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THE SCIENTIFIC RATIONALE FOR NUTRITIONAL THERAPY IN CARDIAC SURGERY IC

The graduate thesis of the Master’s degree study programme “Advanced Nursing Practice” (state code 6211GX008)

Tutor of the graduate thesis
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TABLE OF CONTENTS

ABSTRACT.................................................................3
ABBREVIATIONS........................................................5
INTRODUCTION.......................................................6

1. REVIEW OF LITERATURE
   1.1. Rational for nutrition therapy after cardiac surgery........7
   1.2. Enteral nutrition...........................................11
   1.3. Parenteral nutrition........................................13
   1.4.1. Nutritional assessment..................................19
   1.4.2. Nutritional requirement...............................20
   1.5. Catabolic process after surgery............................21
   1.5.1. Pathophysiology.......................................22
   1.6. Assessment of catabolism before surgery..................24
   1.7. Energy requirements in critically-ill patient..............25
       1.7.1. Assessment method of energy requirements in critically-ill patient........26

2. ORGANISATION AND METHODOLOGY OF A RESEARCH...........35

3. RESULTS..........................................................35

4. DISCUSSION OF RESULT...........................................38

CONCLUSIONS.....................................................39
PRACTICAL RECOMMENDATIONS......................................40
LIST OF LITERATURE SOURCES.....................................44
ANNEXES....................................................................44
DECLARATION OF THE AUTHOR’S CONTRIBUTION AND ACADEMIC HONESTY.45
ABSTRACT

Anchana Satheesan Letha. The scientific rationale for nutritional therapy in cardiac surgery ICU. The graduate Master’s thesis. The tutor-PhD MD Milda Švagždienė. Medical Academy, the Faculty of Nursing, Kaunas, 2019; 46p. Nutrition is the process of providing or obtaining the food necessary for health and growth, nourishment or energy that is obtained from the food consumed. The nutrients include protein, carbohydrate, fat, water, vitamins, and minerals. The nutrition support is increasingly recognized as a clinically relevant aspect of the intensive care treatment of cardiac surgery patient. The nutritional supplement is a simple and safe measure to improve the outcome in high-risk patients who are under-going cardiac surgery help to reduce post operative infection and ensure early prognosis. Nutrition is considered as the admissible cornerstone for the post-operative patient after cardiac surgery because after surgery patient is considered as terminally ill. Nutrition support is a necessary therapy for critically ill cardiac surgery patients. However, conclusive evidence for this population, consisting of well-conducted clinical trials is lacking. Nutritional and metabolic support introduced for terminally-ill patients in the last decade Enteral Nutrition (EN) and Parenteral Nutrition (PN) specific nutrients to modulate system and organ function. AIM:* To find the optimal nutrition regimen for the patient after cardiac surgery. GOALS:* To analyze the recommendations on patient nutrition after cardiac surgery. *To analyze and compare different regiments of nutrition in patients after cardiac surgery. *To create the optimal nutrition plan for the patient after cardiac surgery. METHOD:* This study conducted by analyzing around 40 literature reviews from 2009 to 2019. RESULT:* A 53 years old male admitted with heart failure occlusion of anterior inter-ventricular coronary artery. His condition deteriorated and invasive hemodynamic measurements showed deterioration of heart function: CI 1.74 → 1.21; mean pulmonary artery pressure 32 → 46 mmHg, left atrial pressure 20 → 23 mmHg. His condition became worse and he was scheduled for left ventricle assist device implantation surgery under standard general endotracheal an anaesthesia induction with fentanyl, propofol, rocuronium. Anesthesia was maintained with isoflurane. Cardiopulmonary bypass (CPB) duration was 93 min. Post –operative period was complicated by respiratory failure due to ARDS and pneumonia with the need of prolonged artificial lung ventilation. As the patient was haemo-dynamically stable on the third post-operative day clear fluids were started and well tolerated through the nasogastric tube (200 ml of clear water 3x/d) and PN (Kabiven 20 ml/hour) and I/V supplements like Dipeptiven (Amino-acid solution for parenteral nutrition containing dipeptide alanyl-glutamine), Addamel-N(Trace element additive for parenteral nutrition in adults) are started. Later on EN was increased 10 ml every 12–24 hours if it was tolerated well. When left on spontaneous ventilation patient quickly deteriorated, because of shallow breaths and tachypnea due to inadequate muscle strength.
It was decided to perform tracheotomy and proceed with nutritional support (EN+PN supplements). On the day 18 EN was gradually increased up to 90 ml/hour, but the patient had diarrhea and EN nutrition was stopped. On the day 19 it was restarted at the rate 20 ml/hour and gradually increased up to 60 ml/hour on the day 25. Albumin concentration in blood plasma was monitored to evaluate patient status and efficacy of nutrition.

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<tr>
<th>Dates</th>
<th>15.2.2019</th>
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<th>5.3.19</th>
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<tr>
<td>Albumin in blood plasma</td>
<td>35g/l</td>
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SUMMARY Early nutritional support is very important after surgery with EN and/or PN nutritional intake to reduce surgical stress, maintain physiological functional capacity, and facilitate post-operative recovery of function. Inflammatory response and postoperative complications are predictable due to poor nutritional status. Before surgery, BMI and plasma albumin concentration should be considered. Early enteral and parenteral nutrition is a feasible method for the administration of artificial nutrition in cardiothoracic ICU. More research is also needed to assess the effect of intensive nutrition support on functional outcomes in this cohort of critically ill patients. This case report shows the living proof of the gradual improvement of the patient with nutritional therapy.

ACKNOWLEDGEMENTS:-
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# ABBREVIATIONS

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tr>
<td>EN</td>
<td>Enteral Nutrition</td>
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<td>PN</td>
<td>Parenteral Nutrition</td>
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<tr>
<td>CK-MB</td>
<td>Creatinine Kinase (Muscle &amp; Brain)</td>
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<tr>
<td>BIS</td>
<td>Bio-electrical Impedence Spectroscopy</td>
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<tr>
<td>CABG</td>
<td>Cardiac Pulmonary Bypass Grafting</td>
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<tr>
<td>CPB</td>
<td>Cardiac Pulmonary Bypass</td>
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<tr>
<td>CRP</td>
<td>C-reactive Protein</td>
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<td>CT</td>
<td>Computed Tomography</td>
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<td>FO</td>
<td>Fish Oil</td>
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<tr>
<td>ICU</td>
<td>Intensive Care Unit</td>
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<td>IL</td>
<td>Interleukin</td>
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<td>MNA</td>
<td>Mini Nutritional Assessment</td>
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<td>MST</td>
<td>Malnutrition Screening Tool</td>
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<td>NRS</td>
<td>Nutritional Risk Score</td>
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<tr>
<td>PCT</td>
<td>Pro calcitonin</td>
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<tr>
<td>SIRS</td>
<td>Systemic Inflammatory Response Syndrome</td>
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<tr>
<td>VAD</td>
<td>Ventricular assist device</td>
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<tr>
<td>RCT</td>
<td>Randomized Controlled Trial</td>
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<tr>
<td>NT</td>
<td>Nutritional Therapy</td>
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<tr>
<td>SNAQ</td>
<td>Short Nutritional Assessment Questionaire</td>
</tr>
<tr>
<td>NR</td>
<td>Nutritional Reverse</td>
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<tr>
<td>PPN</td>
<td>Peripheral Parenteral Nutrition</td>
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<tr>
<td>TNF</td>
<td>Tumour Necrosis Factor</td>
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<tr>
<td>WBC</td>
<td>White Blood Cell</td>
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<tr>
<td>TPN</td>
<td>Total Parenteral Nutrition</td>
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<tr>
<td>NPO</td>
<td>Nill Per Oral</td>
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<tr>
<td>DI</td>
<td>Dietery Intake</td>
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<tr>
<td>BMR</td>
<td>Basic Metabolic Rate</td>
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<tr>
<td>BMI</td>
<td>Body Mass Index</td>
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<tr>
<td>EE</td>
<td>Energy Expenditure</td>
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<tr>
<td>ERAS</td>
<td>Enhanced Recovery After Surgery</td>
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INTRODUCTION

Nutrition is the process of providing or obtaining the food necessary for health and growth. Nutrition is nourishment or energy that is obtained from the food consumed. The nutrients include protein, carbohydrate, fat, water, vitamins, and minerals. The nutrition support is increasingly recognized as a clinically relevant aspect of the intensive care treatment of cardiac surgery patient. The nutritional supplement is a simple and safe measure to improve the outlook in high risk patients who are undergoing cardiac surgery help to reduce the post-operative infection and ensure the early prognosis. Nutrition is considered as the admissible cornerstone for the post operative patient after cardiac surgery because after surgery patient is considered as terminally ill(1). Nutrition support is most germane of intensive care treatment of cardiac surgery. Even though affirmation from adequate large scale studies estimated its clinical significance for patients short to long term outcomes remain exiguous. Assess nutrition support as an important component in the peri-operative treatment of patient after cardiac surgery steered us to analyze our knowledge of the metabolic response to the inflammatory process induced by cardiac surgery. Although, How to recognize patient who need nutritional support? How can provide the nutrition? When to start the nutrition therapy? The importance of enteral and parenteral nutrition in critically ill patient. Researchers and clinicians face scarcity in evidence. Nowadays, the debate on the use of artificial nutrition (AN) in critically ill patients is a hot topic. In fact, many controversies still remain on several aspects of nutritional support of these patients, e.g., when to give, quality and quantity of macronutrients, safety, occurrence of complications, and route of administering(2). To provide effective surgical care to an elderly population, the impact of ageing on the physiologic and psychological performance of the individual patient must be understood. Ageing is associated with declining physiologic reserves and an increased susceptibility to disease. Many physiological activities occur near the critical threshold of failure. Reserves that may be needed during surgical stress are not present, which predisposes to organ system failures(2,3). Discuss how to identify patients who may benefit from nutritional therapy, when to initiate nutritional interventions, present evidence of enteral and parenteral nutrition potential role in patients cardiac surgery(3). Patients undergoing cardiac surgery regularly experience an inflammatory systemic response that contributes to acute and persistent injury to the organ. The incidence of comorbidities and malnutrition increases with an increasingly older population undergoing increasingly complex cardiosurgical procedures. Nutritional status and adequate nutritional therapy are key factors that contribute to patient outcome(4).

