

# The Health Advisor Project

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**Abstract** – Healthcare is one of the top social and economic problems facing Americans today, healthcare amounts to 2/3 of the total U.S. budget and it is growing at an alarming rate. Most Americans agree that healthcare reform is necessary. One of the concerns, it is the fact that the healthcare industry is not using today's technology to keep patients records, treatments for illness, and Healthcare provider's history. This concern will be a priority as soon as changes start occurring. The health Advisor project is based on this premise, and its purpose is to help a patient find not only what exactly is his or her illness, but to find the possible treatments, the location of the healthcare providers available for those treatments, the cost of those healthcare providers, and the risk associated with each healthcare provider. The Healthcare Advisor will also help the patients keep track of their progress as they receive treatment.

## INTRODUCTION

As stated above the healthcare system in the U.S. is not working and it needs to be fixed as soon as possible. The annual federal budget is \$3 trillion and the healthcare expenditures exceed \$2 trillion a year. The Robert Wood Johnson Foundation reported that the cost of Healthcare to the regular consumer increased 30 percent between 2001 and 2005, while income for the same period of time increased 3 percent. Nearly 75 million Americans are either uninsured or underinsured, because the cost of health insurance cost an average of \$12,000 a year. Half of the bankruptcies in the United States are caused by medical expenses. At this rate, the healthcare system in the U.S. is becoming, not only the most expensive, but also the worst in the world.

The treatment of chronic diseases is one of the most costly problems of health care. To make health insurance affordable, the treatment and the delivery of the treatment for chronic diseases has to change. 70% of all health care spending is towards chronic diseases like Diabetes, Parkinsons, Alzheimers, and even Asthma. Most chronic diseases develop from preventable problems like smoking, obesity, or inactivity. Therefore, patient involvement in their own care, specially, when the patient has a chronic disease, is necessary, in order to decrease the cost of health care.

The U.S. government and the private industry are well aware of the lack of technology in the health care system. Their focal point is to make sure that within a short period of time, the patient's health record along with the Health care provider's history and information on available treatments for every disease will be available on the internet. This way, patients will have easy access to this information for their own benefit, and doctors and researches will be able to do their work more efficiently.

Having the developments stated above as premise, this paper focuses on a computer system that enables the patients to take control of their disease, through self monitoring and web information.

## METHODS

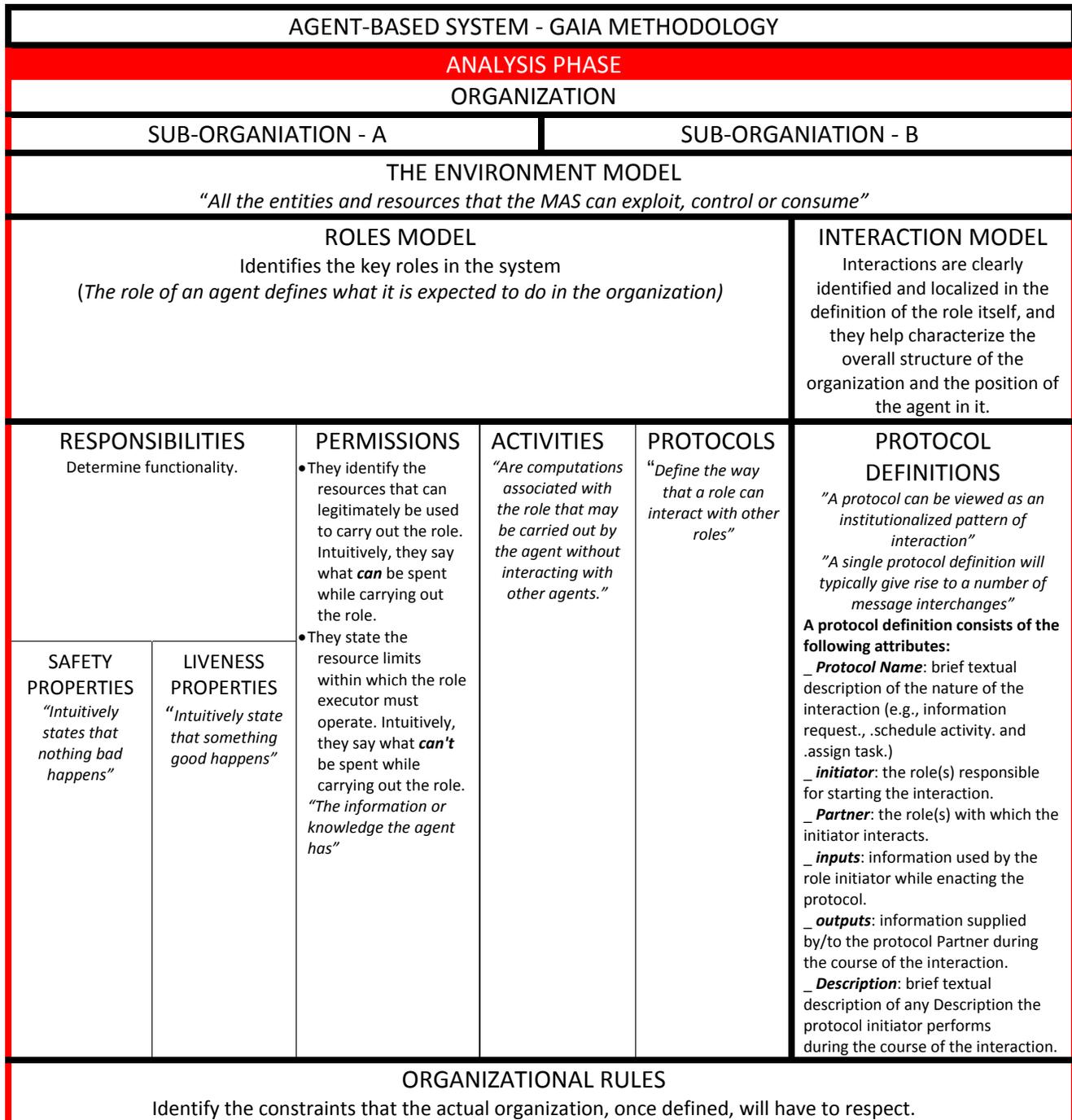
The Health Advisor will have an interface for the patients to enter their Diagnosis, personal information, Health Insurance, and the answers to the Health Related Quality Of Life (HRQOL) questionnaire. The patient will be able to read and print a report with the Diagnostic's description, the possible treatments for the illness, a list of possible healthcare providers along with their cost with and without health insurance, and the risk associated with each healthcare provider. The system will store the patient's personal information, diagnostics, treatments, healthcare providers with their cost and risk, and the patient's progress as it is determined periodically from the answers to the questionnaire.

