# Integrating Knowledge Mapping and Optimization Modeling to aid Nutrition of Patients with Heart Failure.

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**RESUMO**

Este trabalho consiste na estruturação e formulação de um modelo representando o problema de um paciente com Insuficiência cardíaca crônica que requer seguir restrições nutricionais. Doenças cardiovasculares são muito comuns no nosso meio e, mesmo com os avanços da medicina, pouca atenção vem sendo dada ao tratamento não farmacológico, em particular a terapia nutricional mesmo com este aumento de incidência no mundo. Neste trabalho a idéia de Complexidade e como resolver problemas complexos através de PSMs (***Problems Structuring Methods***) são discutidas, apresentando o mapeamento do conhecimento, representado pelos Mapas Conceituais, e a integração deste mapeamento com o modelo de otimização, que é realizado pela programação linear, é feito através do artigo.

**PALAVARAS CHAVE. Estruturação de Problemas, Mapeamento do Conhecimento, Programação Linear.**

**AS - PO na Área de Saúde, OA - Outras aplicações em PO, PM - Programação Matemática**

**ABSTRACT**

This work consists in structuring and formulation of a model representing the problem of a patient with heart failure requiring following nutritional restrictions. Cardiovascular diseases are very prevalent in our midst and, despite recent advances in medicine, little attention has been given to non-pharmacological treatment, in particular to nutritional therapy even with this increased incidence in the world. In this present work the idea of complexity and how to solve complex problems through the PSM (problems structuring methods) are discussed presenting the mapping of knowledge, represented by concept maps, and an integration of this mapping and the optimization model that is done by linear programming is made throughout the paper.

**KEYWORDS. Problems Structuring, Knowledge Mapping, Linear Programming.**

**SA - OR in Health, OA - Other applications in OR, PM - Mathematical Programming**

## 1. Introduction

The major objective of this study is to formulate a model that reliably represents the real situation of a patient who has Chronic Heart Failure and needs to follow either a specific or even stricter diet. The model comprises two stages: the first one consists of the elaboration of concept maps for structuring the problem. Information necessary for the concept maps was collected from the experts and by direct interview with a person suffering from heart failure.

The second stage uses results from the concept maps to the formulation of a linear programming problem, consisting of the development of the objective function and constraints that will be further optimized by the Solver add-in for Excel. The concept maps also allow the eliciting of failures in the implementation of the results.

## 2. Problem Analysis

Heart failure (HF) is a medical condition that causes loss of ability to pump blood efficiently, compromising the demands of the body and manifesting itself most often through edema and dyspnea, fatigue, excessive sweating, and low cerebral blood flow (Ulicny ***et al*** , 2010). Heart failure is a disease of great prevalence and impact on morbidity and mortality worldwide, especially in the elderly. The long-term prognosis is poor, with 5-year survival less than 50%.

The current progress in the field of medical and surgical therapy for heart failure, as well as the effect of aging, contribute to the increased rate of hospitalization of more advanced cases of the disease, where they still may be aggravated by a possible coexistence of other chronic diseases. The increasing industrialization and urbanization in these days can be considered as aggravating to the number of cases of HF in the world as it is contributing to worsening eating habits, increased stress, physical inactivity, smoking, etc., resulting in an increased incidence of cardiovascular disease.

Currently, the HF can be considered a serious and growing problem of public health and became a final common pathway of most heart diseases. Today, there are 23 million patients with HF, with 2 million new cases diagnosed each year (Sharpe ***et al,*** 1998). In Brazil (Arq. Bras. de Cardiologia, 2002), it is the leading cause of mortality, accounting for 32% of total mortality, in addition, it is estimated that up to 6.4 million Brazilians suffer from chronic heart failure. According to DATASUS (Database of the Brazilian Unified Health System) in 2004, in Brazil, there were 340,000 admissions for heart failure, accounting for 28% of all hospitalizations for cardiovascular disease and 3% of total causes.

Therefore, cardiovascular diseases are very prevalent in our midst. Despite recent advances in medicine (which allowed a greater longevity of the general population of heart disease), little attention has been given to non-pharmacological treatment, in particular to nutritional therapy even with this increased incidence of HF in the world.

