A
Decision Support System
For
Prostate Cancer Treatment

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1 INTRODUCTION

The American Cancer Society estimates that one in every six men will be diagnosed with prostate cancer during his lifetime. More than 2 million men in the United State have been diagnosed with prostate cancer at some point are still alive today[1]. Prostate cancer is unique in that it is a slow-moving disease. Quite often a man will die from other natural causes before

their prostate cancer has even become noticeable [2]. Because prostate cancer progresses slowly, patients have a variety of treatment options to choose from. There are many factors that play a role in this complex decision. These factors are driven by the user's health profile (e.g. age or stage of prostate cancer) and preferences (e.g. tolerance of treatment side effects, cost of treatment, etc.).

1.1 OBJECTIVE

The objective of this project is to define, design, and implement a prototype version of a decision support system (DSS) that helps prostate cancer patients choose a treatment that fit both their health profile and preferences. The system is not designed to output an end-all-be-all decision for the patient. Rather it is a self-contained tool that will provide the necessary information to a patient to help him get a better understanding of the available prostate cancer treatments, thereby allowing him to make an informed decision.

1.2 PROBLEM FORMULATION

Typically, a patient will rely on the advice from their doctor. It has been shown that the doctor's advice depends heavily on their specialty [3]. If the doctor is a surgeon, more often than not, they will recommend surgery for the patient. Although surgery may effectively remove the treatment, it may ignore the patient's treatment preferences (e.g. short recovery time, minimal leakage, no chance of recurrence, etc). In addition, patients often receive advice from friends or family based on scientific misconceptions and anecdotal experiences [4]. Thus, a tool needs to be developed that can inform someone who has been diagnosed with prostate cancer about the available treatments.

1.3 SOLUTION

The problem discussed above can be addressed by developing a Decision Support System (DSS) that:

- Can be completed by a patient without any outside help (all the information they need to know is contained within the system)
- Uses data from prostate cancer patients to calculate fields for the model (probability of cancer recurrence, probability of a side effect, etc)
- Elicits the user's health profile (specifically prostate cancer information) and the their preferences concerning prostate cancer treatments
- Accurately assigns weights to the user's preferences for prostate cancer treatment side effects
- Accurately assigns weights to the user's preferences for the following factors:
    - Effectiveness of Prostate Cancer Treatment (Probability of Recurrence)
    - Treatment Recovery Time
    - Tolerance to Side Effects
- Scores the treatments based on the weights and measures of treatment criteria
- Presents the results to the user in a clear manner that allows them to have informed discussions with their doctor about possible treatments

1.4 DELIVERABLES

The following items will be provided:

- A Microsoft Excel based prototype of a Decision Support System for Prostate Cancer Treatments

    - Fully documented to allow for future expansion
- Overview on Decision Support System methodologies
- PowerPoint presentation on the project
- Website based on the project

2 PROSTATE CANCER BACKGROUND

2.1 DEFINITION

Prostate cancer is cancer that starts in the prostate gland. The prostate is a small, walnut-sized structure that makes up part of a man's reproductive system [5].

2.2 DIAGNOSIS

Most prostate cancer is discovered through routine screening. Prostate screening test might include:

- Digital rectal exam (DRE)
- Prostate-specific antigen (PSA) test

PSA testing combined with DRE helps identify cancers at their earliest stages. If an abnormality is detected on a DRE or PSA test, your doctor may recommend a test to determine whether you have prostate cancer or not, such as:

- Ultrasound
- Collecting a sample of prostate tissue

When a biopsy confirms the presence of cancer, the next step, called grading, is to determine the aggressiveness of the cancer. The tissue samples are studied under a microscope, where the cancer cells are compared with healthy prostate cells. As the cancer cells become increasingly different from the healthy cells, the more aggressive and the more likely the cancer will spread quickly. More aggressive cancer cells have higher grades. The most common scale used to evaluate the grade of prostate cancer cells is called a Gleason score. Scoring can range from 2 (nonaggressive cancer) to 10 (very aggressive cancer).

Once a cancer diagnosis has been made, your doctor works to determine the extent (stage) of the cancer. If the doctor suspects your cancer may have spread beyond your prostate, imaging tests may be recommended. Once the testing is complete, your doctor assigns your cancer a stage. The TNM system is commonly used to stage prostate cancer. This system evaluates the size of the tumor (T), the extent of involved lymph nodes (N), and any metastasis or distant spread (M). These are often grouped in four stages, which can be seen in the table below.

Stage	Description
I	Very early cancer that's confined to a microscopic area that your doctor can't feel
II	Cancer can be felt, but it remains confined to your prostate gland
III	Cancer has spread beyond the prostate to the seminal vesicles or other nearby tissues
IV	Cancer has spread to lymph nodes, bones, lungs, or other organs

Table 1: Prostate Cancer Staging Description [6]

Table 2 lists the criteria for each Prostate Cancer Stage.

