirmed over the last few years and ESPEN has submitted evidence-based guidelines for the benefits and risks of enteral nutrition. ESPEN has constituted a working group consisting of experts in clinical nutrition. This group has reached a consensus on key issues related to indications, terminology, application, benefits and dangers originating from practicing nutritional support. In defining these solid guidelines, the expert group has complied with the internationally accepted suggestions of the Scottish Intercollegiate Guidelines Network (SIGN) for development and advancement of these norms. Actually, many of the guidelines discuss specific issues about duration, route of application and compliance with the current decisions for enteral nutrition. However, many questions are still open for discussion and have no relevant and confirmed explanations. The problems with undernutrition and starvation still have no explanation and present a controversy in the process of practicing artificial nutrition [23].

Advantages of enteral nutrition

Advantages of enteral nutrition are:

- preservation of intestinal mucous integrity;
- reduced possibility of bacterial translocation;
- maintenance of hepatic physiological processes;
- reduced possibility of septic morbidity;
- adjusted for easier application and monitoring;
- safer application;
- reduced hospital stay;
- it is much cheaper than parenteral nutrition;
- reduced number of hepato-biliary complications;
- preserved synthesis of visceral proteins;
- confirmed nutritional utilization;
- reduced number of ventilation complications;
- reduced number of fatal complications associated with central vein catheter;
- increased possibility for more effective energy expenditure;
- more efficient control of metabolic processes;
- more efficient water-electrolyte and biological monitoring.

Methods of artificial nutrition in acute caustic poisonings

Nutritional support in caustic poisonings can be: parenteral (in peripheral and central vein) and enteral (by naso-enteral tube or enterostoma).

Cubital veins in the elbow fossa are the most commonly used peripheral veins for administration of nutritional solutions and the duration of application cannot last more than 7-10 days. The most commonly used central vein is v. subcalavia and the administration might last more than 30 days [24].

Since parenteral route of administration of nutritional solutions in nutritional support of critically-ill patients including patients with caustic poisonings is associated with many complications and complexity in performing the entire procedure, it is less used. Thus, enteral feeding is the preferred method of nutritional support in patients with inadequate oral intake and intact gastrointestinal tract.

Enteral nutrition is done with specially designed tubes and stomas, which are most frequently made of silicon but they might also be made of polyvinyl chloride or polyurethane.

Nasoenteral tubes can be: nasogastric, nasoduodenal, nasojejunal. They are inserted under fluoroscopic or endoscopic control and they are suitable to be used when nutritional support is going to last a short period of time (up to 30 days).

Enterostomas can be: gastrostoma, jejunostoma, gastro-jejunostoma. They are inserted under laparoscopic or endoscopic control and they are suitable to be used for nutritional support that lasts more than 30 days [25].

The choice of feeding tube has to be in compliance with the comfort of the patient, site of application and limiting factors, such as: risk of aspiration, viscosity of the nutritional solution, functionality of the digestive system. Tubes are measured by the external diameter expressed in French measures. Tubes' lumen of 8F or bigger is suggested when fiber products and highly viscous solutions are given through enteroport pump. Tubes' lumen of 10F or bigger are used for giving bolus solutions. The size of nasal tubes is between 8 and 12F and they are usually well tolerated by adult patients. Tubes are inserted under radiographic or endoscopic control. Many types of tubes have radiographic markers for easier observation of their installation and location verification [26].

Enteral nutrition may begin 36-48 hours after

Figure 4: Patient with nasojejunal feeding tube.

admission of the patient in a hospital. Some authors recommend initiation of enteral nutrition even 24 hours after admission in patients with severe burns. Early enteral nutrition is also extremely important in the postoperative period for the motility of the small intestines, which is regained in 12-14 hours postoperatively, as well as for the gastric motility regained in 28-48 hours and for colon motility regained in 48-72 hours postoperatively. Therefore, it is recommended to combine early enteral nutrition with gastric decompression and feeding of patients by jejunostoma [27].