All of the information above will be obtained by the system from the patient or databases on the internet.

## THE GAIA METHODOLOGY

The Health advisor is a system that searches for information on the web, thus we decided to use a multi-Agent system (MAS), and found that it will be appropriate to use Michael Wooldridge’s GAIA Methodology for the analysis and design phases of the health advisor. In this paper we will first explain how this methodology works, then how it was applied to this project.

In figure 1 we show from top to bottom a summary of the steps for the analysis phase:



**Figure 1 - Analysis phase with GAIA Methodology**

## **THE ANALYSIS PROCESS**

### **1. The organization**

The GAIA Methodology is based on the notion that the system that is to be analyzed can be compared to a *human organization*, in which there is a group of autonomous individuals who are interacting. Each of these individuals plays one or more well defined roles in the organization, and each of these roles includes a set of responsibilities.

### **2. The Environment Model**

Modeling the environment involves determining all the entities and resources that the MAS can exploit, control or consume when it is working towards the achievement of the organizational goal. In other words while analyzing the environment, it needs to determine what resources can be accessed by the agents and any constraints associated with each resource. This in turn will create a representation of the environment as it is perceived by the agents for any given scenario.

### **3. The Roles Model (Preliminary)**

To identify the roles in the system we can use the human organization analogy, thus the roles will correspond to those of an individual, a department, or the organization itself. After all the roles with their corresponding set of responsibilities, permissions, activities, and protocols have been defined as prescribed in Figure 1, the output will be the preliminary role model.

### **4. The Interaction Model (Preliminary)**

After the role model has been created, each role will have a set of protocols, which determine the Interaction Model. An interaction model, therefore, captures the recurring patterns of inter role interaction. Once fully elaborated an interaction model should document the participants of the interaction, the information being passed, and a description of the interaction.

### **5. Organizational Rules**

In this step of the analysis phase we need to identify the rules that the actual organization, once it has been defined, all entities will have to respect. This step is very important in the analysis phase for at least two reasons. It may redefine the roles previously defined and it helps to determine the structure of the organization for the structure design phase.

**6.** Iterate steps 3 to 5 to find the final Role and Interaction Models.

## THE DESIGN PROCESS

In figure 2 we show a description for the Architectural and Detailed design phases:

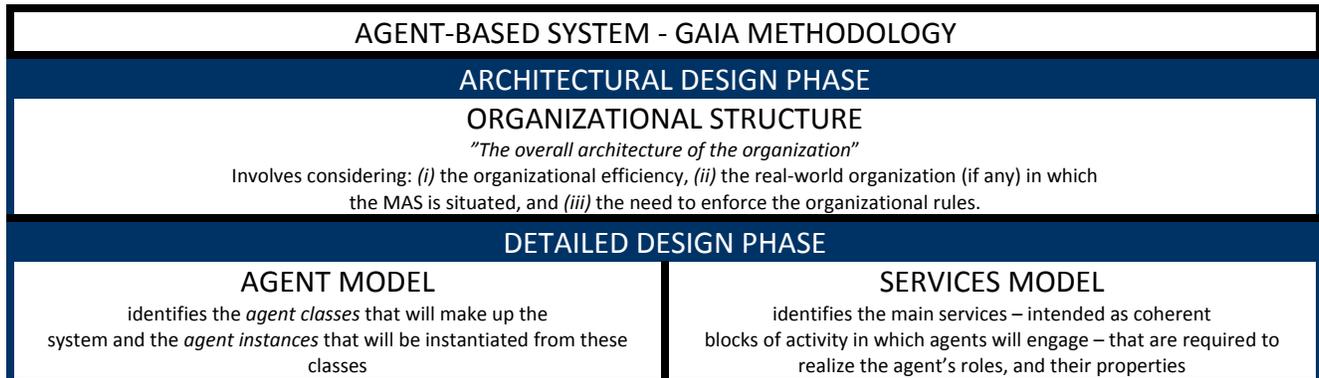


Figure 2 - Architectural and Detailed design phases with GAIA Methodology

### 1. Architectural Design Phase

The role model illustrates all the roles of an organization and their positions in that organization. Therefore, a role model also implicitly defines the overall architecture of the organization.