AIM

To find the optimal nutrition regimen for the patient after cardiac surgery.
GOAL

- To analyze the recommendations on patient nutrition after cardiac surgery
- To analyze and compare different regiments of nutrition in patients after cardiac surgery
- To create the optimal nutrition plan for the patient after cardiac surgery

Rational for nutrition therapy after cardiac surgery

Patients after cardiac surgery prone to get systemic inflammatory response majority of older people commonly face surgical procedures, the incidence of co-morbidities and malnutrition increases. The nutritional status and optimal nutrition are the substantial part of the causatum of the patient. This study help notify or understand the rational or importance of optimal level of nutrition after cardiac surgery. The consequences of nutrition and inflammatory response of body due to less nutrition, chain-reaction of nutrition we can discuss in this study. We can present nutritional status, and highlight how to implement in the daily routines of the patient in the hospital and follow-up practices. Nutrition is considered as the essential part to get considerable result after cardiac surgery. Deficiency in nutritional status will lead to the inflammatory response in the body due to feeble defense mechanism and metabolic reverse in the hospital atmosphere. Malnourished patients are more susceptible to the surgical trauma, anesthesia-related complication, hemodilution as well as inflammation. Under nutrition increases the chances of endothelial dysfunction of gut mucosa, which leads to the possibility of bacterial transport and further infection. Prior malnutrition will increases the chances of adverse effect like infection, Because NPO before surgery and delayed nutritional support in post op period. Patient after cardiac surgery conventionally under-going systematic inflammatory process, in consequence of surgical injury. Systematically, elder population facing complex cardio-surgical procedures, they are already prone to get infection due to aging, decreased immunity power, under-nutrition. These circumstances make us to discuss about the relevance of early nutritional support to the post-op cardiac patients. Post-op cardiac patient used to get systemic inflammatory response which evidenced as fever, increased WBC count, fluid collection, redness over the incision site, altered cardiac rhythm etc. These signs and symptoms reveals the systemic inflammation response after cardiac surgery. Heart is the vital organ so the small variation from the normal will course severe complications. The surgical incision instigate the action of WBC, platelets, and the excretion of the agents which the inflammatory responses, for instance tumor necrosis factor alfa (TNF), diverse interleukins (IL). The antigen for e.g. stent, pace maker, which steered to the invigoration of the cellular components like platelets and WBC, inflammatory mediators like TNF, IL-1, IL-6, IL-8. Mechanisms include impaired nutrient absorption as a result of inflammation or
surgical resection, reduced nutrient intake as a result of poor appetite (Bannerman et al., 2001) or food avoidance, increased gastrointestinal losses, drug-nutrient interactions and increased nutritional requirements as a result of inflammation (Gerasimidis et al., 2011; Lomer, 2011)(2)(34). Surgery causes an inflammatory response to cure tissue damage, but the same predispose-inflammatory response poses patients for infection development. Surgical patients usually only receive clear fluids during the period leading up to surgery and the day-after surgery leading to patient hunger over a longer period of time. Fasting may induce thirst, stress, insulin resistance and deficiencies in nutrients that may impair immune defense. Since most surgical patients are already in a catabolic condition prolonged fasting after surgery will impair recovery(3). Patients undergoing heart surgery are regularly exposed to significant systemic inflammation, resulting in injury to the organ and dysfunction. Cardiopulmonary bypass (CPB) triggers systemic inflammatory response syndrome (SIRS) with release of reactive oxygen species (ROS) and reactive nitrogen species (RNS). This often leads to serious life-threatening complications with physical capacity loss associated with prolonged critical disease, which can negate any benefit from the correction of the original underlying heart disease. Such patients need aggressive, life-sustaining therapies to promote organ recovery and advantage over the medium to long term outcome(1)(2)(3). It is known that cardiac surgery with myocardial ischemia / reperfusion and CPB use is associated with deleterious effects due to the inflammatory response during cardiac surgery. CPB time duration correlates with inflammatory response extent. In addition, surgical trauma, ischemia / reperfusion and contact activation with the CPB circuit result in the release of predominantly pro-inflammatory markers, reactive oxygen species and reactive nitrogen species that contribute to organ dysfunction development(2)(4)(8). These inflammatory response showed in the Fig.1. Patients undergoing heart surgery have a complex systemic inflammatory response syndrome that manifests as pyrexia, tachycardia, leukocytosis, hypotension, edema, and organ failure. During and after cardiac surgery, several stimuli lead to systemic inflammation reactions. The surgical trauma leads to the activation of neutrophils, endothelial cells and platelets and the release of inflammatory response mediators such as α (TNFα) tumor necrosis factor and various interleukins (IL)(1,2). During cardiopulmonary bypass (CPB), foreign surface contact results in the activation of cellular components such as leukocytes and platelets(3,4) and activates additional humoral mediators(4). Although the inflammatory response to cardiac surgery shares mechanisms with that observed in septic patients, the post-operative inflammatory response is more predictable, with the release of pro-inflammatory markers and reactive oxygen species being the main feature. The pre-operative period can therefore be an attractive time window for optimizing nutritional status, correcting deficiencies, and enhancing mechanisms of immune defense before surgery. This
is a particularly effective time to respond to modifiable risk factors and potentially reduce the risk of intra-and post-operative complication (2).

"The changes of biological active agents during inflammatory process

(eg.fig.1)

Under nutrition is the fast or very slow reason for inflammatory response. Nutritional imbalance before or after surgical procedure brought to slow prognosis for the patients. Deficiency in nutrition directed to the patho-mechanism of infection on account of altered defence mechanisms, metabolic reverse and body response etc. Nutritional support help the fast post-op outcome by different causes like *Increase metabolism* *Activate the digestive system and renal function* *Diminished post op dilemma* *Enhance wound healing* *Strengthen-out the body by optimize nutrition* *(3)(8)(13)* Heart medical procedure with myocardial ischemia/reperfusion and utilization of CPB is known to be related with pernicious outcomes, coming about because of the provocative reaction amid cardiovascular medical procedure. The span of CPB time connects with the degree of the provocative reaction. Besides, careful injury, ischemia/reperfusion, and contact actuation with the CPB circuit result in the arrival of fundamentally professional incendiary markers, responsive oxygen species, and receptive nitrogen species that add to the improvement of organ broken- ness. In this setting, the utilization of pharmaco-supplements, which may apply explicit impacts on digestion, the provocative reaction, markers of oxidative pressure, and safe cell movement, are of extensive intrigue *(1)(36)*. The amino acids glutamine and arginine, lipids, for example, omega-3 unsaturated fats, micronutrients, for example, selenium and zinc, or nutrients A, C, D, and E, are instances of such key supplements. Regardless of hypothetical guarantee, a few huge scale clinical preliminaries including these supplements had baffling outcomes in the general
ICU understanding populace (2). Substantiation randomized clinical study of controlled trials surveying the hospital implication of an early starting of nutritional therapy in the terminally ill patients after surgical procedure still sporadic. On account of, we conducted a systemic literature review on nutritional protocols for instance decreased caloric feed, liquid diet, semi-solid, restrictions of some diet, and so on in terminally ill patients after cardiac surgical procedure. The PICO system is the composition for the patient’s problems, interventions, comparison and outcome. Population:- terminally ill, adult patient after cardiac surgical procedure, Intervention and comparison:- routine rules for nutritional support like TPN, EN, and break the NPO as early as possible Outcome:- The prognosis of patients after surgical procedure (1) Type of studies: - Prospective or reflective perception studies, randomized or non-randomized clinical trials, systematic review of literature and more analyses. Medical subject heading used for find-out most suitable word Database of abstracts of reviews of effect, Medical literature review are searched

- “The low evidence received from rather small studies with from heterogeneous patient population with different nutritional intervention and non-comparable outcome assessment
- The resulting need for adequate studies and
- The urgent need for specific guidelines for this cohort of critically ill patients, as current clinical practice may lead to malnutrition in these patients.”

Mainly in hospital atmosphere, small interest put to provide nutrition rich diet. Late supply of nutrition in post op period: - duration of procedure, under anesthesia, NPO before and after procedure, restriction of some diets, delay in starting of nutrition, and so on (1) “The European Society for Clinical Nutrition and metabolism as well as the American society for clinical nutrition and metabolism recommended the initiation of enteral nutrition within 24 hours after surgery and a supplementation of 25-30 kcal and 1.5-2.5 gm of protein per day and kilogram ideal body weight for critically ill patient.” (2)

Rahman et al. suggest a eventual monitoring of an international nutrition survey in terminally ill patient’s department all over The world out the adequate nutritional requirement was low including protein and energy provided to the patient’s after this life saving major surgical procedure. As well as, their study concluded that post-op cardiac patients suffering autogenic nutritional deficiency on account of decreased nutrition support after the procedure (7)(8)(9). One scientific study with 787 post-op cardiac patients who were in the critical care unit stay more than 3 days, the observer found that 40% of patients not received nutritional support while they are in that unit. Patient who getting EN was 2.3 +/- 1.8 days. Patients received EN+PN decreased amount than required. In addition that, patients in ICU (medical or surgical) unit receiving decreased nutritional support, which
revealed that the importance of the adequate supply of nutrition for the better outcome (7). After these all scientific observation and study concluded that nutritional adequacy is the total required protein and energy required from the EN+PN and the medication advised according to the baseline assessment and expressed as percentage. In this study shows that nutrition support less than the required after the post op period (4). Malnutrition is commonly seen in elderly people with heart failure and associated with higher mortality; therefore, it is a problem requiring a solution. Poor nutritional status may also be associated with catabolic state and muscle waste known as "sarcopenia" and is reported to be a predictor of long-term survival following cardiothoracic surgery. We have previously reported that poor nutritional status is associated with muscle wasting and is a predictor of post-cardiac surgery delay in functional recovery (4). Cardiac surgery can cause a further decline in nutritional status due to postoperative catabolic reaction and a decrease in dietary intake (DI). Previous studies revealed that in the perioperative period about 0.90 g/dL of serum albumin was lost. While it remains unclear whether this significant decline in albumin is due to poor nutritional status or surgical catabolic reactions, postoperative DI is thought to be reduced due to loss of appetite or lack of taste. A previous study found that 58% of patients reported loss of appetite in the hospital after cardiac surgery and complained about dysgeusia that might result from anesthesia or mechanical ventilation (4)(8)(9). Quadriceps muscle ultrasound is an easy-to-use and readily available tool for measuring muscle mass and determining muscle and fat tissue changes. Computer tomography (CT) is also an established tool for analyzing body composition, although it is more expensive, not risk-free, and difficult to access (21). Recently, the validity of bioelectric impedance spectroscopy (BIS) calculating fat-free mass from body water measurements has shown promising results in determining cardiac patients’ nutritional reserve (23). A low bioelectrical impedance preoperative phase was associated with malnutrition and increased risk of adverse postoperative events. In a recent clinical trial, in cardiac surgery ICU, peri-operative nutritional therapy was administered to increase the ratio of myocardial and plasma arginine / asymmetric dimethy-larginine and other amino acids. At the beginning and end of cardiac surgery, the investigators showed an increase in inflammatory cells in the cardiac tissue, while peri-operative supplementation during surgery did not affect myocardial inflammatory response (3)(5)(7). In hospital experiences, metabolic requirements, diabetic control, electrolyte balancing altogether help in the nutritional support. Required nutritional support different individuals. According to the physical condition we can supply nutrition by varying roots EN and PN (8)(9)(11).
Enteral nutrition

Enteral administration is food or drug administration via the human gastrointestinal tract. Enteral administration involves the esophagus, stomach, small and large intestine.

