# The role of nutritional intervention in negative pressure wound therapy in a patient treated by open abdomen method - case report.

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CASE REPORT

***Abstract*—Introduction: Wound healing process depends on many factors. As it has been proved many times before, nutrition is one of the key factors in wound healing therapy. When there is an insufficient supply of nutrients and malnutrition, wound healing processes slow down and the inflammatory phase is prolonged, which requires high energy expenditure and as a consequence, may lead to the loss of lean body mass and the development of sarcopenia and cachexia. This promotes the formation of non-healing chronic wounds.**

**In this paper we would like to emphasize the role of nutrition, as an integral part of wound healing processes, which should encompass the current metabolic needs associated with patient's clinical condition.**

**Case report: This case describes a young male patient with gastrointestinal tract insufficiency and an extensive postoperative wound treated by the open abdomen method. In the course of increased catabolism, water and electrolyte loss and disturbances as well as nutritional insufficiencies, body mass loss and progressive cachexia occurred in this patient and, as a consequence, the wound healing processes was significantly diminished.**

**Conclusions: Inducing and maintaining the anabolic processes in the organism and control of the enhanced catabolism in response to metabolic stress or injury are essential actions in optimizing the treatment and healing process. These are possible to achieve by the early introduction of balanced and individualized nutritional treatment regimens, provision of the energy and appropriate nutrients, which enables the restoration of lean body mass and stimulation of the healing processes.**

***Keywords*—negative pressure wound therapy, open abdomen, nutritional intervention, case report**

## I. Introduction

SYSTEMIC (metabolic) factors, e.g. malnutrition, can impair wound healing processes and promote the development of chronic wounds, so it is important not only to implement topical treatment, but also to limit the inflammatory process and provide metabolic and nutritional support for hospitalized patients. Increased cell proliferation, protein synthesis and enzymatic activity during the healing process as well as the accumulation of building substances requires energy expenditure. Malnourished patients, without tissue reserves, are at risk of inhibition of the healing processes with a prolonged inflammatory phase and the development of hard-to-heal wounds. During the course of such uncontrolled stress response to the organism, protein loss occurs resulting in a self-destructive, defensive reaction of the organism. This further leads to intensive consumption of lean body mass (LBM).[1–5] Due to the above-mentioned reasons, nutrition and the patient's nutritional status are of utmost importance for the initiation of proper healing processes and tissue regeneration.[6]

The aim of this work is to present how nutrition and nutritional state influences wound healing processes. The patient in whom the appropriate nutritional management was not implemented, in spite of a very intense surgical treatment, with numerous reoperations developed extreme cachexia with the arrest of wound healing.

## II. Case report

A 19-year-old male patient was admitted to the Intestinal Failure Center of the Poznań University of Medical Sciences on the 30th day following laparotomy and numerous reoperations due to appendicitis with perforation, interloop abscesses and peritonitis, with ileostomy formed. An open abdomen method was applied in the treatment of the postoperative wound (Fig. 1).

At the admission, the patient weighed 32.5 kg (BMI 10.4) and experienced an unintentional 41% body weight loss, what indicated extreme cachexia with significant risk of death.

The stoma exudate fluctuated between 1600-1900 ml/day. The patient was discharged from the surgical department with an indication to ingest numerous large meals and large quantities of fluids, what additionally enhanced stoma exudate and increased loss.

At the hospital admission, blood cultures indicated an alarm pathogen *Klebsiella pneumoniae* and the appropriate antibiotic treatment was implemented. During the 36-day stay at the department, complete parenteral nutrition was implemented, preceded by an exact assessment of patient's nutritional status. A composition of nutritional mixture was adjusted to patient's individual needs including an enhanced catabolism and intensive loss associated with significant discharge from the stoma and open, non-healing postoperative wound. Treatment plan is

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Figure 1. Patient's abdominal wound on admission - body mass 32.5 kg, 10.4 BMI

Figure 2. Negative pressure wound therapy applied in the first 8 days of hospitalization

Table I
NUTRITIONAL MANAGMENT PLAN

| | |
|---|---|
| Nutritional status assessment | NRS 5<br>SGA – C (severely malnourished)<br>involuntary loss 41% of initial body mass<br>blood tests |
| Energy and protein requirements assessment | Energy: 30kcal/kg bw/day<br>protein: 1,5g/kg bw/day |
| Form of energy supply type of formula | Total parenteral nutrition<br>- individual parenteral formula (All In One - AIO) |
| Oral feeding | Nothing by mouth and reducing oral hydration |
| Coverage of the energy requirements first days of parenteral nutrition (prevention of refeeding syndrome) | 1st day – only fluids with electrolyte, vitamins and trace elements;<br>2nd day - 50% of the basic daily requirements + additional fluids intake;<br>then gradually increase the energy value of the nutritional formula, up to 150-180% of patients' daily energy needs |
| Additional losses | Stoma output– additional supply of fluids and electrolytes.<br>Wound therapy by open abdomen method – additional supply 2g nitrogen/1l of intra-abdominal fluid secretion |
| Weight control and monitoring of nutritional status (min. 1x / week) | |

presented in table I. Negative pressure therapy was topically applied to the wound for the first 8 days - Fig. 2.