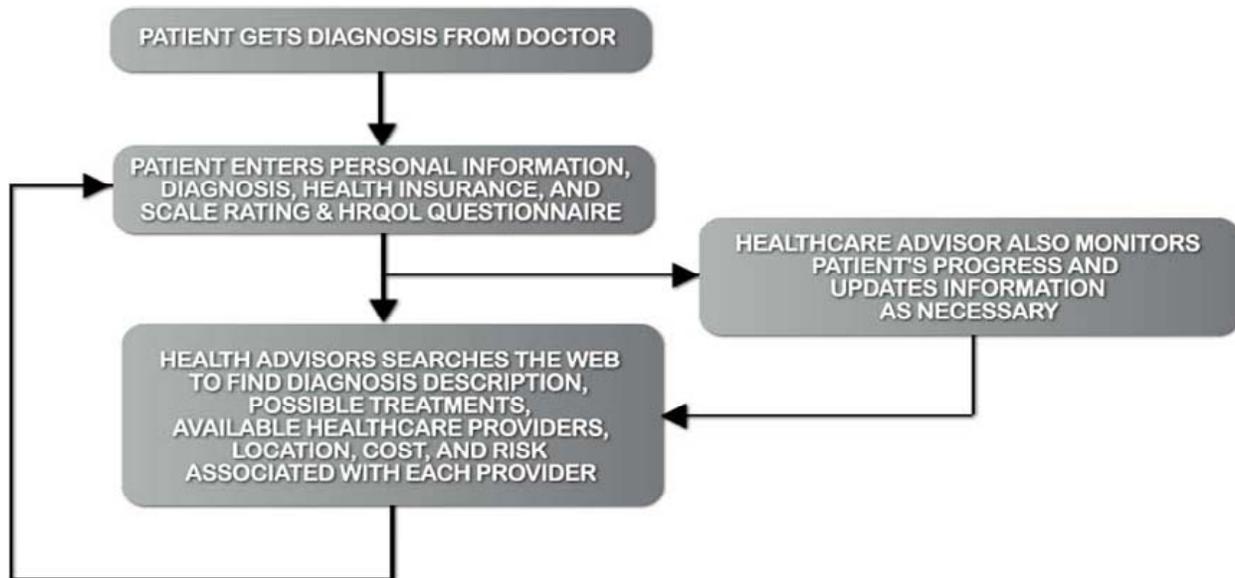
### 2. Detailed Design Phase

- **The Agent Model:** Identify the *agent classes* that will make up the system. There may be a one-to-one correspondence between roles and agents, although a number of closely related roles can be assigned to the same agent class for the purpose of efficiency. Each agent class should be defined with its corresponding name, associated roles, and operations.
- **The Services Model:** This model identifies the main services, which should be coherent blocks of activity in which the agents will engage. These blocks of activity are necessary to accomplish the agent's roles with their related properties.

## THE HEALTH ADVISOR OVERVIEW

For the health advisor to work it is essential that the patient first get the illness diagnosis from the doctor. This information, along with the patient's Health Insurance and personal information (i.e. Name, Age, Ethnic, address, etc) will serve as the input to the health advisor, the first time around. Later for the health advisor to be able to monitor the patient's

progress, it is necessary that the patient answers the health related quality of life (HRQOL) questionnaire as accurate as possible.



**Figure 3 - Health Advisor Overview**

The Health advisor takes this information and searches on the internet for the following:

- A detailed description of the illness
- A list of possible treatments for the particular illness
- A list of healthcare providers for each particular treatment
- The cost with and without insurance for each healthcare provider
- The risk associated with each healthcare provider

On a regular basis the patient will answer the HRQOL questionnaire. Using the answers to the questionnaire, the health advisor will determine the patient's progress and decide whether it should search for new treatments and/or healthcare providers.

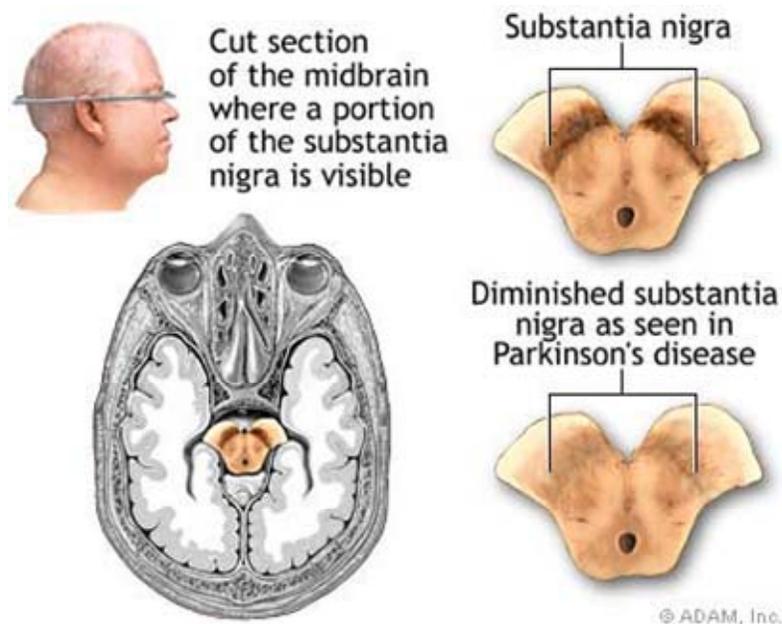
## **CASE OVERVIEW**

In order to do a more accurate analysis, we used as a test case the Parkinson's disease. We will give an overview of this disease as background for the actual analysis and design of the health advisor.

### **Parkinson's disease**

Parkinson's disease arises when nerve cells of the substantia nigra in the brain die or become damaged. When the nerve cells are normal, they produce a chemical known as dopamine. Dopamine is the messenger responsible for broadcasting signals between the

substantia nigra and the corpus striatum, to produce smooth movement of the muscles. When there is a lack of dopamine, the nerve cells of the striatum fire uncontrollably, leaving patients unable to move normally.



**Figure 4 – Parkinson's Disease (Univ. of Wisconsin School of Medicine)**

### **Possible Causes of Parkinson's Disease**

Free radicals, which are unstable and potentially damaging molecules produced by chemical reactions, may be the reason for the death of nerve cells, which consecutively leads to Parkinson's disease. Free radicals are missing one electron; as a result, they are unstable. In a process described as oxidation, the free radicals try to replace this missing electron by reacting with other molecules, especially metals such as iron. This oxidation harms tissues, as well as neurons. Evidence of oxidative free radicals, is the fact that patients with the disease have high levels of iron in the brain, more specifically in the substantia nigra, and low levels of ferritin, which forms a ring around the iron to isolate it, and consequently provides a protective mechanism.

External or internal toxins that destroy dopaminergic neurons, when the person is exposed to pesticides or through toxins in the food, may be the cause of Parkinson's disease. This theory is based on the fact that there are a number of toxins and neuroleptic drugs that are known to induce parkinsonian symptoms in humans. So far, however, the research is not conclusive that toxins are the cause of the disease.