Figure 5: Patient with inserted gastrostoma.

Advantages of early enteral nutrition are: reduced possibility of septic morbidity and more rapid reactivation of immunologic processes in patients.

Prior to commencement of enteral nutrition, it is necessary to determine basal energy needs in patients using the standard Harris-Benedict equation corrected with the correction factors by Long. In this way, actual energy needs are obtained:

$$\text{BEN (men)} = 66 + 13\,\text{(body weight)} + 5\,\text{(body height)} - 6.7\,\text{(age)}$$

$$\text{BEN (women)} = 655 + 9.6\,\text{(body weight)} + 1.8\,\text{(body height)} - 4.6\,\text{(age)}$$

$$\text{AEN} = \text{BEP} \times \text{FA} \times \text{FD} \times \text{TF}$$

(where AEN is actual energy need, BEN is basal energy need, FA is a factor of activity, FD is a factor of damage and TF is a thermal factor).

The type of nutritional support in acute corrosive poisonings depends on the grade of post-corrosive injuries of the upper gastrointestinal tract. In injuries of grade I and II A 48-hour nutritional support is practiced with total parenteral nutrition in peripheral vein. If patients with grade I have no complications, they are dismissed to home care and patients with grade II A receive liquid diet for additional ten days until the phase of small vessels' thrombosis lasts [28].

In patients with grade II B and III injuries nill per os (NPO) status is conducted, or the so-called "esophageal rest" until the first endoscopic control (10-15 days). During this period, the patient is fed completely parenterally by peripheral or central vein, enterally by nasogastric or nasojejunal tube, and by gastrostoma or jejunostoma [22].

Esophageal rest may last until the 10th day after corrosive ingestion or some authors say until the 15th day, that is, until the first endoscopic control. Some authors recommend taking liquids 48 hours after ingestion if the patient can swallow his/her saliva [27].

Special attention has to be paid to nutritional support in patients who additionally develop acute renal insufficiency. It usually appears after poisoning with concentrated acetic acid and is a result of metabolic disorders, hypovolemia, infection, erythrocyte destruction associated with tubular necrosis.

In conditions like these, when there is an acute renal impairment, the patient needs specific nutrition because of the limited intake of liquids, amino acids, proteins, lipids and oligo elements. Therefore, the responsible doctor has to have a solid knowledge about clinical nutrition. He/she also has to collaborate with a

Figure 6: Patient with nasojejunal tube receiving enteral nutrition by enetroprt pump.

professional team consisting of clinical toxicologist, nephrologist and anesthesiologist for coordinated control of the patient's condition and for conducting nutritional support in line with strictly defined criteria.

Over the last several years, nutritional solutions have appeared on the market. They are specially adjusted for artificial nutrition of patients with renal function impairment.

Enteral nutritional support in patients with acute corrosive poisonings begins with 20 ml per hour and 500 ml per 24 hours. In the next three days it is increased to 60, that is, 80 ml per hour and 1500 ml per 24 hours. Until the 7th day, the administration is increased to 120 ml per hour and 2000 ml per 24 hours, which is a maximum amount of specially prepared solutions for enteral nutrition through inserted gastrostoma or jejunostoma for 24 hours. The eventual addition of calories is given per os or parenterally.

The new terminology used worldwide is prepyloric or postpyloric enteral nutrition, meaning methods of application of specially prepared nutritional solutions containing ideally mixed proportions of carbohydrates, fats, amino acids, oligo-elements, vitamins, electrolyte solutions, etc. either in the stomach or duodenum and jejunum [25].

In 2006, a consensus has been reached in all fields where clinical nutrition is being practiced, respecting the individual specifics and characteristics of medical areas that make use of enteral nutritional support.

Agreement has been reached on specific and debatable questions. It has been stated that inadequate nutrition in critically-ill patients leads to higher morbidity rate, longer hospital stay, poorer quality of life, delayed recovery and higher hospital costs [29].

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