In the initial phase of treatment, the use of negative pressure wound therapy was associated with a number of technical problems and maintaining dressing tightness was fundamental. High volume of wound exudate and its character led to the penetration of exudate under the foil, detaching the adhesive foil and resulting in loss of tightness. In the situation when lack of tightness and infiltration of intestinal contents were observed and an immediate change of negative pressure dressing was not possible (absence of qualified staff at the moment of unsealing, the necessity to provide the appropriate abdominal wound dressings), silver dressings (Suprasorb A+Ag) were applied to the abdominal wound. The metabolic state of the patient became stable, his body mass increased up to 43 kg, stoma exudate was limited to 300-500 ml/day and the wound healing process significantly improved. Afterwards the patient was referred to the surgical department for further treatment.

Surgical treatment consisted of restoration of continuity of gastrointestinal tract, re-implementation of negative pressure therapy (NPT). NPT dressing was applied for 20 consecutive days. After obtaining good healing results the wound was closed with the use of a skin graft. Parenteral nutrition was continued, and afterwards partial and then complete oral nutrition was introduced, enriched in high-energy, high-protein immunomodulatory preparations. A very good tolerance was obtained. After 48 days of hospital stay at the surgical department the patient was discharged from the hospital in good overall condition, with BMI of 15.3, with indication to implement a gradual enrichment and modification of oral nutrition. Figures 3-4 show the scar on the day of discharge and after the following 3 months.

## III. DISCUSSION

Nutritional management should reflect actual needs of an organism and always be preceded by a thorough analysis of patient's nutritional status, which directly influences the course of treatment process. Since malnourished patients belong to the group at high risk of postoperative complications - optimal nutrition is considered as a key factor in maintaining wound healing process. The early assessment of nutritional status alongside with the implementation of nutritional treatment is paramount in order to cover all the deficiencies.

Large wounds lead to the development of a hypermetabolic state and increased catabolism driven by significant increase in nutritional and energetic demand of the organism.[1–3] Factors that should be taken into consideration include, above all, the choice of the administration route and also the optional formation of access to the gastrointestinal tract to facilitate

parenteral nutrition, with initial estimation of the level of coverage of the patient's daily energy expenditure. A risk of development of metabolic complications, such as refeeding syndrome, especially in extremely malnourished patients, should be taken into consideration. It is also essential to choose a nutrient mixture of optimal composition, adequate to the patient's current needs. Additional hydration is also very important, and so is the determination of total fluid volume and route of administration with estimation of the type and volume of fluids that are taken orally by a patient. Further nutritional management - the expansion and modification of indications depends on the level of tolerance and improvement of nutritional status and metabolic control in patient's organism.

The unintentional loss of more than 15-20% of lean body mass (LBM) in the period preceding 6-12 months disturbs and slows down the wound healing process, this is because the processes of LBM recovery are a priority at that time. On the other hand, the unintentional loss of more than 30% of body mass favours the formation of spontaneous wounds such as pressure sores and can facilitate wound dehiscence; it is also associated with a complete arrest of healing processes until at least partial recovery of LBM occurs. A 40% decrease of LBM is associated with high risk of pneumonia and death. The above facts prove that the course of treatment is directly associated with the level of LBM loss.[1, 6, 7]

Clinical situations which should be taken into account when assessing the risks for developing malnutrition includes: catabolic stress in response to injuries, surgical procedures, wounds, infections, chronic diseases, non-healing open wounds, intestinal fistulae, gastrointestinal tract insufficiency with malabsorption.[1] In this case one of the mistakes in treating the patient was the fact that oral nutrition was introduced too early, with concomitant gastrointestinal tract insufficiency and heavy stoma exudate. Contraindications of enteral nutrition are: long-term gastrointestinal tract insufficiency for example following a broad resection of the small intestine – short bowel syndrome, intolerance of enteral nutrition, significant increase in fistulae/stoma exudate. In such situations the introduction of enteral nutrition can damage the surrounding tissues, worsen the healing ability and, most importantly, can worsen water and electrolyte disturbances.[8]