Types of enteral feeding

Nasogastric tube—Start from the nose and end in the stomach
Orogastric tube—Start from the mouth and end in the stomach
Nasoenteric tube—Start from the nose and ends in the intestine

Indication of enteral nutrition

Enteral feeding indicates nutrition taken through the mouth or through a tube that goes directly to the stomach. A person on enteral feed usually has a condition that prevents them from eating a regular diet by mouth, but their GI tract can still function. Enteral feeding may constitute all of their caloric intake or may be used as an addition. (5),(12) Enteral nutrition (EN) is the most physiologic method of administering artificial/supplementary nutrition. Early EN has been shown to have beneficial effects on the patient's immune-competence, as well as on intestinal integrity and motility (13),(15). Furthermore, there is a more efficient utilization of nutrients and a better glucose homeostasis. Biliary secretion and emptying of the gall bladder is maintained. Splanchnic blood flow may increase. Even in critically ill patients it therefore seems reasonable to start EN early, if possible. EN was started either on the first postoperative day, or when it became obvious that the patient would remain on artificial ventilation for several days (12). The patients were sedated and the enteral feed was delivered by a pump device in a nasogastric tube. Administration time was 20 hours/d. Gastric residual volume was assessed daily. Enteral feeding was started at 10-20 ml/h and increased by 10 ml/h each day (5)(3). If patient can't eat enough calories to meet your nutritional needs, tube feedings may become necessary. This can happen if patient can't eat physically, can't eat safely, or if the caloric requirements are higher than patient's eating ability. Patient are at risk of malnutrition, weight loss, and very serious health problems if patient can't eat enough. For a variety of reasons, this may happen. Some of the underlying reasons for enteral feeding include: a stroke that may impair swallowing ability, cancer that can cause fatigue, nausea, and vomiting that makes it difficult to eat, critical illness or injury that reduces energy or eating ability, failure to thrive or eating incapacity (6). After surgical procedure provide nutritional support will help to improve the nutritional status and protein energy needed catabolic process. Monitoring of intake and output chart after surgery, this close observation helps to identify the patient's daily needs, any decrease in intake rate
leading to increased nutrition intake will help avoid further complications after surgery, and help in early prognosis and discharge. EN should start after being hemo-dynamically stable. The magnitude of the metabolic response depends on many factors including the extent of the surgical trauma, the pre-operative nutritional status of the patient, his age, and post-operative complication. Metabolic changes following open-heart surgery follow the usual pattern of injury. The post-operative nutritional status and metabolic balance would appear to be significant factors in the patient's recovery from pre-operative disease, surgical procedure, and any post-operative complications. A study by Flordelis Lasierra et al. including cardiac surgery patients with hemodynamic failure (dependence on two or more vasoactive drugs and/or mechanical circulatory support), EN was supplemented with a mean energy delivery 1228.4 kcal/day over a mean of 12.3 days. The mean energy target was achieved in 15 patients (40.4%). The most common EN related complications were constipation, where no case of mesenteric ischemia (Mesenteric ischemia is a medical condition in which injury to the small intestine occurs due to not enough blood supply) was detected, further supporting the feasibility and safety of EN in these patients.

Possible complications of enteral feeding

There are some complications that can occur as a result of enteral feeding. Some of the most common include:

- aspiration, which is food going into the lungs
- refeeding syndrome, dangerous electrolyte imbalances that may occur in people who are very malnourished and start receiving enteral feeds
- infection of the tube or insertion site
- nausea and vomiting that may result from feeds that are too large or fast, or from slowed emptying of the stomach
- skin irritation at the tube insertion site
- diarrhea due to a liquid diet or possibly medications
- tube dislodgement
- tube blockage, which may occur if not flushed properly

There are not typically long-term complications of enteral feeding. (45)
Parenteral nutrition
PN is the most complex and comprehensive form of artificial nutritional support. This form of nutrition is used to help people who are unable or unable to obtain their core nutrients (17). Parenteral nutrition is a method of getting nutrition through veins into the body. It is often referred to as either total parenteral nutrition (TPN) or peripheral parenteral nutrition (PPN) depending on which vein is used (15) (20). Parenteral nutrition (PN) is the aseptic delivery of nutrition into the circulatory system via intravenous catheter or the peripheral vein. Intravenous administration of nutrition which include protein, carbohydrate, fat, minerals, vitamins, electrolytes, and other trace elements for the patient who cannot eat or absorb enough food through tube feeding formula or through mouth to maintain good nutrition status (16) (24). Depending on which vein is used this procedure is often referred to as either total parenteral nutrition (TPN) or peripheral parenteral nutrition (PPN), this form of nutrition is used to help people who cannot or should not get their core nutrients from food (11) (12). Parenteral nutrition is necessary to patients who cannot get essential nutrients to maintain high energy, hydration, and strength levels (journal of clinical nutrition & dietetics) (13). The goal of parenteral nutrition (PN) is to complete the therapy without complications. But the goal of “near zero” PN-related complications is achievable if appropriate prevention and monitoring procedures for reducing PN complications are instituted (17) (32). The key message of this review is the strong recommendation for the development and implementation of protocols for the safe management of PN in critically ill patients, in which each healthcare professional will be actively engaged. If accurately managed, PN can be safely provided for most critically ill patients without expecting a relevant incidence of PN-related complication (4) (43). Parenteral Nutrition (PN) is a high-alert drug with a complex process of drug use. Practices and safeguards are critical to maintaining patient safety, including policies, procedures, and supporting systems that surround this process. Patients received PN during about 302,000 hospital stays in 2013, while many others received it in the home or long-term care settings. The expectations are that standardization throughout the process and communication between health care providers will support patient safety, especially when each provider is competent in their role (16) (17). Parenteral nutrition (PN) is a high-alert drug with a complex process of drug use. Key process steps include reviewing each PN prescription followed by formulation preparation. The preparation step involves compounding the PN or activating a commercially available standardized PN product (7) (18) (23).
How is parenteral nutrition administered?

Parenteral nutrition is given through tubing attached to a needle or catheter from a bag containing the nutrients that need. Healthcare provider places the catheter in a big vein with TPN, called the superior vena cava, which goes to the heart or may also place a port, such as a needleless port of access, which facilitates intravenous feeding. Physician may recommend PPN for temporary nutritional needs. Instead of a central line threaded into your superior vena cava, this type of intravenous feeding uses a regular peripheral intravenous line. It most likely complete at home with intravenous feedings. It usually takes 10 to 12 hours, and five to seven times a week you will repeat this procedure. You will provide detailed instructions for this procedure with your healthcare provider. Generally speaking, first check the nutrient bags for floating particles and discoloration, then insert tubing into the bag and attach the tubing to your intravenous catheter or port as your healthcare provider designates. For most or all of the day, you need to leave the bag and tubing in place. You subsequently remove the nutrient bag and tubing.

TPN indications

- Severe malnutrition
- significant weight loss,
- hypo proteinemia
- Long bowel rest Inadequate absorption resulting from short bowel syndrome

Access the routes and duration

- Establishing and maintaining an appropriate circulation assessment is essential for the successful management of TPN.
- The route used depends on the expected feeding duration,
- The solution's osmolarity.
- Central vein cannulation is the most frequently used route, but peripheral feeding is an acceptable alternative for short-term feeding (46)(44).

Nutritional assessment

Prior to commencement of TPN the patients nutritional requirements are assessed. Energy Nitrogen requirements can vary, depending on age, sex, body composition, clinical status Activity. A baseline biochemical assessment is needed for the patient before administration of TPN like electrolyte balance, renal and liver function test, glucose level, or lipid screen.
Nutritional requirements

- To maintain fluid: 18-60 years old 35ml/kg/day
  Above 60yrs 30ml/kg/day

Energy: Energy requirements are most commonly estimated using predictive.

Nitrogen: Patients do not have a requirement for nitrogen per se, but for amino acid (1gm nitrogen = 6.25gm protein) The aim of nutritional support is to achieve a state of nitrogen balance using nitrogen balance data where available or general recommendations. Nitrogen provide as amino acids (41)(43).

Electrolytes daily requirements are

- Na-1-1.5mmol/kg
- K-1-1.5mmol/kg
- Ca-0.1-0.15mmol/kg
- Mg-0.1-0.2mmol/kg
- Ph-0.5-0.7mmol/kg

Vitamins and trace elements

Water soluble (Pabrinex) Fat soluble (Vitlipid) vitamins are available
Additrace contain trace elements
Eg:; iron, zinc, manganese, copper, selenium, iodine, and fluoride (41)(43)(46).