HF leads to a series of physiological changes in which many directly influence the nutritional status. The clinical course of patients with HF, as a rule, leads to malnutrition (Souza ***et al,*** 2010).This is due to dyspnea, fatigue, nausea, anorexia, etc., resulting in weight loss and a decrease in muscle mass of the heart. This can be an additional factor in cardiac decompensation and eventually constitute an important factor in reducing the survival of HF patients, hence the importance of having a study that includes nutritional therapy to treat these patients.

## 3. Problem Structuring in Complex Systems

According to Axelrod and Cohen (2000) "complexity deals with systems composed of many interacting agents. While complex systems may be hard to predict, they may also have a good deal of structure and permit improvement by thoughtful intervention". Casti (1994) argues that the meaning of the word complex depends on the context, to him the complexities of a situation or systems are not an intrinsic aspect of this situation or system taken in isolation but ***"a property of the interaction between a system and an observer/decision maker"*** (Casti, 1986).

Tsoukas and Hatch (2001) recognize the core role played by existencial paradoxes

(Lins, 2011), as they ask "***what might be an appropriate mode of thought able to accommodate contradictions?***". And proceed "if practitioners are to increase their effectiveness in managing paradoxical social systems, they should generate and accommodate multiple inequivalent descriptions" (Weick, 1979, Bateson, 1979; Beer, 1973 apud Tsoukas and Hatch, 2001). The regulator needs to acquire the ability to replicate the regulated system, increase the complexity of their understanding and, therefore, will be more likely, in logico-scientific terms, to match the complexity of the situation they attempt to manage (Bartunek et al., 1983; Bolman & Deal, 1991; Bruner, 1996; Morgan, 1997), or, in narrative terms, to enact it (Weick, 1979).

The complexity comes from the limitations of our cognition as well as the characteristics of the problem, this happens when considering multidisciplinary problems. This nature found in complex problems cannot be treated by the traditional modeling approach because it involves qualitative and informal criteria hindering the structuring and modeling of the problem. The way to address the complex problems is through multidisciplinary modeling tools that have a better ability to deal with problems difficult to structure.

According to the Methodology of Societal Complexity proposed by DeTombe (2002), the complex social problems ***"cover all the stages in the process of handling a problem, from their perception to the evaluation of interventions."*** The complex problems have multiple causes, conflicting and inefficient data, involves different actors, each with their points of view, objectives, and subjectivity itself.

Therefore, in order to allow for the subjective aspects of the problem and provide an integration of qualitative and quantitative approaches, it is necessary to have an interaction between user and decision maker. Barabba (1994), Little (1994) and Minstrel et al (2004), apud Lins (2011), emphasize that the decision maker must state which aspects of the situation are not accounted for in the model, identifying conflicts between the qualitative and qualitative approaches.

Methods for structuring complex problems congregate approaches that assist decision making, as they integrate different perspectives of the problem. They make use of graphical representations of the problem, thus facilitating the communication amongst stakeholders, the elicitation and aggregation of knowledge to aid decision making.

Many approaches to formal modeling start from the available databases; the latter are both an asset and an impediment to critical inquiry on the problematic situation. Actually the decision maker may give way to the perspective that fits the available data in order to save time and investments, and reduce risks, thus sometimes accepting incomplete, inadequate or biased information. The constructed model for decision support must be built between advances and retreats, acting cyclically and recursively (Vleck ***et al***, 1984), alternating between the various stages of decision making and following an interactive and constructive approach (Bana e Costa, 1993).

Since the 70's, the Operations Research (OR) began to be used as a tool for solving complex problems and the subsequent decision-making, seeking to achieve goals and objectives previously defined. This aspect of the OR has been the subject of studies in recent years, being discussed by Ackoff (1979) and Checkland (1984), who, noting that some problems are very difficult to be modeled mathematically in the traditional way due to their complexity, need other tools and methodologies that escape the traditional way of OR modeling.

In the words of Checkland (1983) ***"The weakness of the traditional PO is being closely tied to the logic itself, even in situations where the logic is not strictly necessary."*** The soft OR appears just to complement the traditional OR strand (called hard), using qualitative techniques of interpretative and subjective nature to interpret and define a problem. Debates have been generated in recent years about the use of soft OR for structuring complex problems, so in literature, most methods of soft OR are called "Problem Structuring Methods - PSM" (Rosenhead, 1980).