If the patient is cachectic due to malnutrition, we begin our nutritional intervention with partial energy supply (50% of daily energy expenditure), calculated on the basis of energy requirement of 30-35 kcal/kg bodyweight and protein requirement at the level of 1.5-2 g/kg bodyweight. These allow us to optimally support the inflammatory response of the organism whilst minimising the risk of metabolic complications described above. Additionally, in patients treated by the open abdomen (OA) method, increased protein loss associated with increased catabolism and the exposure of internal organs should be taken into consideration. Due to this, the addition of nitrogen balances out the loss of 2g of nitrogen with each litre of intra-abdominal fluid released.[9] Skin regeneration includes at least 2 processes which requires protein as a substrate: cell proliferation (mainly fibroblasts) and the synthesis of protein – collagen. All the cell structures are made of protein, so its

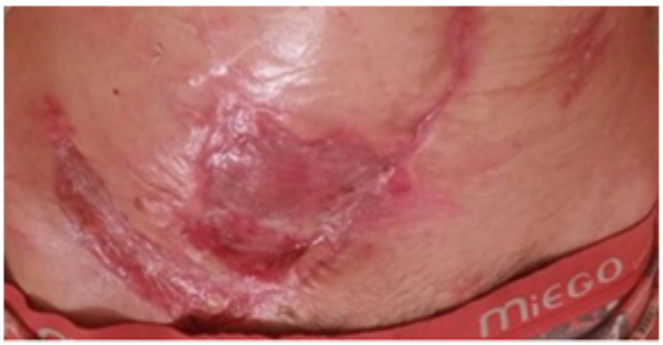


Figure 3. The state of wound healing - on the day of discharge (84th day since admission) - weight 47,5 kg, 15,3 BMI

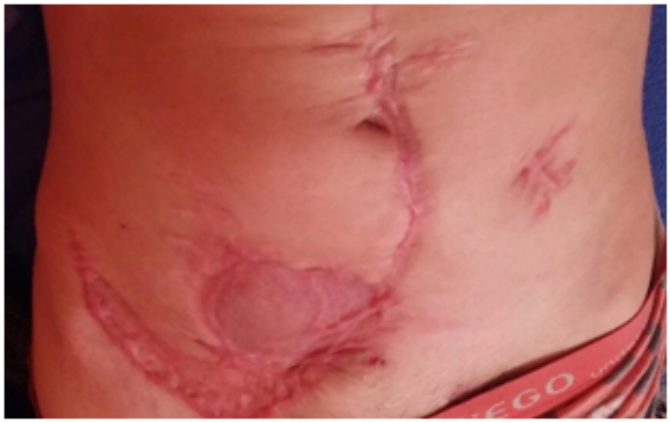

Figure 4. The scar following 3 months after discharge from hospital - weight 54 kg, 17.6 BMI

synthesis is essential to tissue damage repair and constitutes active metabolic factors that are indispensable for the survival of the organism, among others, in the situations of increased catabolism. However, it should be remembered that even in the case of considerable protein demand, an organism has limited absorbing capabilities, unless the anabolic activity is increased.[1, 2]

Apart from protein, the supplementation of additional water and electrolyte loss is also taken into account. In case of a patient with short bowel syndrome, intravenous hydration is recommended. The volume of fluids administered by mouth is individually adjusted based on the amount of stoma exudate or the presence of concomitant diarrhoea – in such cases isotonic fluids are indicated, because unlike hypotonic fluids, they do not increase electrolyte loss due to the intensification of release. The remaining non-protein energy supply consists of fats that cover 30-50% of the demand. Medium-chain triglycerides (MCT) and carbohydrates – 50-70% are particularly recommended, depending on patient's actual needs. It should be remembered as well that glucose is the main source of cellular energy.[10, 11]

Numerous papers concerning the perioperative care confirm the legitimacy of introducing nutritional intervention before the implementation of surgical treatment. Patients who are prepared for the procedure, respond better to metabolic stress

and postoperative catabolism. Our aim is to prevent lean body mass loss, as well as to improve patient's nutritional status according to ESPEN guidelines,[12] even if it is associated with postponing the date of non-urgent surgery. Evident advantages are also observed in healing of postoperative wounds. It is recommended to include the nutrition approximately 7-10 days prior to the operation and to continue it after the procedure.[12]

In case of patients who, as the man described above, suffer from gastrointestinal tract insufficiency developing as a consequence of broad intestinal resections, numerous complications are expected, such as chronic diarrhoea, water and electrolyte disturbances, dehydration, body mass loss and nutritional deficiencies that usually lead to cachexia. Monitoring mainly the level of $Na^+$, $K^+$, $Mg^{2+}$, $Ca^{2+}$, $P^{3-}$, $Fe^{2+}$, vitamin B12 and fat-soluble vitamins is extremely important.[13] In such case maintaining oral administration of food, if possible, usually serves as a supplement of parenteral nutrition. It should be remembered that oral nutrition must be introduced when there is a metabolic balance and, at the same time, the stoma exudate has been limited to the volume of up to 1000 ml/day. Meals should be introduced gradually, at the beginning with small portions of 150-250 g, of quite dry consistency, easily assimilated, acting to slow down the passage of intestinal content, mainly based on rice, starch and wheat flour prepared in different ways. High-energy commercial preparations of possibly low osmolarity – complete in terms of nutrition and/or high in protein are also administered, as well as preparations that are enriched in ingredients with anti-inflammatory-immunomodulatory activity, what has a particularly beneficial effect during the postoperative period or the healing process.