Genetic factors are the latest theory being explored in the development of Parkinson's disease. The reason for this theory is that fifteen to twenty percent of the people with Parkinson's disease have a close relative who has Parkinson's disease themselves, or have experienced parkinsonian symptoms such as tremors.

## Clinical Motor features of Parkinson’s Disease

- **Resting tremor:** An unintentional shaking movement produced when muscles constantly contract and relax
- **Bradykinesia:** Slowed ability to start and continue movements, or impaired ability to adjust the body's position. This can be a symptom of Parkinson's disease, or a side effect from the medications
- **Rigidity:** or **cogwheel rigidity** basically refers to the muscle tone. Rigidity is experienced as a sense of stiffness or tightness of the muscles
- **Postural instability:** this refers to the state when a person can not keep the body in an stable or balance position.

## Clinical Non-Motor features of Parkinson’s Disease

- **Psychiatric disorders:** Depression and anxiety
- **Cognitive disorders:** memory processing, perception and problem solving
- **Sleep abnormalities:** REM sleep behavior disorder, Insomnia, Daytime somnolence
- **Autonomic dysfunction:** Constipation, Dysphagia (difficulty in swallowing), Hypersalivation, Orthostatic hypotension
- **Sensory:** Olfactory dysfunction (anosmia)
- **Miscellaneous:** Fatigue and weight loss

## PD Rating Scales: Motor Symptoms

<p><b>Hoehn and Yahr scale:</b> commonly used system for describing how the symptoms of Parkinson's disease progress. The scale allocates stages from 0 to 5 to indicate the relative level of disability.</p>	<ul style="list-style-type: none"> <li>• 0 (no signs of disease) to 5 (wheelchair-bound)</li> <li>• Valuable for broadly classifying disease severity             <ul style="list-style-type: none"> <li>• Stage one: Symptoms on one side of the body only.</li> <li>• Stage two: Symptoms on both sides of the body. No impairment of balance.</li> <li>• Stage three: Balance impairment. Mild to moderate disease. Physically independent.</li> <li>• Stage four: Severe disability, but still able to walk or stand unassisted.</li> <li>• Stage five: Wheelchair-bound or bedridden unless assisted.</li> </ul> </li> </ul>
<p><b>UPDRS: (Unified Parkinson's Disease Rating Scale)</b> is a rating scale used to follow the longitudinal course of Parkinson's disease.</p>	<ul style="list-style-type: none"> <li>• Widely employed for assessing disability</li> <li>• 70% of physicians incorporate into clinical practice</li> <li>• Comprehensive assessment of motor symptoms</li> <li>• It is made up of the following sections:             <ul style="list-style-type: none"> <li>• Mentation, behavior, and mood;</li> <li>• Activities of daily living;</li> <li>• Motor;</li> <li>• Complications of therapy;</li> </ul> </li> </ul>
<p><b>MDS-UPDRS:</b> clinimetric testing program for the Movement Disorder Society (MDS)-sponsored revision of the Unified Parkinson's Disease Rating Scale.</p>	<ul style="list-style-type: none"> <li>• Modified UPDRS to integrate nonmotor symptoms</li> <li>• Currently being validated</li> </ul>

**Table 1 – Motor Symptoms - PD Rating Scales**

## PD Rating Scales: HRQOL

Measure	No. items	Description of items addressed
PDQ-39	39	Mobility, ADL, emotional well-being, stigma, social support, cognition, communication, physical discomfort
PDQ-8	8	Same as PDQ-39
PDQUALIF	33	Social function, self-image, sexuality, sleep patterns, outlook, physical function, independence, urinary function, plus 1 item of global HRQOL
PDQL	37	Parkinsonian symptoms, systemic symptoms, emotional function, social function
PIMS	10	Self-image, family/community relationships, work, leisure, travel, safety, financial security, sexuality

**Table 2 – Non-Motor Symptoms HRQOL - PD Rating Scales**

## Effective treatment strategy for PD

Lack of dopamine is the primary cause of the symptoms in Parkinson's disease, therefore, to replenish dopamine should be the main goal. There are three drug treatments available for this purpose:

1. levodopa with dopa-decarboxylase inhibitors (DDIs) (eg, carbidopa, benserazide) and catechol-*O*-methyltransferase (COMT) (eg, entacapone, tolcapone) inhibitors,
2. dopamine agonists
3. MAO-B inhibitors.

The other possibility is to block the transmissions from the corpus striatum, which requires surgery.

Levodopa or L-DOPA (3,4-dihydroxy-L-phenylalanine) is an amino acid that occurs naturally in the body from L-Tyrosine. It is also found in some foods. In the brain, L-DOPA is converted into dopamine. Because levodopa is rapidly metabolized in the periphery by dopa-decarboxylase and/or Catechol-*O*-methyltransferase before it crosses the blood brain barrier, it is typically administered in combination with a dopa-decarboxylase inhibitor (DDI) like carbidopa, or benserazide, and Catechol-*O*-methyltransferase inhibitors (COMT) like entacapone, or tolcapone. These combinations of drugs have side effects including dyskinesia, nausea, and vomiting.

Dopamine receptor agonists were originally developed as an addition therapy to levodopa to treat the motor features of PD. Discovery of nonergot agonists (pramipexole, ropinirole, and rotigotine) have been approved for monotherapy in the initial stages of PD with the intention of delaying the treatment with Levodopa. Clinical studies have demonstrated that when administered as monotherapy or as adjunct therapy to levodopa, these agonists allow reduced doses of levodopa, improve motor symptoms, and improve activities of daily living in patients who initiate therapy early. There are side effects associated with this treatment, including postural hypotension, somnolence, hallucinations, and impulse-control disorders.

Monoamine oxidase-B inhibitors (MAO-B) like selegiline and rasagiline are known to block the breakdown of dopamine to dihydroxyphenylacetic acid in the brain, resulting in a better supply of dopamine. Therefore, inhibition of MAO-B can increase the dopaminergic response without having to increase the dosage of levodopa. However, these inhibitors are metabolized to amphetamine and methamphetamine metabolites, which may provoke sleep disorders and hallucinations in some patients.