According to Rosenhead (1996) OR traditional techniques provide little basis to identify where the problem actually is, and being the PSMs responsible for aiding in the identification of problems, resulting in a well defined and structured problem for later resolution by hard OR.

The PSMs represent methods that capture different perceptions of the situation, integrating different points of view and, as defined by Rosenhead (1996), are ***"a large group of approaches to deal with problems and whose purpose is to assist in structuring problems instead of seeking their direct solution. These methods are participatory and interactive, offering the OR access to a range of problems where the classical OR has limitations."***

According to Mingers and Rosenhead (2004), unlike traditional methods of OR reaching only “well structured” problems, PSMs allow access to poorly structured problems with limitations due to its complexity (called "ill structured"), problems that before its mathematical solution needs to be structured in a proper way, being characterized by having multiple agents, uncertainty, multiple perspectives, subjectivity and intangibility in the interests of certain factors.

This way, PSMs offer a way to represent a situation that allows agents to converge on the issues and reach an agreement that can solve the problem partially. For this, according to Mingers and Rosenhead (2004) PSM must:

- Allow multiple perspectives on the alternatives be seen together with one another.
- Be "cognitively" accessible to actors with different levels of knowledge and without specialist training.
- Be operated in an iterative manner, so the representation of the problem fits reflecting the discussions between the actors.

In consequence of these requirements, although the PSMs are sophisticated in the way they conceptualize and interact with the decision-making process, PSMs have a rudimentary apparatus of mathematical and statistical modeling (Mingers and Rosenhead 2004), requiring a posterior approach through mathematical methods to obtain a final solution.

So the soft PO arises from questions concerning the applicability of the hard OR methods in complex problems. In the literature discussions can be found about the differences between soft and hard approach, widely discussed by Checkland (1985) and Pidd (1998) in many articles.

In this paper we present two PSM methodologies for problem structuring, Cognitive Maps and Concept Maps, which is the tool used to structure the problem suggested in this work and will be further detailed along the text presenting the concept maps for each step in the problem structuring and modeling.

## 4. Knowledge Mapping for eliciting different perspectives

### 4.1. Cognitive Maps

The cognitive mapping of Colin Eden (Eden ***et al***, 1983) aims to assist its users in structuring and understanding of a given problem situation, and from the evidences, make decisions to revert it. The cognitive mapping of Eden was proposed to develop both individual and organizational maps of a group of people (Cossette & Audet, 1992). As a group, the mapping has been used as the main tool of the Strategic Options Development & Analysis - SODA (Eden & Radford, 1990) methodology facilitating the process of communication between members of a decision-making group, helping them to express their points of view, so, they can reach a consensus and commitment for action (Eden, 1989).

Cognition is a general concept that reaches all forms of knowledge, including perception, reasoning and judgment (Chaplin, 1985). Cognitive maps can be viewed as graphical representations of sets of discursive representations made by a subject (the actor) with a view to an object (the problem), according to Cossette and Audet (1992).This graphical representation is the result of a mental interpretation that the analyst (facilitator) makes from the discursive representation performed by the subject (actor) about a problem.

The interaction of the thought, through which the cognitive map is built, is a dynamic operation, fraught with subjectivity, mismatch in time, and characterized by the recursive reflection and learning. In the cognitive approach, a negotiation process is established in which a problematic situation and the facilitator (s) and actor (s) undertake (s) to build the definition of the problem, accepting the assumption of intersubjectivity and learning. Cognitive maps can, thereby, serve as instruments of negotiation.

When the intention is to structure complex problems and establish guidelines and strategic actions involving questions such as "what we know, what we do and how we do it," the efficient use of cognitive maps depends essentially on three factors: particular type of problem to be structured, the nature and characteristics of the connection making and the decisor objective (Jardim, 2001).

Faced with complex problems involving multiple decision makers, with different power relations, each with different values, perceptions and goals, the role of facilitator in the practice of decision support, is seek to the understanding and interpretation that each of the decision makers have of the problem (Netto, 1996). In a complex problem approach, should also be considered a lack (or excess) of information, the influence of the environment outside the decision context and the conflict of interest (Jardim, 2001).

At a macro view, the cognitive maps contemplate at their top the main goals, directions or the key and strategic issues at the center and, at the base, the possible options that can potentially enable such strategies. Permeating these three layers are all the details, either in terms of examples, explanations, options, which underlies the arguments and reflections of who reports the problem and map a model of an unquestionable wealth.