Complications

Infection
Nutritional complication include;
Fluid overload/dehydration
Electrolyte imbalance
Hyper/hypo glycaemia
Nutrient deficiency

What are the parenteral nutrition risks?
Developing catheter infection is the most common risk of using parenteral nutrition.
Other risks include: blood clots, hepatitis, bone disease

How to minimize the risks

- It is essential to maintain clean tubing.
- Needleless ports of access, catheters, and other equipment((44)(46).
Components of PN

Parenteral nutrition delivers nutrients such as sugar, carbohydrates, proteins, lipids, electrolytes, and trace elements to the body. These nutrients are vital in maintaining high energy, hydration, and strength levels. Some people only need to get certain types of nutrients intravenously(44)(43)(46). Preliminary results from small phase II emulsion-containing fish oil (FO) studies have shown that pre-operative application of FO is a promising strategy for modulating biological and clinical response to cardiac surgery. Berger et al. demonstrated that peri-operative FO infusions significantly reduced biological and clinical signs of inflammation in a relatively low risk population of cardiac surgery patients as reflected in a low mean Euroscore (5) that is routinely used in cardiac surgery patients for preoperative risk stratification(35)(38). Fish oil (FO)-containing emulsions have shown that preoperative FO application is a promising methodology to balance the natural and clinical reaction to cardiovascular medical procedure (1)(37). Berger et al. exhibited that perioperative FO imbuements essentially diminished natural and clinical indications of aggravation, in a fairly generally safe populace of heart medical procedure patients, as reflected by a low mean Euroscore, which is routinely utilized for the preoperative hazard stratification in cardiovascular medical procedure patients. Moreover, chiefly uncomplicated coronary vein sidestep medical procedure was performed. Given these discoveries, supplementation of FO might be of specific pertinence in patients with progressively complex systems with increasingly drawn out CPB time and ensuing articulated incendiary reaction. Manzanares et al. as of late led an orderly audit and included 10 randomized controlled preliminaries (RCTs), in which scientists assessed FO-containing emulsions in PN or EN in the ICU. The specialists found that FO-containing emulsions may altogether lessen the rate of contaminations. Furthermore, FO-containing emulsions were related with clinically imperative decreases in span of mechanical ventilation and medical clinic length of stay. Further research is energized and is required in cardiovascular medical procedure patients to clear up the job of FO (37).

Common side effects include

Mouth sores, poor night vision, skin changes, changes in heartbeat, confusion, convulsions or seizures, difficulty breathing, fast weight gain or weight loss, fatigue, fever or chills, increased urination, jumpy reflexes, memory loss, muscle twitching, weakness, or
cramps, stomach pain, swelling of your hands, feet, or legs, thirst, tingling in your hands or feet, vomiting.

How to prepare the parenteral nutrition?

PN is prepare according to the need of the patient. Health care provider prescribe the appropriate liquid for fulfill the need of patient. Store the liquid in a refrigerator or freezer. Take the solution from the refrigerator 4-6 hours prior to the administration for make the solution in room temperature avoid complications(20)(33)(43).

What are the risks of parenteral nutrition?

The most common risk of using parenteral nutrition is developing catheter infection. Other risks include: blood clots, liver disease, bone disease. It’s essential to maintain clean tubing, needleless access ports, catheters, and other equipment to minimize these risks. Following parenteral nutrition, many people experience some improvement in their condition, may not be able to get rid of your symptoms, but body can heal faster (20). Patient probably feel more powerful and energetic. This can help to do more despite condition's effects. After several weeks of this nutrition program, a doctor or dietitian will reassess the nutritional needs to see if any adjustments need to be made in the dosage. It will probably have tests done to evaluate patient’s needs. The parenteral nutrition results in maintaining body's health and energy levels. It may only temporarily need this treatment or might need to use it for the rest of the time. Nutritional needs may change with time (43)

Parenteral feeding refers to giving nutrition through a person’s veins. Will have a type of venous access device, such as a port or a peripherally inserted central catheter (PICC or PIC line), inserted so patient can receive liquid nutrition. If this is supplementary nutrition, it’s called peripheral parenteral nutrition (PPN). When patients getting all of nutritional requirements through an IV, it’s often called total parenteral nutrition (TPN). Parenteral feeding can be a life-saving option in many circumstances. However, it’s preferable to use enteral nutrition if at all possible. Enteral nutrition most closely mimics regular eating and can help with immune system function. In some cases, enteral feeding may not be an option. If at risk for malnutrition and don’t have a functional GI system, may need an option called parenteral feeding discomfort as body readjusts to solid foods(40)(42).
Nutritional assessment of an adult patient

**Definition:** Nutritional assessment is the interpretation of anthropometric, biochemical (laboratory), clinical and dietary data to determine whether a person or groups of people are well nourished or malnourished (over-nourished or under-nourished). Height, Weight, **Body Mass Index (BMI)** is the weight of a person in kilograms divided by their height in metres squared. A non-pregnant adult is considered to have a normal BMI when it falls between 18.5 and 25 kg/m². Table 1 shows you the different categories of nutritional status based on a person’s BMI.

**Table 1:**

<table>
<thead>
<tr>
<th>BMI (Kg/m²)</th>
<th>Nutritional status</th>
</tr>
</thead>
<tbody>
<tr>
<td>More than 40</td>
<td>Very obese</td>
</tr>
<tr>
<td>30-40</td>
<td>Obese</td>
</tr>
<tr>
<td>25-29.9</td>
<td>Over weight</td>
</tr>
<tr>
<td>18.5-24.9</td>
<td>Normal</td>
</tr>
<tr>
<td>17-18.49</td>
<td>Mild chronic energy deficiency</td>
</tr>
<tr>
<td>16-16.9</td>
<td>Moderate chronic energy deficiency</td>
</tr>
<tr>
<td>&lt;16</td>
<td>Severe chronic energy deficiency</td>
</tr>
</tbody>
</table>

If an adult person has a BMI of less than 16 kg/m² they will not be able to do much physical work because they will have very poor energy stores. In addition they will be at increased risk of infection due to impaired immunity. In cardiac conditions, low BMI can be caused by hypo- as well as hyper- metabolism. A low BMI increases the risk for complications such as infection, reintubation and mortality, as well as an increased length-of-stay. Cardiac disease often coexists with other chronic conditions, which may lead to weight loss. Unintentional weight loss is a predictor of mortality, independent of low BMI for patients of any age. A normal BMI does not exclude the presence of malnutrition. In patients with heart failure, cardiac surgery patients and ICU-patient, a low BMI is an obvious risk factor although it may be masked by fluid retention. Thus, body composition is not always correctly reflected by BMI. High BMI does not necessarily increase the mortality risk. Five-year survival was higher in patients with BMI between 24 and 30, as well as for those with mild obesity (BMI 30-34). BMI is thus an imprecise measure. Its sensitivity as a marker is high but its specificity may be low. Risk of mortality and morbidity is related to the nutritional status as assessed by the BMI. If people are too fat or too thin their health suffers. The risk of mortality and morbidity increases with a decrease in the BMI. Similarly when the BMI increases to over 25 kg/m², the risk of mortality and morbidity increases. **Relationship between**
BMI and morbidity and mortality. Clinical methods of assessing nutritional status involve checking signs of deficiency at specific places on the body or asking the patient whether they have any symptoms that might suggest nutrient deficiency from the patient (27) Clinical signs of nutrient deficiency include: - pallor (on the palm of the hand or the conjunctiva of the eye), Bitot’s spots on the eyes, pitting oedema, goitre and severe visible wasting. Table 2 shows how to identify nutritional abnormality.

Table 2 Identify nutritional abnormality
(e.g. table 2)

<table>
<thead>
<tr>
<th>Signs &amp; Symptoms</th>
<th>Nutritional deficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pale: palms, conjunctiva, tongue</td>
<td>Anaemia due to the deficiency of vit B12, copper Folic acid, protein</td>
</tr>
<tr>
<td>Shortness of breath, general weakness</td>
<td></td>
</tr>
<tr>
<td>Bitot’s spots (white triangular shaped patches in the eyes)</td>
<td>Vit A deficiency</td>
</tr>
<tr>
<td>Goitre (neck swelling)</td>
<td>Iodine deficiency disorder</td>
</tr>
<tr>
<td>Pellagra, Xerophthalmia</td>
<td>Vit K</td>
</tr>
<tr>
<td>Scurvy, Rickets, Beriberi</td>
<td>Protein-Energy malnutrition</td>
</tr>
<tr>
<td>Osteomalacia, hypocalcaemia</td>
<td>Vit D</td>
</tr>
</tbody>
</table>

Catabolic process after surgery

Clinical features of perioperative catabolism are hyperglycemia and loss of body protein, both metabolic consequences of impaired insulin function. Muscle weakness and (even moderate) increases in perioperative blood glucose are associated with morbidity after major surgery. Although the optimal glucose concentration for improving clinical outcomes is unknown, most medical associations recommend treatment of random blood glucose > 10 mmol·L\(^{-1}\). Neuraxial anesthesia blunts the neuroendocrine stress response and enhances the anabolic effects of nutrition. There is evidence to suggest that the avoidance of preoperative fasting prevents insulin resistance and accelerates recovery after major abdominal surgery (22). Patients undergoing major surgery are exposed to metabolic and endocrine alterations in carbohydrate, protein, and insulin metabolism, often summarized as the catabolic response. Preventing stress in an effort to minimize
this catabolic response to surgery represents one key mechanism on which perioperative programs such as the Enhanced Recovery After Surgery (ERAS) (9)(22). Although the inflammatory response to cardiac surgery shares mechanisms with that observed in septic patients, the postoperative inflammatory response is more predictable, with the release of pro-inflammatory markers and reactive oxygen species being the main feature. The pre-operative period can therefore be an attractive time window for optimizing nutritional status, correcting deficiencies, and enhancing mechanisms of immune defense before surgery. This is a particularly effective time to respond to modifiable risk factors and potentially reduce the risk of intra-and post-operative complication (21).

**Pathophysiology**

**Glucose metabolism**

Characteristic features of glucose metabolism are increased glucose production rates combined with reduced peripheral use of glucose, resulting in hyperglycemia. Hyperglycemia magnitude depends on the severity of the trauma of the surgical tissue. Typically, blood glucose levels increase to 7-10 mmol•L⁻¹ in fasting non-diabetic patients undergoing elective intraperitoneal operations. In non-diabetic patients, glycemia often exceeds 10 mmol•L⁻¹ and in diabetic patients, 15 mmol•L⁻¹ (22)(9)(48) The intravenous administration of dextrose-diluted drugs (antibiotics, catecholamines, and nitroglycerin), blood products containing large amounts of glucose, and nutritional support further aggravates this hyperglycemia. Importantly, in a non-diabetic patient weighing 70 kg, an infusion of 5% dextrose 100 mL (= 5 g glucose) doubles the circulating glucose (29)(9). Although not well studied the effect of surgical technique on perioperative catabolism, laparoscopic procedures may have less impact on the metabolism of glucose than the open approach. Patients undergoing laparoscopic resection of the colon showed better use of glucose compared to laparotomy, possibly mediated by tissue trauma reduction, inflammatory response mitigation, and insulin sensitivity preservation (48). Anesthetic drug selection also affects homeostasis of glucose. Unlike propofol, high doses of opioids and neuraxial techniques, inhalation agents have been shown to accentuate the hyperglycemic response to surgery (5),(6), (48) Corticosteroid administration to prevent postoperative nausea and vomiting, even in small doses, further exacerbates hyperglycemia in patients who are not diabetic. 7,8. Unforeseenly large numbers of patients before surgery show an abnormal homeostasis of glucose. 26% of previously undiagnosed patients showed blood glucose levels in the impaired-fasting glucose or diabetic range in a prospective study of 500 patients presenting for elective procedures (48).
Protein metabolism

Muscle wasting occurs early and rapidly during the first week of critical illness and is more severe among patients with multi-organ failure. Significant muscle weakness and physical disability may persist for more than five years after injury and critical illness. There is no evidence to suggest that the magnitude of catabolic changes in elderly patients differs from those in younger adults. However, age may be associated with reduced muscle mass and reduced nutrient use capacity. Therefore, older patients may be more vulnerable to catabolism of proteins (48)(41).