The surgery option is called Deep Brain Stimulation, which is a way to inactivate the areas of the brain that cause Parkinsons without destroying the brain. In deep brain stimulation, a couple of electrodes are placed in the thalamus for the treatment of tremor with multiple sclerosis, or in the globus pallidus for Parkinson's disease.

The electrodes are connected by wires to a device like a pacemaker called an impulse generator (IPG), which is implanted under the skin of the chest, below the collarbone. This device sends continuous electrical pulses to the target areas blocking the impulses that cause tremors. This has the equivalent effect of a thalamotomy or a pallidotomy surgery without destroying those parts of the brain.

## **HEALTH ADVISOR ANALYSIS PHASE (Parkinsons Case)**

**THE ORGANIZATION** (The Health Advisor does not have to be divided into Sub-organizations)

**THE ENVIRONMENT** (*All the entities and resources that the MAS can exploit, control or consume*)

- Diagnosis Information (Illness)
- Patient Personal Information (Name, Age, Ethnic, Health Insurance)
- Patient's answers to Rating Scale and Health Related quality of Life (HRQOL) questionnaire
- Web database of illness information
- Web database of Treatment information for all illnesses
- Web database of Health Insurance
- Web database of Health Care Providers (Hospitals, Clinics, Doctors, Locations, and cost/treatment)
- Web database of Health Care Providers' History and Statistical Records
- Knowledge of particular illness features
- Knowledge of particular illness development rating scales
- Patient's History Database

**ROLES MODEL** (*What is each entity expected to do in the organization*)

<b>Role Schema:</b>	<b>Patient</b>
<b>Description</b>	Person with illness
<b>Protocols and Activities</b>	Inputs via user interface the Diagnosis, personal information, Health Insurance, and answers to rating scale and HRQOL questionnaire
<b>Permissions</b>	Use doctor's diagnosis Answer rating scale and HRQOL questionnaire Use Health Advisor System's recommendations
<b>Responsibilities</b>	
<b>Liveness</b>	Input personal information (Name, Age, Ethnic, etc.) Answer rating scale and HRQOL questionnaire
<b>Safety</b>	Input accurate information

**Table 3 – Patient Role Schema**

<b>Role Schema:</b>	<b>User Interface</b>
<b>Description</b>	Screens where patient communicate with computer
<b>Protocols and Activities</b>	Display screen for Input of Patient's personal info and health Insurance Display screen for rating scale and HRQOL questionnaire Receive the Diagnosis Receive personal information and Health Insurance Name Receive answers to rating scale and HRQOL questionnaire Store information in patient's history database Send information to diagnosis description finder Send information to Monitor Receive report from report generator Display recommendations report
<b>Permissions</b>	Read Patient's input Update patient's history database
<b>Responsibilities</b>	
<b>Liveness</b>	Receive patient's input Store data in patient's history database Send information to diagnosis description finder Send information to Monitor Receive report from Report Generator Display report
<b>Safety</b>	If incorrect input, prompt patient for correct input

**Table 4 – User Interface Role Schema**

<b>Role Schema:</b>	<b>Diagnosis description finder</b>
<b>Description</b>	Search the Web for description of illness
<b>Protocols and Activities</b>	Search in Web database of illness information for description of illness and pass information to Treatment Finder
<b>Permissions</b>	Get diagnosis from user interface Search Web database of illness information Change patient's history database
<b>Responsibilities</b>	
<b>Liveness</b>	Receive diagnosis from user interface Find description of illness Update patient's history database send diagnosis description and patient personal info to Treatment Finder Using Diagnosis and monitor's assessment to decide whether to search for another description or not.
<b>Safety</b>	If illness not found, ask patient through user interface for correct diagnosis

**Table 5 – Diagnosis Description Finder Role Schema**

<b>Role Schema:</b>	<b>Treatment Finder</b>
<b>Description</b>	Search the Web for possible treatments for illness
<b>Protocols and Activities</b>	Get diagnosis description from Diagnosis description finder Get patient progress assessment from monitor if any Get health insurance from patient history database Search in Web database of treatments for illness and return all possible treatments available, then pass information to Health Care Provider finder
<b>Permissions</b>	Read Patient's answers to questionnaire from user interface Read Monitor's patient progress assessment Read patient's history database Read Diagnosis description from Diagnosis description finder Search Web database of treatments for illness
<b>Responsibilities</b>	
<b>Liveness</b>	Receive answers to questionnaire from user interface Receive patient progress assessment from monitor Receive last assessment from patient's history database Find all possible treatments for illness Send possible treatments info and patient Health Ins. to Health Care Provider Finder Using Diagnosis, Monitor's assessment, Patient History, and time range decide whether to search for another set of treatments or not.
<b>Safety</b>	If treatments not found send "Treatment not found" message to user interface

**Table 6 – Treatment Finder Role Schema**

<b>Role Schema:</b>	<b>Health Care Provider Finder</b>
<b>Description</b>	Search the Web to find all possible Health Care Providers for each treatment
<b>Protocols and Activities</b>	Get monitor's assessment Get possible treatments and health insurance from Treatment finder Search in Web database of Health Care Providers and return all possible Health Care Providers available with location and cost Send Health Care Providers to Cost Finder and to Risk finder.
<b>Permissions</b>	Read monitor's assessment Read treatment information from Treatment finder Search Web database of Health Care Providers
<b>Responsibilities</b>	
<b>Liveness</b>	Receive monitor's assessment Receive treatment information from Treatment finder Find all available Health Care Providers for all treatments Send Health Care Providers list and patient health Insurance to Cost and Risk finders Send Health Care Providers info for all treatments in Location order to report generator Using Monitor's assessment, list of possible treatments, and time range decide whether to search for another Health Care Provider for each treatment or not.
<b>Safety</b>	If Health Care Provider not found for a particular treatment, send "Health Care Provider not found" to report generator