Guidelines confirm the role of enteral nutrition as a factor associated with earlier fascial closure, better healing of postoperative wound and also reducing the risk of fistula formation.[14, 15] In case of patients treated by OA method, the advantages of the introduction of enteral nutrition between the 36th hour and the 4th day after the laparotomy (regardless the stage of fascial closure) were proved, but the scope of the performed operation and the stage of dysfunction of gastrointestinal tract were also considered.[16–18] The above-mentioned beneficial effect is observed only at the supply of 20% of daily energy requirement (the so-called trophic nutrition). So despite the fact that in the described case enteral nutrition in the early postoperative period was risky and caused the development of cachexia due to gastrointestinal insufficiency, it is recommended to introduce enteral nutrition as soon as possible, once the appropriate tolerance was gained.

Negative Pressure Wound Therapy (NPWT) is currently a well-recognised method of wound treatment, including the method of open abdomen, whereas the aspect of nutrition and the problem of malnutrition in the context of wound healing are often described and scientifically proved facts. However, only two papers from the Brooke Army Medical Center of San Francisco in Texas present the analysis of the content of wound exudate based on their own studies. The analysis shows the loss of protein and microelements (vitamins and trace elements) which should be taken into account in the adjustment of nutrition during negative pressure wound therapy. The authors conducted the studies in patients treated by the open abdomen method and patients with soft tissue damages treated by NPWT. As it was demonstrated, there is a considerable protein loss with exudative fluid. There is no significant difference in total protein concentration in exudative fluid from various types of wounds; the degree of protein loss can be assumed to be 2.9 g/dl in exudative fluid, what gives 12-25 g of protein/day according to the currently accepted ratio.[19, 20]

Significant differences were observed, depending on the type of wound, in the level of vitamins A, C and E as well as ions: Zn, Cu and Fe. Microelement content in exudative fluid is similar to its content in blood serum and microelement loss depends on the volume of fluids released by the wound. The prolonged microelement loss with wound exudate, not compensated by the additional supply, can lead to deficiencies, especially in patients with open abdomen, in whom the total exudate volume is large.[20]

Deficiency of essential microelements can also be enhanced by a severe stress reaction or protein and energetic malnutrition. Microelements are essential for proper cell functioning so only their increased supply can prevent the deficiencies.[1] Vitamins and trace elements take part in the healing process where they play a key role in the stimulation of healing processes, among others, they stimulate the synthesis of collagen and other proteins that are essential in the processes of regeneration and recovery. The vitamins and microelements include, among others, vitamins A and C as well as zinc, copper, manganese. The supply of the individual microelements is not precisely determined for the state of metabolic stress in the course of wound healing process, but in the available data there is a dose constituting even 5-10 fold of the recommended daily allowance (RDA), until the achievement of metabolic control.[1, 2]

Additionally, when minimising the risk of infection and taking into consideration the anti-inflammatory activity it is worth considering the supply of immunomodulatory ingredients, whose effectiveness was confirmed particularly in wound therapy. Those ingredients include: glutamine, arginine, omega-3 fatty acids and nucleotides. They have a favourable effect on immunological response in the states of metabolic stress of an organism (such as, among others, an injury, pressure sores, burns, a large surgical procedure or mild sepsis), by the actions that modulate the activity or the results of activation of immune system. A favourable immunomodulatory action is also attributed to such ingredients as the above-mentioned: copper, zinc, iron, vitamins B2, B6, C and E. Immunomodulatory ingredients can be added both to the mixtures intended for nutrition via the gastrointestinal tract (oral or enteral) and for parenteral nutrition.[21–25]

It has been proved that the use of mixtures of nutrients with immunomodulatory action diminishes the risk of infection and shortens the total duration of hospital stay. Particularly favourable effects were achieved among the patients with concomitant malnutrition, compared to the well-nourished patients. The choice of an optimal composition of the mixture - the appropriate nutrients, as well as the dose and the total period of supply, is crucial.[26–30] A group of patients to whom the immunomodulatory nutrition is not recommended includes

critically ill patients with severe sepsis and the patients in the state of a fully developed shock.[27–29]

## IV. Conclusion

During wound therapy it is important to consider the patient as a whole, without restricting to local factors only. The aim of this paper was to raise the awareness concerning the complexity of healing and the amount of expenditures of the organism that are necessary for the proper course of healing. Nutritional treatment and the appropriate management in this field are often an underestimated part of patient therapy in many centres. An organism which is not under metabolic control is unable to respond appropriately to the treatment implemented.

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