### 4.2. Concept Maps

Concept maps are diagrams used in the representation and transmission of knowledge. Concept maps can be conveyed through directed graphs, where nodes represent concepts expressed by a few words, the relationship between two concepts are propositions, read from a node through an arc to a second node. In a broader sense, concept maps are only diagrams showing relationships between concepts.

The Concept Map approach is based on the constructivist theory, which assumes that the process that individuals use to construct their knowledge and meanings serve as instrument to facilitate the systematic learning of the content.

The concept map is a powerful tool to annotate information in a non-linear way, being developed in web form, constituting a good graphic resource that replaces the conventional process of annotations in the form of linear list. A good concept map shows a "snapshot" of the subject, shows the relative importance of information or concepts related to the theme and their associations, thus enabling an overview of the problem (Archela ***et al,*** 2004). There is empirical evidence on the efficiency of search, which proves that a person can locate more information when they are presented in form of maps instead of text (O'Donnell, 1993).

According to Crandall ***et al*** (2006), the concept maps were developed during Joseph Novak's research program in which he tried to understand and track changes in the student's scientific knowledge. Concept maps encourage students to use meaningful learning patterns, instead of learning by mechanical repetition, and engage in critical thinking (Mintzes, Wanderse and Novak, 2000), therefore, the concept maps are diagrams used to represent and transmit knowledge. The idea of using diagrams to express logical structures has a rich history in mathematics, including some work of the logical-psychologist Charles Pierce and mathematician Gottfried Frege (Crandall ***et al,*** 2006).

The construction of concept maps requires skill and experience to structure the knowledge into aggregated subdomains (clusters) and functional hierarchies, causal or intentional (Lins, 2010). Unlike other methods based on diagrams, such as cognitive maps (Eden and Ackermann, 2001), conceptual graphs (Sowa, 1984) and mental maps (Buzan and Buzan, 1996), the concept maps does not impose restrictions on the semantic interconnections between concepts (Lins, 2010). Unlike semantic networks (Fisher, 1990) and mental maps, in which the most basic concepts are located in the center of the diagram and the subordinate concepts radiate outward in all directions, in the concept maps the most important concepts are usually placed at the top of the map, and the more particular at the bottom.

Concept maps are graphic organizers that convey factual information, but are more effective than text to help readers build complex inferences and integrate the information they provide (Vekiri, 2002). They also have the potential to improve the accessibility and usability during a research and present visual-spacial cues that can guide a selection or categorization.

Concept maps can be used in two different approaches: for representing the tacit knowledge regarding analytical structures that are not perspective dependant or for making explicit different subjective points of view toward a particular problem.

In the first approach they seek to understand the perspectives of different stakeholders involved in a complex societal problem, eliciting and representing knowledge formally, being an important tool for structuring and decision making. In this sense, they are one alternative tool for conveying information in problem structuring methods (Rosenhead & Mingers, 2001).

In the second approach they seek to reflect the conceptual organization of a discipline or part thereof, i.e., derive their existence from the conceptual structure of an area of knowledge (Moreira, 1979). They represent a structure that goes from the broader concepts to the less inclusive and are used to support hierarchical ordering and sequencing of learning content in order to provide adequate stimuli to the reader.

## 5. State of Art – Nutrition software

Computerized self-assessment programs have been well received by nutrition practitioners, especially when key features such as "point and click" and professional support are available throughout the self-assessment (Heath et al, 2000). Where computer programs have been used in dietary self-assessment for diabetes management programs, comprehension of assessment results was greater than in prior interventions that did not include computerized self assessment (Nebel et al, 2002). A lack of computer knowledge and skills can result in negative experiences with computerized dietary self-assessment programs (Nebel et al, 2002) but it appears that the main limitation is users' ability to report accurately on their health rather than their ability to use the computer (Probst et al, 2005).

Moura et al (2006) presented a study making a comparison between the usability of the software to support clinical nutrition in Brazil. In their work they used the diet DietWin Pro 2.0 and Pro 4.0 since they are the main contributors to the nutritional assessment, according to professionals working in the field of clinical nutrition. Both present requirements for clinical evaluation and composition of patient's diet (formula for calculating energy expenditure and nutritional assessment, tables of food registered composition, follow up medical tools like anthropometric and biochemical data) that are used daily by nutritionist.