**Table 7 – Healthcare Provider Finder Role Schema**

<b>Role Schema:</b>	<b>Cost per Health Care Provider Finder</b>
<b>Description</b>	Search the Web to find cost of treatment for a particular Health Care Provider
<b>Protocols and Activities</b>	Get available Health Care Providers for all treatments and Health Insurance from Health Care Provider finder Search in Web database of Health Insurance and return cost associated with Health Care Providers for each treatment through Patient's health insurance Sort information in cost order send information to report generator
<b>Permissions</b>	Read Health Care Providers information and Patient's health Insurance from Health Care Providers finder Search Web database of Health Insurance
<b>Responsibilities</b>	
<b>Liveness</b>	Receive Health Care Providers for all treatments and Health Insurance Find cost associated with Health Care Providers for each treatment using patient's health Insurance Sort information in cost order Send cost of Health Care Providers info in cost order to report generator Using Monitor's assessment, list of possible treatments, and Health Insurance plan to negotiate best possible cost.
<b>Safety</b>	If cost not found, pass "Cost not found" message to report generator
<b>Role Schema:</b>	Cost per Health Care Provider Finder

**Table 8 – Cost per Health Care Provider Finder Role Schema**

Description	Risk per Health Care Provider Finder
<b>Protocols and Activities</b>	Search the Web to find risk associated with treatment with a particular Health Care Provider
<b>Permissions</b>	Get available Health Care Providers for all treatments and Health Insurance from Health Care Provider finder Search in Web database of Health Care Providers' statistical records and return risk associated with Health Care Providers for each particular treatment. Sort information in Risk order Send information in Risk order to report generator
<b>Responsibilities</b>	Read Health Care Providers for all treatments and Patient's health Insurance Information from Health Care Provider finder Search Web database of Health Care Providers' statistical records
<b>Liveness</b>	
<b>Safety</b>	Receive Health Care Providers for all treatments and Patient's health Insurance Info Find risk associated with Health Care Providers for each treatment Sort Health Care Providers in risk order Send Health Care Providers for each treatment info in risk order to report generator Using different statistical measurements from database decide the risk level for each Health Care Provider for each treatment.

**Table 9 – Risk per Health Care Provider Finder Role Schema**

Description	Report Generator
<b>Protocols and Activities</b>	Software that organizes results and displays them for Patient use
<b>Permissions</b>	Get results from Health Care Provider finder Get results from Cost finder Get results from Risk finder Organize results Display results and recommendations
<b>Responsibilities</b>	Read Patient's Information from questionnaire Read Monitor's patient progress assessment Read Health Care Providers information from Health Care Providers finder Read cost information from cost finder Read risk information from risk finder
<b>Liveness</b>	
<b>Safety</b>	Read Patient's Information from questionnaire Read Monitor's patient progress assessment Read Health Care Providers information from Health Care Providers finder Read cost information from cost finder Read risk information from risk finder Organize results by location, by risk, by cost Send report to User Interface

**Table 10 – Report Generator Role Schema**

<b>Description</b>	<b>Patient Monitor</b>
<b>Protocols and Activities</b>	Monitors Patient's progress
<b>Permissions</b>	Get patient's answers to questionnaire from user interface Get history from Patient's History Database Make patient's progress assessment Send assessment to Treatment finder Send assessment to Report Generator
<b>Responsibilities</b>	Read Patient's answers to questionnaire Read Patient's History Database
<b>Liveness</b>	
<b>Safety</b>	Receive patient's answers to questionnaire Receive history from Patient's History Database Make patient's progress assessment Send assessment to Treatment finder Send assessment to Report generator Store assessment in patient's history database

**Table 11 – Patient Monitor Role Schema**

**INTERACTIONS MODEL** (*Message Interchanges*)

<b>Protocol Name:</b>	<b>Input patient Info</b>
<b>Initiator</b>	Patient
<b>Partner</b>	User Interface
<b>Inputs</b>	Name, Age, Ethnic, Health Insurance, and Diagnosis
<b>Outputs</b>	Prompt messages for correct input Patient's information, Health Insurance, and Diagnosis
<b>Description</b>	Get patient's personal information, Health Insurance and Diagnosis

**Table 12 – Input Patient Info Protocol**

<b>Protocol Name:</b>	<b>Answer Rating Scale and HRQOL questionnaire</b>
<b>Initiator</b>	Patient
<b>Partner</b>	User Interface
<b>Inputs</b>	Name, Age, Ethnic, Health Insurance, and Diagnosis
<b>Outputs</b>	Prompt messages for correct input, Patient's answers to questionnaire
<b>Description</b>	Get patient's personal information, Health Insurance and Diagnosis

**Table 13 – Answer Rating Scale and HRQOL questionnaire Protocol**

<b>Protocol Name:</b>	<b>Send Diagnosis to Dictionary finder</b>
<b>Initiator</b>	User interface
<b>Partner</b>	Diagnosis description finder
<b>Inputs</b>	Diagnosis
<b>Outputs</b>	Prompt message for correct diagnosis input if diagnosis not found Diagnosis read
<b>Description</b>	The Diagnosis that the patient has input into the user interface is sent to the Diagnosis description finder

**Table 14 – Send Diagnosis to Dictionary finder Protocol**

<b>Protocol Name:</b>	<b>Store Patient’s info in patient’s history database</b>
<b>Initiator</b>	User interface
<b>Partner</b>	Patient’s History Database
<b>Inputs</b>	Patient’s personal info, health Insurance, and diagnosis Answers to questionnaire
<b>Outputs</b>	Prompt message for correct input Patient’s History Database is updated with Personal Info, Health Insurance, and Diagnosis Patient’s History Database is updated with answers to questionnaire
<b>Description</b>	Store Patient’s information, answers to questionnaire in patient’s history database