Glycemic control after cardiac surgery

Observational studies conducted in diabetic patients undergoing open heart surgery in Portland, Oregon, USA, showed reduced morbidity and mortality with improved glycemic management. In 2001, the Leuven-I study showed superior outcomes with maintenance of normoglycemia, i.e., a mean blood glucose of 4.4-6.1 mmol·L$^{-1}$. In critically ill patients, predominantly after cardiac procedures, mortality decreased by 50%. Besides saving lives, normoglycemia reduced the risk of infection, acute renal failure, liver dysfunction, peripheral neuropathy, muscle weakness, and anemia (41)(48). Several limitations of this unblinded trial raised concerns about the wider applicability of the study; these included the early administration of a relatively large amount of calories within the first 24 hr of admission, an unusually high mortality rate in the control group, and a treatment effect exceeding that of previous ICU studies (32). A meta-analysis of cardiac surgery studies suggested a lower mortality and risk of arrhythmias with tight perioperative glycemic control. In contrast, more recent studies in cardiac patients showed no benefit, but an increased incidence of hypoglycemia was reported. A meta-analysis of cardiac surgery studies suggested a lower mortality and risk of arrhythmias with tight perioperative glycemic control. In contrast, more recent studies in cardiac patients showed no benefit, but an increased incidence of hypoglycemia was reported (27). While it is metabolically important to maintain normal glycemia and avoid large variations in glycemia, insulin itself has non-metabolic properties with potential benefits for surgical patients, particularly those with cardiovascular disease. Protocols using supraphysiological doses of insulin in patients with coronary artery bypass grafting showed anti-inflammatory and cardioprotective effects as reflected by lower tumor necrosis factor α, interleukin 6, interleukin 8, and troponin levels. These immunological changes were associated with lower inotropic support requirements and with echo-cardiographic sign of improved nutrition (39). Critical disease and the immediate period after abdominal surgery, due to anorexia and/or
limited oral intake, are characterized by semi-starvation. There is a rapid net loss of lean tissue unless amino acids and calories are provided in quantities sufficient to meet ongoing demands. The primary objective of nutritional support is therefore to reduce protein waste by optimizing the delivery of nutrients within the limitations of organ function. Providing hyper-, iso-, or hypocaloric amounts of energy, with or without protein, is a therapeutic method traditionally used in surgical patients to achieve this goal. Hyper-nutrition, i.e. the administration of large amounts of hypercaloric energy and amino acids, is the only traditional strategy to induce anabolism after surgery. However, in clinical practice, overfeeding has been abandoned due to serious adverse effects (hyperglycemia respiratory distress, liver dysfunction) (9)(34). The provision of iso-caloric amounts of glucose and amino acids improves nitrogen balance and attenuates protein losses after surgery, but it fails to produce a positive nitrogen balance, i.e., anabolism. Meta-analyses in surgical patients concluded that concepts of hyper- and iso-caloric intravenous feeding have no overall clinical benefit and, in fact, may even be harmful, i.e. increase the rate of infectious complications and cardiovascular morbidity (30). Clinical advantage of early enteral nutrition after major optional surgery, certain protocols, including ERAS programs, advocate early restarting oral food intake. Patients receiving preoperative carbohydrates and complete enteral feeding immediately following colorectal surgery remained normoglycemic and maintained a positive protein balance, according to the results of one clinical trial. Early enteral nutrition has been shown to be safe and associated with less ileus and anastomotic leakage after major rectal cancer surgery (26). More recent studies focused on the effects of nutrients that improve the immune system, such as n-3 fatty acids, arginine and nucleotides. One meta-analysis using preoperative immuno-nutrition reported a decrease in total complications and infections compared to no or standard therapy. Another study did not demonstrate the superiority of preoperative immuno-nutrition over the use of standard oral supplements(32). Perioperative immuno-nutrition may be beneficial in selected surgical cancer populations (head and neck, pancreas). Limited efficacy in surgical patients of hypocaloric nutritional concepts. These include disregarding the type and quality of analgesia, lack of nutrition support individualization, inadequate pre-operative catabolism assessment, underestimation of pre-operative hunger, and disregard for hyperglycemia (40).

Individualization of nutritional support:-Nutrition is typically prescribed on the basis of body weight and/or estimations of the patient’s energy expenditure (EE). Use of body weight as the sole reference does not account for variations in body fat and lean tissue, the main determinant of whole-body energy consumption. The Harris-Benedict equation (is a method used to estimate an individual’s basal metabolic rate) is a formula commonly used to predict EE (energy expenditure)
in surgical patients; High-dose opioid anesthesia attenuates most endocrine and metabolic reactions to surgery, but is rarely used for short- and medium-length procedures. Newer short-acting drugs, such as sufentanil, alfentanil, and remifentanil, also prevent intraoperative catabolism when used at a lower dose. However, postoperative catabolic changes are either uninfluenced or even more pronounced. However, marked differences between measured and calculated EE have been reported, with measured amounts from 50-150% of the predicted EE value(36)(40). Indirect calorimetry allows direct measurement of the patient’s EE and prompt adjustment to individual nutritional needs. The estimated BMR value may be multiplied by a number that corresponds to the individual’s activity level(40).

Calculating The Harris-Benedict BMR

<table>
<thead>
<tr>
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<th>Formula</th>
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<tbody>
<tr>
<td>MEN</td>
<td>$BMR = (10 \times \text{weight in kg}) + (6.25 \times \text{height in cm}) - (5 \times \text{age in years}) + 5$</td>
</tr>
<tr>
<td>WOMEN</td>
<td>$BMR = (10 \times \text{weight in kg}) + (6.25 \times \text{height in cm}) - (5 \times \text{age in years}) - 161$</td>
</tr>
</tbody>
</table>

Assessment of catabolism before surgery

To assess the effectiveness of nutritional support, the baseline catabolic state of the patient must be quantified as sarcopenia (the loss of skeletal muscle mass and strength resulting from aging) is related to postoperative morbidity and mortality. There is a significant association between the degree of preoperative catabolism and the anabolic effect of nutrition, with most benefit to catabolic patients. These more recent observations in perioperatively fed malnourished patients support the previous substantiation of superior outcomes(41). Many clinical and biochemical indices have been used to characterize surgical patients’ nutritional status, but all techniques have limitations. Measurements of anthropometric and body composition in subjects who are dehydrated and/or have edema or ascites need to be treated with caution. Pathophysiological markers of serum proteins are influenced by factors other than malnutrition or catabolism (49). Novel tracer methods using metabolic substrates (glucose, amino acids) labeled with stable isotopes (2H, 13C, 15N) are considered the technique of choice for global catabolism assessment in humans and its relationship to protein and energy intake. They provide a dynamic picture of the kinetics of glucose and amino acids throughout the body (protein breakdown, oxidation and synthesis, glucose p (37).

Preoperative fasting
After overnight fasting, elective surgery was routinely performed to minimize the risk of aspiration. Under certain conditions, such as high risk of aspiration or preoperative preparation of the intestine, fasting periods are long enough to deplete hepatic glycogen stores and thus increase demand for gluco-neogenesis amino acids rather than tissue repair (41). After gastrointestinal surgery, overnight glucose treatment prevents postoperative decrease in insulin sensitivity and early protein loss and increases voluntary muscle function (23) (24).

Hyperglycemia

During critical illness, hyperglycemia per se has been shown to exacerbate protein catabolism and may therefore blunt the anabolic response to feeding strategies including glucose. Net muscle protein catabolism increased proportionately with blood glucose levels in severely burned patients. After major cancer surgery, muscle protein catabolism was associated with hyperglycemia induced by parenteral nutrition, while maintaining normoglycemia restored a neutral protein balance (13)(23). Hyperglycemia, loss of protein and resistance to insulin are important features of the so-called catabolic response to surgery. All of these characteristics are associated with adverse results. The optimum concentration of glucose is unknown to improve clinical outcomes. Most associations advise random blood glucose treatment > 10 mmol•L−1. The administration of glucose insulin while maintaining normaloglycemia (GIN) therapy enables the maintenance of perioperative normoglycemia, even in patients undergoing major surgery. In addition, GIN reduces glycemic variability, enables feeding while preventing glucotoxicity, and has anti-inflammatory, cardioprotective, and inotropic effects (8)(25)(43). Enhanced recovery after surgical procedure advocate early enteral feeding after cardiac surgery with potential clinical benefits.

Energy requirements in critically ill patients

Optimal nutritional support is an important key for achieving positive clinical outcomes. Compared to healthy people, critically ill patients have higher energy expenditure, thereby their energy requirements and risk of malnutrition being increased. Assessing individual nutritional requirement is essential for a successful nutritional support, including the adequate energy supply. Methods to assess energy requirements include indirect calorimetry (IC) (Indirect Calorimetry is the accurate determination of energy expenditure) (18) (24). Terminally illness is accompanied by a hypermetabolic state related to the activation of various catabolic hormones (Adrenaline, cortisol, and glucagon are catabolic hormones, Growth hormone, testosterone and estrogen are anabolic hormones.). This situation results in Under-feeding has been shown to result in an increased
hospital length of stay, increased incidence of complications such as infections and organ failure, and increased risk of mortality(6)(9). Overfeeding has also been associated with various complications, including hyperglycemia, hypertriglycemia (abundant fatty molecules in the blood), hepatic steatosis (accumulation of fat in the liver), azotemia (a medical condition characterized by abnormally increased level of nitrogen containing compound such as urea, creatinine, body waste compounds) and hypercapnia (CO₂ retention), and increased rate of mortality among patients elevated energy expenditure (EE), increasing the risk of malnutrition among this patients(24)(28). Indirect calorimetry (IC) is the gold standard for assessing energy requirements in critically ill patients. However, due to the difficulty of applying IC method to certain patient conditions, its high cost and expertise requirement, predictive equations are commonly used to estimate the resting energy expenditure (REE)(REE=16.318 VO₂+4.602 VCO₂. VO₂=volume of O₂ uptake ml/min, VCO₂=volume of CO₂ output ml/min). Some of the equations commonly used in critically ill patients include the Harris-Benedict (HB), Mifflin, Swinamer, Ireton-Jones and Penn State equations, and the American College of Chest Physicians (ACCP) recommendation(38)(41).