From the point of view of decision support, there are still many functions to be implemented. DietWin Professional 2.0 provides a higher level of user satisfaction, because of its friendly interface, ensuring a higher quality of use. Similar results were obtained by Quadros et al (2004) for DietWin Professional 2.0 and 4.0 PRO diet. Coelho et al (2008) published a further study with a comparison of the functionality of the software to support clinical nutrition in Brazil, analyzing eight different software on different criteria and concluded that DietWin Professional 2.0, followed by diet PRO 4.0 are the most complete.

## 6. Using the Concept Map for the specification of food constraints (Diet Therapy)

The diet therapy aims to provide calories and nutrients needed to minimize weight loss, regain nutritional status and avoid cardiac overload. Information for the first stage of this work comes from the interviews conducted with professionals on nutrition from the Institute of Nutrition of UFRJ and a patient who suffers from heart failure (HF).

To achieve these goals some nutrients should be observed especially in patients with HF (specifically a patient who fits into the problem addressed, a gentleman of 55 years and 80kg 176 pounds), these are (adapted from Sahade and Montera, 2009):

| Nutrients | Recomendations |
|---|---|
| Dietary Energy Values | 28 to 32kcal/kg/day |
| Carbohydrate | 50 to 60%<br>Prioritize low-glycemic load carbohydrates |
| Protein | 0,8 to 1,0g/kg/day |
| Saturated Fat | <30% of the energetic value of the diet (aprox 9g/day) |
| Calcium | 1000 mg/day at least |
| Copper | 0,9 to 10 mg/day |
| Cholesterol | <200g/day |
| Sodium | 2-3g/day |
| Zinc | 15 to 40 mg/day |
| Vitamin C | >90 mg/day |
| Fibers | 20g to 30g/day |
| Vitamin B6 | 2mg/day |
| Magnesium | 350 to 420mg/day |
| Manganese | 2,3mg to 11mg/day |
| Iron | 8mg to 40mg/day |

Table 1: Dietary adequacy for patients with heart failure (adapted from Sahade and Montera, 2009)

To aid in the problem modeling, a conceptual map was made where the nutritional needs are central elements of the concept map. Some of their main nodes will be detailed below, which in this problem correspond to the constraints of the linear programming model:

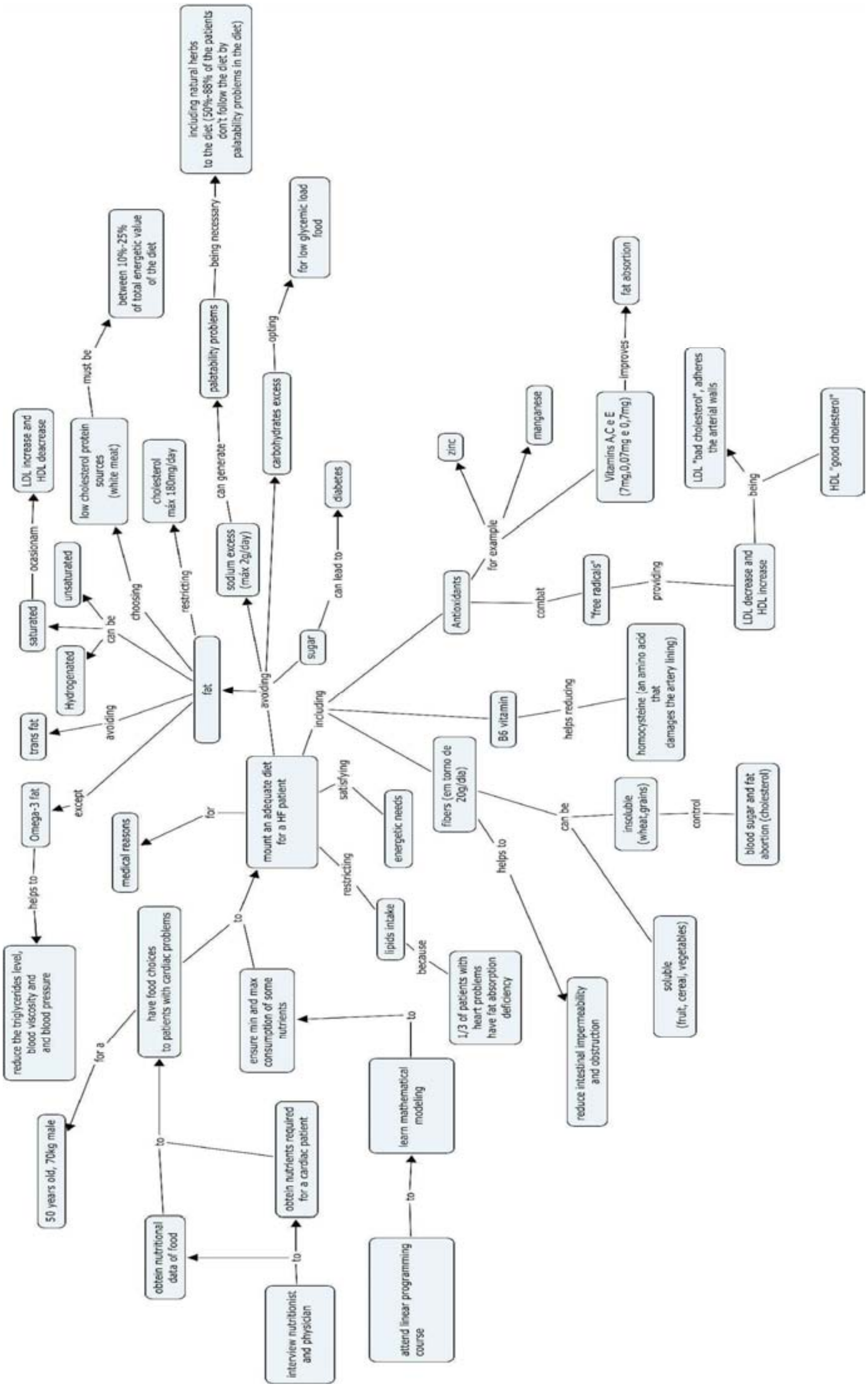


Figure 1: Nutrition for a cardiac patient – Concept Map

- **Energy Constraint**

Given the weight loss that often occurs, the specialist should seek to supply energy needs in order to keep weight as close as one considers the ideal.

In previous studies (Aquilani ***et al,*** 2003), based on the analysis of nutritional intake, recommended for clinically stable HF patients 28kcal/kg for patients with adequate nutritional status, and up to 32kcal/kg for nutritionally depleted patients. An intake below these levels can cause loss of lean mass.

- **Carbohydrate Constraint**

The recommendation of carbohydrates in general ranges from 50% to 60% of the energetic value of the diet, always giving preference to carbohydrates with low glycemic load (Sahade ***et al,*** 2009).

- **Fibers Constraint**

The daily recommendation for fibers is 20g to 30g per day. The intake of fiber prevents constipation and therefore straining, since the intestinal peristalsis may predispose to changes in heart rhythm (Sahade ***et al,*** 2009).

- **Proteins Constraint**

Protein requirements for adults with heart failure range from 0.8g/kg to 1.0g/kg (adult with normal BMI) (Sahade ***et al,*** 2009).

- **Cholesterol Constraint**

There should be a maximum intake of 200 mg of cholesterol per day. It is important to regulate the consumption of cholesterol in heart patients because these fatty substances accumulate in the arteries, narrowing and clogging them.

- **Calcium Constraint**

Calcium is a essential nutrient for maintaining bone mass. Previous studies (Largeril ***et al,*** 2005) show that 50% of patients with heart failure have osteopenia or osteoporosis. In addition, low calcium levels are potentially proarrhythmic. HF patients should limit their intake in 1000mg to 2500mg of Calcium daily..

- **Copper, Zinc, Vitamin C and Manganese Constraints**

These micronutrients act as antioxidants contributing to the reduction of oxidative stress and the resulting damage (Sole ***et al*** 2002, Witte ***et al*** 2002, Lorgeril ***et a***l 2005) and therefore promotes a reduction of the so-called "free radicals", providing a decrease in LDL and increase in HDL. Specialists should restrict intake in 2,3mg to 11mg/day of Manganese, between 15mg and 40mg zinc/day, at least 90 mg/day of Vitamin C and 0,9 to 10 mg/day of Copper.