**Table 15 – Store Patient’s info in patient’s history database Protocol**

<b>Protocol Name:</b>	<b>Send diagnosis description to Treatment finder</b>
<b>Initiator</b>	Diagnosis description finder
<b>Partner</b>	Treatment finder
<b>Inputs</b>	Diagnosis, Diagnosis description
<b>Outputs</b>	Diagnosis description is read Diagnosis description available flag ON
<b>Description</b>	The Diagnosis description finder sends Diagnosis description to Treatment finder

**Table 16 – Send diagnosis description to Treatment finder Protocol**

<b>Protocol Name:</b>	<b>Send progress assessment to Treatment finder</b>
<b>Initiator</b>	Monitor
<b>Partner</b>	Treatment finder
<b>Inputs</b>	Patient's progress assessment Message "progress assessment cannot be determined"
<b>Outputs</b>	Patient's progress assessment read Message read
<b>Description</b>	The monitor sends the Patient's progress assessment to Treatment finder Store assessment in patient's history database Get Patient's personal info from patient's history database Pass assessment to Report generator (set assessment available flag ON)

**Table 17 – Send progress assessment to Treatment finder Protocol**

<b>Protocol Name:</b>	<b>Store progress assessment in Patient's History Database</b>
<b>Initiator</b>	Monitor
<b>Partner</b>	History Database
<b>Inputs</b>	Patient's progress assessment Message "progress assessment cannot be determined"
<b>Outputs</b>	Update Patient's History Database with Patient's progress assessment Progress assessment available flag ON
<b>Description</b>	The monitor stores assessment in patient's history database Get Patient's personal info from patient's history database Pass assessment to Report generator (set assessment available flag ON)

**Table 18 – Store progress assessment in Patient's History Database Protocol**

<b>Protocol Name:</b>	<b>Send progress assessment to Report Generator</b>
<b>Initiator</b>	Monitor
<b>Partner</b>	Report Generator
<b>Inputs</b>	Patient's progress assessment Message "progress assessment cannot be determined"
<b>Outputs</b>	Patient's progress assessment or Message read by report generator
<b>Description</b>	The monitor sends patient's assessment to Report

**Table 19 – Send progress assessment to Report Generator Protocol**

<b>Protocol Name:</b>	<b>Send list of treatments to Health Care Provider finder</b>
<b>Initiator</b>	Treatment finder
<b>Partner</b>	Health Care Provider finder
<b>Inputs</b>	Possible treatments Patient's personal info including health insurance
<b>Outputs</b>	List of possible treatments and personal info read by Health Care Provider finder Set Treatments available flag ON
<b>Description</b>	The Treatment finder sends list of possible treatments and Health Insurance to Health Care Provider finder

**Table 20 – Send list of treatments to Health Care Provider finder Protocol**

<b>Protocol Name:</b>	<b>Send Health Care Providers list to Cost finder</b>
<b>Initiator</b>	Health Care Provider finder
<b>Partner</b>	Cost finder
<b>Inputs</b>	List of Health Care Providers Patient's personal info including health insurance
<b>Outputs</b>	List of Health Care Providers read Patient's personal info including health insurance read Set Health Care Providers available flag ON
<b>Description</b>	The Health Care Provider finder sends the list of available Health Care Providers and Health insurance to the Cost finder

**Table 21 – Send Health Care Providers list to Cost finder Protocol**

<b>Protocol Name:</b>	<b>Send Health Care Providers list to Risk finder</b>
<b>Initiator</b>	Health Care Provider finder
<b>Partner</b>	Risk finder
<b>Inputs</b>	List of Health Care Providers
<b>Outputs</b>	List of Health Care Providers read
<b>Description</b>	The Health Care Provider finder sends the list of available Health Care Providers to the Risk finder

**Table 22 – Send Health Care Providers list to Risk finder Protocol**

<b>Protocol Name:</b>	<b>Send Health Care Providers list in location order to the Report Generator</b>
<b>Initiator</b>	Health Care Provider finder
<b>Partner</b>	Report Generator
<b>Inputs</b>	List of Health Care Providers in location order
<b>Outputs</b>	List of Health Care Providers in location order read
<b>Description</b>	The Health Care Provider finder organizes the Health Care Providers in location order, then sends the list to the Report Generator

**Table 23 – Send Health Care Providers list in location order to the Report Generator Protocol**

<b>Protocol Name:</b>	<b>Send Health Care Providers list in cost order to the Report Generator</b>
<b>Initiator</b>	Cost finder
<b>Partner</b>	Report Generator
<b>Inputs</b>	List of Health Care Providers and cost in cost order
<b>Outputs</b>	List of Health Care Providers and cost read
<b>Description</b>	The Cost finder organizes Health Care Providers and cost list into cost order, then sends the list to the Report Generator

**Table 24 – Send Health Care Providers list in cost order to the Report Generator Protocol**

<b>Protocol Name:</b>	<b>Send Health Care Providers list in risk order to the Report Generator</b>
<b>Initiator</b>	Risk finder
<b>Partner</b>	Report Generator
<b>Inputs</b>	List of Health Care Providers and Risk in risk order
<b>Outputs</b>	List of Health Care Providers and Risk read
<b>Description</b>	The Risk finder organizes Health Care Providers and cost list into risk order, then sends the list to the Report Generator

**Table 25 – Send Health Care Providers list in risk order to the Report Generator Protocol**

<b>Protocol Name:</b>	Send answers of questionnaire to Monitor
<b>Initiator</b>	User Interface
<b>Partner</b>	Monitor
<b>Inputs</b>	patient's answers to rating scale and HRQOL questionnaire
<b>Outputs</b>	patient's answers to rating scale and HRQOL questionnaire read by monitor
<b>Description</b>	The User Interface prompts patient for answers to questionnaire, then sends the patient's answers to rating scale and HRQOL questionnaire to the monitor

**Table 26 – Send answers of questionnaire to Monitor Protocol**

## ORGANIZATIONAL STRUCTURE

There may be some changes in the role model, as we further analyze the system for efficiency. As the Role Model stands, the structure of the organization is single level peer-to-peer.