Assessment methods for energy requirements in critically illness

IC (Indirect Calorimetry) is the gold standard for the measurement of EE in critically ill patients, and it remains as the best method whenever practical. The method has served as a reference both in the development of various equations used to predict the REE in critically ill patients and in validation studies for the developed equations. The principle of IC is based on the measurement of inspired oxygen (VO₂) and expired carbon dioxide (VCO₂). Obtained values are used to calculate the REE by using the Weir's equation. The abbreviated version of this equation is commonly used, and it is as follow

$$\text{REE (kcal/day)} = (3.941 \times \text{VO}_2 \text{ [L/min]} + 1.106 \times \text{VCO}_2 \text{ [L/min]}) \times 1.440$$

VO₂ is the volume of consumed O₂ and VCO₂ is the volume of produced CO₂. In critically ill patients, other factors that may limit the use of IC include the presence of air leaks or chest tubes, supplemental oxygen (e.g., nasal cannula, bilevel positive airway pressure), ventilator settings (fractional inspiratory oxygen and positive end-expiratory pressure), continuous renal replacement therapy (CRRT), anesthesia, physical therapy, and excessive movement (48)(49). Critically ill patients are usually more likely to have REE than healthy people. It may indicate that there are increased energy requirements for critical ill patients. It is important to accurately evaluate EE in individual patients in order to ensure adequate nutritional support for critically ill patients. The existing REE formulas are inaccurate compared to IC, the gold standard, thus increasing the risk of underfeeding or overfeeding (35). This challenge concerns not only the equations developed from
healthy population data, but also those specifically developed in patients with critical illness. Further studies are needed to develop more accurate equations in order to provide patients with optimum energy. The SCCM and ASPEN guidelines recommend the caloric goal for critically ill adult patients as energy requirements calculated either through simplistic formulas (25–30 kcal / kg / day) or published predictive equations and measured by IC(40)(42).

Energetic needs in healthy adults

Dietary energy intake from food must meet the requirement to achieve and maintain optimum health, physiological function and well-being. Energy balance is achieved when input (i.e. dietary energy intake) is equal to output (i.e. total energy expenditure). Energy requirement is the amount of food energy needed to balance energy expenditure to maintain body size, composition and a level of physical activity necessary and desirable, consisting of long-term good health(41)(43).

Optimal caloric goal in critically-ill patients

Adequate nutritional support during critical disease is an important impact on the clinical outcome of the patient. In critically ill patients, both energy underfeeding and overfeeding were associated with negative outcomes. An observational study conducted by Faisy et al., showed that the large negative energy balance is an independent determinant of intensive care unit (ICU) mortality in very sick medical patients requiring prolonged mechanical acute ventilation, particularly when the energy deficit exceeded 5,021 kJ per day (9)(19). The optimal calorie target for critically ill patients, however, remains a hot topic of discussion. Some studies reported good results from achieving target energy requirements, while others reported better results in patients receiving less energy than caloric requirements measured or calculated(21). Taylor et al. and Martin et al. observed that patients who received a greater volume of enteral nutrition (EN) had better clinical results than those who received lower volume. These findings are in agreement with the results from the work of van Schijndel et al. have found that providing lower calories than the measured requirements was associated with beneficial effects. A cohort study conducted by Zusman et al. evaluated the clinical outcome according to the caloric administration rate (percent of administered calories divided by measured REE [% AdCal/REE]) in ICU patients: Rice et al. evaluated the benefits of initial lower-volume trophic enteral feeding in comparison to initial full enteral feeding in patients with acute lung injury: compared with full enteral feeding, initial trophic enteral feeding for up to 6 days did not improve ventilator-free days, 60-day mortality, or infectious complications, but it was associated with less gastrointestinal intolerance(35). Similar results were reported by Rice et al. who compared the initial trophic EN with full-energy EN in mechanically ventilated patients. In
this study, the 2 approaches resulted in similar clinical outcomes (including ventilator-free days, ICU-free days and mortality to hospital discharge), but initial trophic EN resulted in fewer episodes of gastrointestinal intolerance. The optimal energy target in critically ill patients remains an unsettled issue among researchers, and more studies are needed before a clear consensus can be reached. According to the recent guidelines published in 2016 by the Society of Critical Care Medicine (SCCM) and American Society of Parenteral and Enteral Nutrition (ASPEN), the optimal caloric goal in critically ill adult patients was recommended as energy requirements calculated through simplistic formulas (25–30 kcal/kg/day), or published predictive equations, as well as measured by IC. The guidelines indicate IC as a method to be used for the assessment of energy requirements in critically ill patients, whenever applicable (39). A low S-Albumin, especially in the elderly, is thought to be a prognosis for poor outcome. Albumin is affected by malnutrition, infection, inflammation, oedema or dilution as well. In addition, normal concentrations of albumin do not exclude malnutrition. In one Study, we found that patients with low preoperative S-Albumin were more frequently infected than patients with normal concentrations with low preoperative S-Albumin (45). In over 90 percent of study patients, preoperative CRP was normal, indicating that the vast majority were not affected by inflammatory or infectious conditions. So we find it plausible that S-Albumin reflects the nutritional status of these patients. Unlike other authors, in multivariate analysis, we did not observe any relationship between low S-Albumin and mortality. S-Albumin declined with age in the population (50). A low S-Albumin has been shown to indicate a weak response to the influenza vaccine in healthy elderly people. An age-related, increased frequency of infections with sternal wounds has been described previously. This can be due to the combined effect of an aging immune system and poor nutritional status of low S-Albumin (48)(50).

Nutrition risk stratification in cardiac surgery patients

Patient selection that will benefit most from post-operative nutrition support is critical, but has not been established or standardized. This selection process, if developed, would be based on a combination of clinical and biochemical parameters related to validated nutritional risk scores, cardiac surgery, critical disease, and emerging systemic inflammation markers, especially those related to cardiopulmonary bypass and postoperative ICU pharmacology and technology (27)(31). Pre operative nutrition risk assessment:-Several scores or evaluation tools were introduced to enable nutrition risk quantification. In critically ill patients, these tools were neither developed nor validated. Measuring the current nutritional status of a patient therefore identifies predominantly those who have already reached a general undernourished state. In order to
anticipate an aggravation of the nutritional status, a nutritional risk assessment must also identify patients at a pre-critical level of malnutrition who benefit from nutritional support. The Universal Screening Tool for Malnutrition (MUST), Mini Nutritional Assessment (MNA), Short Nutritional Assessment Questionnaire (SNAQ), Malnutrition Screening Tool (MST), and Subjective Global Assessment (SGA) are well-established evaluation tools used in clinical practice to evaluate nutrition status. Lomivorotov and colleagues have shown that malnutrition detection is associated with prolonged ICU stay (> 2 days) in patients undergoing cardiac surgery and that both MUST and MNA have independent predictive accuracy in postoperative complications. In a subsequent study, the authors also found that the SNAQ and MUST detect malnutrition with comparable accuracy. However, the authors recognize that it is necessary to study whether preoperative nutritional therapy would improve the outcome of malnourished patients (38).

Post operative nutrition risk assessment to identify patients who need nutrition therapy

Because the above tools consider all critically ill patients at high risk of malnutrition, the Critically Ill Nutrition Risk (NUTRIC) score was developed to define nutritional risk in critically ill patients with ICU. The observation that not all ICU patients will respond equally to nutritional interventions was the key driver for NUTRIC score development. However, the NUTRIC score in cardiac surgery patients has not yet been validated. The Nutritional Risk Score (NRS)-2002 must be carefully interpreted as an Acute Physiology and Chronic Health Evaluation (APACHE) score > 10 in patients with cardiac surgery indicates that a patient is already at high risk of malnutrition. Patients with a score of NRS-2002 > 3 are defined as "risk for malnutrition," and those with a score of NRS-2002 > 5 are defined as "high risk of malnutrition," which may be too broad and unspecific to guide aggressive nutrition support. Casaer et al. compared those with inadequate intake (caloric limitation) to early parental supplemental nutrition (PN) with prior loading of glucose (38)(39). Early initiation of PN to supplement insufficient EN was associated with increased infection incidence, delayed recovery, and higher health care costs compared to late initiation of PN. Again, this might have been the wrong target population as most patients in the study had a short ICU stay, suggesting a low nutritional risk. In addition, the results may have been negatively affected by tight glycemic control and high-dose glucose loading. Patients with cardiac surgery and low nutritional risk would benefit from aggressive early PN, so it would be nonsensical for these patients to be enrolled in a large clinical trial. To first identify high-risk patients for cardiac surgery before scientifically studying the implementation of nutrition support, an adequate risk assessment is required (40).
Optimal period of starting nutritional therapy in cardiac surgery

Determining the ideal time for starting feeding in relation to cardiac surgery is a crucial factor in achieving effective nutritional support.

- Preoperative: at least 2-7 days before surgery
- Early preoperative: 24 hours before surgery
- Early postoperative: > 24 hours after surgery
- Postoperative: > 24 hours after surgery

One challenge facing perioperative nutritional support is the fact that on the day of surgery more than half of patients undergoing cardiac surgery are admitted as outpatients, creating a significant challenge for pre-operative nutritional risk assessment and timely intervention. If a beneficial role for a pre-operative approach is determined, clinicians will need to overcome this challenge and consider a pre-admission outpatient approach to optimize nutritional status. Meanwhile, the best evaluation and treatment window is immediately after surgery or shortly after ICU arrival (32) (40).