- **Vitamin B6 Constraint (piridoxin)**

Vitamin B6 helps in lowering homocysteine, an amino acid that damages the lining of the arteries. It is recommended a minimum intake of 2 mg daily (Sole ***et al,*** 2002).

- **Saturated Fat Constraint**

The intake of saturated fats increases bad cholesterol (LDL) that is deposited in the arteries, so it is very important to control their intake. The upper limit for intake is 9g/day (Sahade ***et al,*** 2009).

- **Iron Constraint**

Cardiac involvement is a major complication of iron overload and the HF framework may be aggravated if the patient exceeds the upper limit of iron intake (Cancado, 2007). HF patients should limit their intake in 8mg to 40mg/Day.

## 7. Data used

An adequate dataset for available food can be found in the Brazilian Table of Food Composition, TACO (produced by the Center for Studies and Research in Nutrition of UNICAMP – University of Campinas), it contains 597 different kinds of food consumed in Brazil and their nutritional value. The data in this table refers to portions of 100g of raw food and 200 types of food were chosen (for software limitation reasons), with representatives from all the following groups of aliments: meats, vegetables, fruits, cereals, milk and dairy products and grains, in order to get a balanced diet.

As regards the formulation of the constraints, nutritionists from the Nutrition Institute at UFRJ (Federal University of Rio de Janeiro) were consulted for validating and aggregating additional information about requirements for a person with HF. The concept map was a key tool for communicating and constructing knowledge concerning the problem structuring.

## 8. Formulation and Results

Linear programming was used for the formulation and problem solving, where the decision variables were portions of food (grams) satisfying the constraints, as explained above. Initially it was considered an objective function to minimize saturated fat, therefore, we obtained the daily diet meeting only nutritional requirements at the lowest possible consume of saturated fat:

- 400g of pasta
- 110g of caruru
- 80g of okra
- 110ml of skimmed milk
- 69g of pea
- Total saturated fat: 0g

One can clearly observe that this is not an adequate diet for a real case since it is totally unbalanced, which does not make it palatable, so, restrictions on food consumption were introduced, including a mass of food consumed for each food group (fruits, vegetables, milk and dairy products, meats, cereals and grains), where the patient is required to consume at least certain amounts of each food group, avoiding excessive consumption of certain foods, thus making the meal more palatable and balanced.

These restrictions on consumption were obtained through consultation with dietitians, estimated by the sensitivity and experience of the specialist and can be seen below:

- Mín 100g and Máx 150g of fruits
- Mín 200g and Máx 300g of vegetables
- Mín 200g and Máx 300 g of meat
- Mín 100g and Máx 200g of milk and dairy products
- Mín 200g and Máx 300g of cereals
- Mín 160g and Máx 200g of grains.

From this new situation, much more suited to a real scenario, was obtained the following result for a daily menu:

- 140g of rice
- 60g of bread
- 200g of okra
- 100g of orange
- 200g of fried European hike (fish)
- 200ml of skimmed milk
- 160g of cooked black beans

## 9. Conclusions and Future Developments

In general, people with heart problems suffer change in his normal life, because of inability to perform certain everyday tasks, resulting from the HF symptoms. The impact of the HF and negative interference in people's lives are important, so it is extremely important that the patient understands why the diet changes, for only thus will he follow it, making it efficient.

This paper also highlights how the CMs can help to structure and model the problem treated, since it is a complex problem and has multiple agents, the use of CMs becomes invaluable as it will emphasize the vision of multiple agents, as well as their reactions, interests and complex nature, assisting in structuring, organizing and glimpse of the data to the subsequent mathematical approach that will be given.

Also, it can be seen that through a simple approach by linear programming is possible to reach satisfactory results and consistent with reality. Since the HF is a relevant issue to society, this work may have future developments through a more complex modeling via multiobjective programming or goal programming, reaching to the development of a model or software that allows you to customize the cardiac diet. This customization would be a difference in the model and can be achieved by increasing the database of food and capturing inputs relating to patient characteristics, inserting particular data such as age, sex, weight and even if the patient practice physical activities optimizing different objective functions. Thus, in this new model, the formulation of the diet would be much more personal and not so widespread, and more useful as heart diseases are complex problems and have to be analyzed more variables than simply meet the nutritional constraints.

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