**AGENT MODEL** (*identifies the agent classes that will make up the system and the agent instances that will be instantiated from these classes*)

<b>Agent Name:</b>	Dictionary Agent
<b>Agent's roles:</b>	Diagnosis description finder
<b>Agent's Operations:</b>	(+) Receive Diagnosis from User Interface (-) Search in Web database of Illness information for description (-) send description of diagnosis to Treatment Agent (A) Using Diagnosis and monitor's assessment decide whether to search for another description or not.

**Table 27 – Dictionary Agent**

<b>Agent Name:</b>	Treatment Agent
<b>Agent's roles:</b>	Treatment finder
<b>Agent's Operations:</b>	(+) Receive Diagnosis description from Dictionary Agent (+) Receive patient's progress assessment from Monitor (+) Get Health Insurance from Patient's History Database (-) Search in Web database of treatments for Illness for possible treatments (-) send possible Treatments to Health Care Provider Agent (A) Using Diagnosis, Monitor's assessment, Patient History, and time range decide whether to search for another set of treatments or not.

**Table 28 – Treatment Agent**

<b>Agent Name:</b>	<b>Healthcare Provider Agent</b>
<b>Agent's roles:</b>	Health Care Provider finder
<b>Agent's Operations:</b>	(+) Receive list of possible treatments from Treatment Agent (+) Receive patient's progress assessment from Monitor (+) Get Health Insurance from Patient's History Database (-) Search in Web database of Health Care Providers for all available Health Care Providers for each treatment. (-) send available Health Care Providers and Health Insurance to Cost Agent (-) send available Health Care Providers and Health Insurance to Risk Agent (A) Using Monitor's assessment, list of possible treatments, and time range decide whether to search for another Health Care Provider for each treatment or not.

**Table 29 – Healthcare Provider Agent**

<b>Agent Name:</b>	<b>Cost Agent</b>
<b>Agent's roles:</b>	Cost per Health Care Provider Finder
<b>Agent's Operations:</b>	(+) Receive list of available Health Care Providers for each possible treatment from Health Care Provider Agent (+) Get Health Insurance from Patient's History Database (-) Search in Web database of Health Insurance for cost of treatment for each Health Care Provider using Health Insurance. (-) send results in cost order to Report Generator (A) Using Monitor's assessment, list of possible treatments, and Health Insurance plan to negotiate best possible cost.

**Table 30 – Cost Agent**

<b>Agent Name:</b>	<b>Risk Agent</b>
<b>Agent's roles:</b>	Risk per Health Care Provider Finder
<b>Agent's Operations:</b>	(+) Receive list of available Health Care Providers for each possible treatment from Health Care Provider Agent (+) Get Health Insurance from Patient's History Database (-) Search in Web database of Health Care Providers' statistical records for risk associated with all Health Care Providers for each treatment. (-) send results in risk order to Report Generator (A) Using different statistical measurements from database decide the risk level for each Health Care Provider for each treatment.

**Table 31 – Risk Agent**

**SERVICES MODEL** (*Identifies the main services – intended as coherent blocks of activity in which agents will engage – that are required to realize the agent’s roles, and their properties*)

<b>Service Name:</b>	<b>User Interface</b>
<b>Service’s roles:</b>	User Interface
<b>Service’s Operations:</b>	<ul style="list-style-type: none"> <li>(+) Receive Diagnosis, Personal information, and Health Insurance from Patient</li> <li>(+) Receive Answers to Questionnaire from Patient</li> <li>(-) Store Diagnosis, Personal information, and Health Insurance in Patient’s History Database</li> <li>(-)Store Answers to Scale Rating and HRQOL Questionnaire in Patient’s History Database</li> <li>(-) Send Diagnosis information to Dictionary Agent</li> <li>(-) Send Diagnosis, Personal information, Health Insurance, and Answers to Scale Rating and HRQOL Questionnaire to Report Generation service</li> </ul>

**Table 32 – User Interface Service**

<b>Service Name:</b>	<b>Report Generation</b>
<b>Service’s roles:</b>	Report Generator
<b>Service’s Operations:</b>	<ul style="list-style-type: none"> <li>(+) Get Diagnosis, Personal information, Health Insurance, and Answers to Scale Rating and HRQOL Questionnaire from User Interface service</li> <li>(+) Receive Health care provider list in location order from Health care provider Agent</li> <li>(+) Receive Health care provider list in cost order from Cost Agent</li> <li>(+) Receive Health care provider list in risk order from Risk Agent</li> <li>(-) Organize Health care provider by location, by risk, by cost</li> <li>(-) Send report to User Interface service</li> </ul>

**Table 33 – Report Generation Service**

<b>Service Name:</b>	<b>Monitoring</b>
<b>Service’s roles:</b>	Monitor
<b>Service’s Operations:</b>	<ul style="list-style-type: none"> <li>(+) Get Diagnosis, Personal information, Health Insurance, and Answers to Scale Rating and HRQOL Questionnaire from User Interface service</li> <li>(+) Get History from Patient’s History Database</li> <li>(-) Make patient’s progress assessment</li> <li>(-) Store patient’s progress assessment in Patients History database</li> <li>(-) Send patient’s progress assessment to Treatment Agent</li> <li>(-) Send patient’s progress assessment to Report Generation service</li> </ul>

**Table 34 – Monitoring Service**

## CONCLUSION AND FUTURE DEVELOPMENTS

With the Health Advisor, patients will be able to take control of their illness, by becoming knowledgeable about their disease, the treatments, the available healthcare providers, their cost, and their risk. The patients will also be able to keep track of their progress with the disease while they are being treated. If all patients become knowledgeable about their health problems, eventually it will affect positively the healthcare system as a whole.

We have the first analysis of the Health Advisor; we might consider changing the Role Model for better efficiency. Once the Role Model has been finalized, we will have to redesign the Agent Model and possibly the Services Model. The final step will be the implementation using possibly Java.

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