Nutrition in cardiac surgery patients enteral and parenteral

There is a strong consensus on international guidelines, and most experts will report that EN is always preferred to PN. Due to inflammatory response syndrome, vasoplegia, and/or postoperative low output syndrome due to myocardial stunning, critically ill patients are frequently treated with vasopressor after cardiac surgery. The need to support vasopressor further results in significant changes in energy expenditure and frequent intolerance to oral feeding, resulting in significant energy / protein deficits and increased risk of malnutrition (43). Especially in hemodynamically unstable patients with large doses of inotropes and/or vasopressors, EN is often thought to be contraindicated and considered harmful, leading to widespread use of PN in clinical practice. Berger et al. were among the first to provide evidence in patients following cardiac surgery from a small cohort on the feasibility and safety of early nutrition support. The investigators demonstrated that hypocaloric EN was feasible in patients with a

In a large-scale, multi-center observational study, Kahlid et al. demonstrated that mechanically ventilated, vasopressor-dependent patients (mixed population) had a significant survival advantage when EN feeding began within 48 hours of ICU admission compared to those receiving EN feeding after 48 hours(45). In addition, in a subgroup analysis, they demonstrated a more pronounced survival advantage for the sickest patients (on multiple vasopressors compared to those on a single vasopressor only). Furthermore, nutrition support in patients with extracorporeal life support systems has been shown to be feasible for patients with extracorporeal life support systems has been shown to be feasible using a well-established paracetamol absorption test (39). The use of vasopressors per se is not a contraindication to EN, given the current evidence. There is at least
some evidence in hemodynamically unstable critically ill or cardiac surgery patients that early EN is absorbed and metabolized without any harmful effect on systemic oxygenation and perfusion measurements and supporting evidence from a large-scale observational study that this translates into a mortality advantage(44). Therefore, after initial resuscitation from critical organ failure, early EN may be beneficial in patients. Future well-designed studies are needed to properly assess this important issue Tepaske et al. conducted a double-blind, three-arm clinical trial to determine if adding glycine to oral nutrition may improve the outcomes of patients following cardiac surgery. Oral immune-enhancing nutrition has been shown to reduce postoperative complications, whereas the addition of glycine has not resulted in any further beneficial effects (40). Taken together, recent data show no clinically relevant benefit in patients undergoing cardiac surgery following supplementation of arginine or glycine (35). In addition, mostly uncomplicated bypass surgery on the coronary artery was performed patients with more complex procedures with longer CPB time and subsequent pronounced inflammatory response, supplementation of FO may be of particular relevance. Recently, Manzanares et al. conducted a systematic review, including 10 randomized controlled trials (RCTs), in which researchers assessed FO-containing emulsions in PN or EN in the ICU. Researchers have found that emulsions containing FO can significantly reduce infection rates. Furthermore, emulsions containing FO were associated with clinically significant reductions in mechanical ventilation duration (35).

METHOD
The literature search was performed in the databases Pub Med, Science Direct, PLOS Google Scholar. Reviewed more than 45 literature reviews, published between 2009-2019. The analysis of Case Report and the PICO questionnaire method is thoroughly performed in the literature review.

RESULT
CASE REPORT
A 53 year old white male arrived for elective haemodynamic examination due to progressing heart failure. The patient suffered acute myocardial infarction (MI) in 2008 and has occlusion of anterior interventricular coronary artery from 2009. In 2010 electric pacemaker/cardioverter due to cardiac rhythm disorders was implanted. Since then his condition deteriorated and now he has terminal heart failure: severe failure of the right and left ventricles (LV EF is 10 %). Invasive haemodynamic measurements showed deterioration of heart function: CI
1.74 → 1.21; mean pulmonary artery pressure 32 → 46 mmHg, left atrial pressure 20 → 23 mmHg.

The patient is included in the Heart failure program. The patient has concomitant COPD. The patient’s condition was discussed in the Heart Team and it was decided to transfer the patient from the list of Heart and lung transplantation recipients to the list of Heart transplantation recipients. But as the patient condition deteriorate quickly it was decided to implant left ventricular assist device (Heart Mate III) as a bridge to transplantation.

DIAGNOSIS: MIC. IM senex (2008). PTCA et implantatio stenti S7 (2008). Occlusio S6-100% (2009, 2016, 2018.02.12). AP stabilis cl. f. II (RD). Aneurysma ventriculi sin. Insuff. mitralis ischaemica. Insuff. tricuspidalis relativa. Bocus cruris sin. completus. Implantatio CRT-D (2010 0315). FA paroxysmalis (CHA2DS2-VASc - 4b.). IC cl. f. IV (NYHA). Asthma cardiale. Tachycardia ventricularis (2018.02.08). Syncopae (2018.02.08). Hypertensio primaria III* (R-4). Cardiopathia hypertensiva. Dyslipidaemia. Osteoporosis. Before the surgery patient status was evaluated as ASA IV class. Laboratory examination before the surgery 14 02 2019 heart ultrasound, chest x-ray before the surgery. The surgery: implantation of left ventricular assist device Heart Mate III. Anesthesia: standard general endotracheal anesthesia. Induction with fentanyl, propofol, rocuronium. Anesthesia maintenance with isoflurane. Cardiopulmonary bypass (CPB) duration 93 min. The early postoperative period was complicated by respiratory failure, cardiovascular failure due to hypovolemia, metabolic acidosis. On the second postoperative day heart ultrasound was performed to evaluate heart function and the size of heart chambers: Before the treatment correction - LV diameter is very small, RV – 2.5 cm. After treatment correction (massive infusion therapy). 1. LV diameter 40 mm, only base and side segments contract. Septum moves in the direction of LV. 2. The position of the cannula in 2D and 3D is correct, the V max at the cannula of LV is 1.5 m / s. 3. RV is 30 mm, not dilated. 4. The contraction of RV base segments visually appears to be fairly good. RV systolic function is decreased quite significantly 8 mm, tissue doppler S '3-4. TV regurgitation remains I-II. 4. There is no fluid in the pericardium. 5. AoV does not open. After the treatment cardiovascular function improved, but respiratory function deteriorated. The patient was still sedated and ventilated mechanically. The ventilation parameters were adjusted according to blood gas analysis and varied from SIMV → APRV → PCCPAP → SIMV, FiO2 varied 80 → 50 → 70 %, Psup. 20, PEEP +5cm/H₂O. As the patient was haemodynamically stable on the third post-operative day clear fluids were started and well tolerated through the nasogastric tube (200 ml of clear water 3x/d) and PN (Kabiven 20 ml/hour) and I/V supplements like Dipeptiven (Amino-acid solution for parenteral nutrition containing dipeptide alanyl-glutamine), Addamel-N (Trace element additive for parenteral nutrition in adults) are started. Later on EN was increased 10 ml. On the fourth postoperative day patient had fever 38,5 ºC, inflammatory parameters increased (CRP, leucocytosis), and cefuroxime i/v 3x / day and
vancomycine 1 g 2x/ day was started. Mycrobiological samples were collected from blood and respiratory track secretions. Artificial lung ventilation – SIMV FiO2 80%. The status is considered to be complicated by respiratory failure due to ARDS and possibly pneumonia. Nutritional support is given by PN (Kabiven 30 ml/hour) and nasogastric tube (200 ml of clear water 5x/day). On the fifth postoperative day EN (Fresubin HP energy 20 ml/hour) was started additionally to PN (Kabiven 40 ml/hour) and i/v supplements. Later on EN was increased 10 ml every 12–24 hours if it was tolerated well. From the day 6 to day 12 the condition of the patient was improving a little bit. He still had respiratory failure, but his body temperature remained normal, artificial ventilation parameters SIMV $\leftrightarrow$ CPAP, FiO2 decreased to 60 $\rightarrow$ 50%. But when left on spontaneous ventilation patient quickly deteriorated, because of shallow breaths and tachypnea. It was decided to perform tracheostomy and proceed with nutritional support (EN+PN+ supplements). From the day 15 nutritional support was ensured only by EN (Fresubin HP energy 80 ml/hour). The sedation was stopped and the patient was encouraged to breath spontaneously (CPAP, FiO2 – 50%), but the muscle strength was low and tachypnea, desaturation develop after 2–3 hours of spontaneous breathing. On the day 18 EN was gradually increased up to 90 ml/hour, but the patient had diarrhea and EN nutrition was stopped. On the day 19 it was restarted at the rate 20 ml/hour and gradually increased up to 60 ml/hour on the day 25. The patients condition improved gradually. Spontaneous breathing through tracheostomy tube was adequate on the day 22 and the tracheostomy tube was eliminated on the day 25. The patient was still in the ICU, but he was conscious, active, his vital functions were adequate, he could eat and drink with the minor help of medical personal, amnd was moving freely within the bed and around it with the minor help.

**LABORATORY INVESTIGATION**

<table>
<thead>
<tr>
<th>DAY IN ICU</th>
<th>D1</th>
<th>D6</th>
<th>D10</th>
<th>D12</th>
<th>D20</th>
<th>D27</th>
</tr>
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<tbody>
<tr>
<td>Albumin concentration in plasma, g/l (35-48 g/l)</td>
<td>35</td>
<td>28</td>
<td>26</td>
<td>25</td>
<td>30</td>
<td>34</td>
</tr>
<tr>
<td>WBC (3.9-8.8*10^9/l)</td>
<td>11.2</td>
<td>12.1</td>
<td>10.1</td>
<td>9.2</td>
<td>9</td>
<td>10</td>
</tr>
<tr>
<td>CRP (0-7.5 mg/l)</td>
<td>187.59</td>
<td>122.27</td>
<td>3.9</td>
<td>4.0</td>
<td>2.0</td>
<td>2.7</td>
</tr>
<tr>
<td>Na (134-148)</td>
<td>148</td>
<td>146</td>
<td>142</td>
<td>140</td>
<td>138</td>
<td>136</td>
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DISCUSSION OF RESULT

This study shows early nutritional support by EN and/or PN nutritional intake after surgery to reduce surgical stress, maintain physiological functional capacity, and facilitate post-operative functional recovery. Even though inflammatory responds and post operative complications due to poor nutritional status are predictable, clinical practice has limitations to provide optimal nutrition therapy. Nutrition parameters should be considered before surgery, BMI and Plasma albumin concentration mainly. Early enteral nutrition is a feasible method to administer artificial nutrition in the cardiothoracic ICU. It is reasonably safe and well tolerated by patients, when individually adjusted. However, it is often not possible to meet the entire nutritional requirement by this route, a reason why parenteral supplementation is necessary. It is important to consider nutritional needs throughout the peri-operative period. The energy intake is increased with motivated and active staff. Case report shows the evidence of gradual improvement of the patient condition after surgical procedure due to the administration of PN & EN.

<table>
<thead>
<tr>
<th>ICU days</th>
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<td>35</td>
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<td>26</td>
<td>25</td>
<td>30</td>
<td>34</td>
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</table>

CONCLUSION

Nutrition is considered as the essential part to get considerable result after cardiac surgery. Deficiency in nutritional status will lead to the inflammatory response in the body due to miniaturized defense mechanism and metabolic reverse in the hospital atmosphere. "Malnourished patients are more susceptible to the surgical trauma, I/R-injury, anesthesia –related complication, hemodilution as well as inflammation(3) "Nutrition is the process of providing or obtaining the food necessary for health and growth. Nutrition is nourishment or energy that is obtained from the food consumed. The nutrients include protein, carbohydrate, fat, water, vitamins, and minerals. The nutrition support is increasingly recognized as a clinically relevant aspect of the intensive care treatment of cardiac surgery patient. The nutritional supplement is a simple and safe measure to improve the outlook in high risk patients who are undergoing cardiac surgery help to reduce the
post operative infection and ensure the early prognosis. Basic principle guiding nutrition in surgical patient are EN & PN. Prevent or reverse the catabolic effect of disease or injury, meet the energy requirements of metabolic process, maintain a normal core body temperature, nutrition help to substrates for adequate tissue repair. Use the oral route if the GI tract is fully functional and there are no other contraindications to oral feeding. Initiate nutrition via EN route if the patient is not expected to be on a full oral diet with in 7 days post surgery and there are no GI tract contraindication. If the enteral route is contraindicated or not tolerated use the parenteral route with 24-48 hours in patients who are not expected to be able to tolerate full EN within 7 days. Administer at least 20% of the caloric and protein requirements enterally while reaching the required goal with addition PN. Maintain PN until patient is able to tolerate 75% of calories through the enteral route and EN until the patient is able to tolerate 75% of calories via the oral route. The role of nutrition in surgical patients with increased metabolic demands cannot be over-emphasized. A clear understanding of body’s energy, fluid, electrolytes, and micro-nutrients is essential. Whenever the gut is available for use, USE IT!! PN should be reserved for the patients in whom a clear contra indication to EN is present. Even with PN, 20% of the total energy requirement should be tried to meet with EN for the trophic effect on gut. A careful watch for possible complications should be kept on patients receiving both EN & PN. Overfeeding should be avoided for its dangerous complications in critically ill patients. The role of immune nutrients are still under study and till then, its use can be reserved for the patients in which proven efficacy has been shown studies. Early nutritional support is very important after surgery with EN and/or PN nutritional intake to reduce surgical stress, maintain physiological functional capacity, and facilitate post-operative recovery of function. Inflammatory response and postoperative complications are predictable due to poor nutritional status. Before surgery, BMI and plasma albumin concentration should be considered. Early enteral and parenteral nutrition is a feasible method for the administration of artificial nutrition in cardiothoracic ICU. More research is also needed to assess the effect of intensive nutrition support on functional outcomes in this cohort of critically ill patients. This case report shows the living proof of the gradual improvement of the patient with nutritional therapy. Albeit both provocative reaction and postoperative intricacies are unsurprising, clinical practice has a few limitations, restricting ideal nourishment treatment. The exact recognizable proof of patients who advantage most from wholesome treatment displays a clinical basic requiring approval by satisfactorily controlled clinical investigations. The role of nutrition in surgical patients with increased metabolic demands cannot be over-emphasized. A clear understanding of body’s energy, fluid, electrolytes and micro-nutrients is essential. Whenever the gut is available for use, USE IT. Parenteral nutrition should be reversed for the patients in whom a clear contra-indication to enteral nutrition is present. A careful watch for possible complications should be kept on patients.
receiving both EN&PN. Overfeeding should be avoided for its dangerous complications in critically ill patients.

PRACTICAL RECOMMENDATIONS

For Medical personal in ICU

- Physical Examination:- Check the patient’s height, weight, BMI, Vital signs, before surgery
- History collection:- All the past Medical & Surgical History. Any allergic reactions to drugs or food, Assess the patient general and nutritional status of the patient before surgery.
- Special attention given to the aged and critically ill patient
- Early starting of nutritional therapy EN or PN
- Assess the patient hemodynamically before starting EN
- Avoid prolonged fasting before & after surgery
- Early mobilization of the patient

For staff nurses

- Periodically check the vital-signs:- Check the vital signs that will help to identify the problems before facing complications, it will help to assess the physical condition of the patient.
- Assess for bleeding :- Heavy bleeding will lead to problems like, loss of nutrients and minerals, hypotension, tachycardia, shock, and so on.
- Start EN & PN as per physician’s order :- Early starting of nutrition will help to avoid complications like infection, hypo-glycaemia, electrolyte imbalance.
- Always follow aseptic techniques before and after the procedure: - Aseptic techniques help to avoid infections and complications.
- Assess the tolerance of patient for giving EN or PN: - Over or under feeding will lead to problems, diarrhoea, vomiting, constipation, electrolyte imbalance, protienemia and so on. In my case analysis patient cannot tolerate the feed 3rd day of nutritional therapy, leads to diarrhea, vomiting then the feed stop for two days and started slowly, gradual increase of feed will help to identify the tolerance of patient. Loss of trace elements, In severe cases pneumatosis intestinalis with bowel necrosis and perforation.
- Assess the site for infection in PN: - Assess any signs of infection like redness, pain, swelling of the central venous catheter, Earliest sign may be glucose intolerance, Fever without any
other septic focus for more than 48 hours removal of catheter and re-introduction at new
site,Pneumo/hydro/hemothorax,Cardiac arrhythmias,cardiac tamponade,Air embolism,thoracic duct injury.

- Assess metabolic complications like:-Hyperglycaemia,Electrolyte abnormality,Overfeeding-Co2 retention and respiratory insufficiency,hepatic steatosis Cholestasis and gall stones,Raised liver enzymes.
- Assess Intestinal atrophy.
- Assess the position of tube before starting the feed:-Assess the tube for correct place before starting the procedure,avoid aspiration.Local problems:-Epistaxis,sinustis,nasal necrosis.Mechanical problems:Tubemalpositioning,dislod-gement,Gastroparesis:-Vomiting .aspiration,Re feeding syndrome:-After prolonged fasting period leads to sudden rise in insulin and electrolyte abnormalities-res,hepatic and renal dysfunction,Rate of feeding should be slow at starting,
- Keep a good inter personal relationship with patient and relatives:-Inter personal relationship help to aliviate the anxiety,Patient feels comfort and safe in the hospital atmosphere.It will help to improve the patient condition.
- Provide health education while nutritional therapy continue in home.
PUBLICATIÓN
Anchana Satheesan Letha, Dr. Milda Švagždienė, The scientific rationale for nutritional therapy in cardiac surgery ICU. 2019; Nurses: A voice to lead – health for all, 2019 May 7; Kaunas (Lithuania). Abstract was accepted for oral presentation.
LIST OF LITERATURE SOURCES

   Received: 22 December 2016 Accepted: 2 May 2017 Published: 5 June 2017

   PMCID: PMC5986477 PMID: 29751629


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44. Adam S. Evans, MD, MBA. Correspondence information about the author. MD, MBA Adam S. Evans. Samuel Kurtis MD, Jeffrey I. Mechanick MD. Nutrition and the Cardiac Surgery Intensive Care Unit Patient, 2015. 03. 02(10.1053)


V. ANNEXES

Annex 1
APPROVED
by the Council of the Faculty of Nursing of LSMU
2018-09-13 protocol No SLP-9-5

INDIVIDUAL PLAN OF PREPARATION OF THE GRADUATE MASTER'S THESIS

The study programme: Advance Nursing Practice, Year: 2017-19, Group: 2nd

A post-graduate student: Anchana Satheesan Letha

A topic of the graduate thesis: The scientific rationale for nutritional therapy in the cardiac surgery ICU.

A supervisor of the graduate thesis: Dr. Milda Švagždienė MD, PhD.

<table>
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<th>Date</th>
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<td>2019 04 10</td>
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<td>2019 04 10</td>
<td>Conclusions; Practical recommendations</td>
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<tr>
<td>2019 04 10</td>
<td>Present thesis during scientific conferences or make it publicly available in peer-reviewed journals</td>
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Post-graduate student: Anchana Satheesan Letha

Supervisor of the graduate thesis: Dr. Milda Švagždienė MD, PhD.

Chairman of the Qualification Commission:
LITHUANIAN UNIVERSITY OF HEALTH SCIENCES
MEDICAL ACADEMY
FACULTY OF NURSING

Aneha Saheesan
Letha LSMU 175996
(Full name of the post-graduate student, student ID No)

DECLARATION OF THE AUTHOR’S CONTRIBUTION AND ACADEMIC HONESTY

The 19th of April 2019

Title of the graduate Master’s thesis: The Scientific rationale for nutritional therapy

I have (please tick the right line with “x” and fill in as appropriate):

- [ ] independently formed and defined the topic of the graduate thesis, the scope of the research on the basis of personal observations:
  (please specify your previous research in this field, other sources and research that helped formulate the problem, objectives and tasks of the graduate thesis)

- [ ] selected from those suggested by the tutor of the graduate thesis or other scientists, lecturers:
  (please specify full name of the scientist or lecturer)

I have been advised by researchers, lecturers and specialists during collection and assessment of material, and preparation of the graduate thesis, their contribution during preparation of the graduate thesis:

[ ] I have used the dataset prepared by the tuition of

[ ]

I have been using the following measures and infrastructure of Lithuanian University of Health Sciences while collecting material (please tick as appropriate if any has been used; please specify expression in a percentage: if no measures and infrastructure belonging to other persons have been used – 100%, if any have been used – please specify a size of the University’s part):

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<td>Laboratory and laboratory instruments</td>
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<td>Reagents</td>
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<td>Other measures and materials (substances) (please specify)</td>
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I confirm that my graduate Master’s thesis has been written independently, the material provided is not plagiarized, falsified, the data of the research are not fake, the graduate thesis has not been duplicated. Quotes from other sources used both directly or indirectly are marked in literature.
references. Contribution of other persons (if any is available in the graduate thesis) has been clearly declared. I confirm that the graduate thesis is written in correct Lithuanina/English language.

(Signature)

ANCHANA SATHICINGA KETHA
(Full name of the post-graduate student)

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ANCHANA SATHICINGA KETHA
(Full name of the post-graduate student)