Group	T	N	M	PSA	Gleason
I	T1a–c	N0	M0	PSA <10	Gleason ≤6
	T2a	N0	M0	PSA <10	Gleason ≤6
	T1–2a	N0	M0	PSA X	Gleason X
IIA	T1a–c	N0	M0	PSA <20	Gleason 7
	T1a–c	N0	M0	PSA ≥10 <20	Gleason ≤6
	T2a	N0	M0	PSA ≥10 <20	Gleason ≤6
	T2a	N0	M0	PSA <20	Gleason 7
	T2b	N0	M0	PSA <20	Gleason ≤7
	T2b	N0	M0	PSA X	Gleason X
IIB	T2c	N0	M0	Any PSA	Any Gleason
	T1–2	N0	M0	PSA ≥20	Any Gleason
	T1–2	N0	M0	Any PSA	Gleason ≥8
III	T3a–b	N0	M0	Any PSA	Any Gleason
IV	T4	N0	M0	Any PSA	Any Gleason
	Any T	N1	M0	Any PSA	Any Gleason
	Any T	Any N	M1	Any PSA	Any Gleason

Table 2 - Prostate Cancer Staging Criteria [7]

2.3 AVAILABLE TREATMENTS

Prostate cancer treatment options depend on several factors, such as how fast your cancer is growing, how much it has spread, your overall health, as well as the benefits and potential side effects of the treatment. The following treatments are available:

Hormone Therapy		
Treatment	Patient Profile	Description
Androgen Deprivation Therapy (ADT)	Therapy can slow the tumor's growth or lower a PSA level; it may be used before, during, or after other treatment.	Prostate hormone therapy suppresses, blocks, or eliminates testosterone to slow the tumor's growth. Treatment is given orally or by injection.
Active Surveillance / Watchful Waiting		
Treatment	Patient Profile	Description
Active Surveillance / Watchful Waiting	Recommended to those with low Gleason and PSA levels, and non-palpable tumors.	Patient undergoes careful monitoring instead of more aggressive therapy. Expectant therapy includes regular visits to a doctor for prostate specific antigen (PSA) tests and digital rectal exams.
Chemotherapy		
Treatment	Patient Profile	Description
Chemotherapy	Recurrent prostate cancer that has stopped responding to treatment may benefit from chemotherapy.	Chemotherapy is administered orally, or by a computerized pump, or by frequent injections at a doctor's office.
Alternative		
Treatment	Patient Profile	Description
High Intensity Focused Ultrasound (HIFU)	Most effective for patients with Stage I or II prostate cancer or whose cancer recurs locally after radiation therapy.	Minimally invasive procedure that uses ultrasound waves to heat and destroy affected tissue within the prostate.
Surgery		
Treatment	Patient Profile	Description
Prostatectomy	Usually recommended only for younger patients who are in otherwise good health.	The removal of the prostate by surgical incisions in abdomen or perineum, or small incisions and laparoscope use.

Robotic Prostatectomy	Reserved only for patients whose cancer is confined to the prostate gland.	Minimally invasive procedure involving the removal of the prostate and surrounding cancerous tissue. Surgeon-controlled robotic arms are used to remove the prostate gland.
Radiation Therapy		
Treatment	Patient Profile	Description
Electron Beam Radiation Therapy (EBRT)	Men with organ-confined disease and men whose cancer has extended locally beyond the prostate cancer.	Standard type of external radiation therapy used in treatment of prostate cancer. Will target prostate gland with external radiation.
Intensity Modulated Radiation Therapy (IMRT)	Men with organ-confined disease and men whose cancer has extended locally beyond the prostate cancer.	With IMRT, radiation doses to tissues in the target area can be adjusted more precisely, allowing a higher radiation dose to the prostate and reduced doses to nearby normal tissues.
Image-Guided Radiation Therapy (IGRT)	Men with organ-confined disease and men whose cancer has extended locally beyond the prostate cancer.	IGRT is radiation therapy, or often IMRT for deep seated tumors, guided by imaging equipment, such as CT, ultrasound or stereoscopic X-rays, taken in the treatment room just before the radiation treatment is delivered.
Cryotherapy		
Treatment	Patient Profile	Description
Cryotherapy (or Cryosurgery)	Used for patients with localized cancer.	Minimally invasive procedure uses needles to apply freezing gases to the prostate.
Brachytherapy		
Treatment	Patient Profile	Description
Brachytherapy	More effective for younger patients in good health with localized prostate cancer.	Minimally invasive radiation therapy implants low or high dose radiation (LDR or HDR) seeds in the prostate.

Table 3 – Treatments [8]

3 DECISION SUPPORT THEORY

The purpose of this section is to provide Andromeda Systems with a high-level understanding of decision support systems. Not every methodology discussed in this section is implemented in the model for two reasons. First, many of the methods are not applicable due to their underlying assumptions. Second, many of the methods are meant to be interactive between a client and DSS designer, such as MAUT, and thus should not be implemented in a standalone environment.

3.1 INTRODUCTION

Decision Support Systems generally consist of three components: a database, an interface, and a model. The database if the raw form of the collected data; the interface is a translating agent between the user and the model; and the model contains the algorithms and data mining tools to perform the decision analysis. Below is a general DSS architecture.

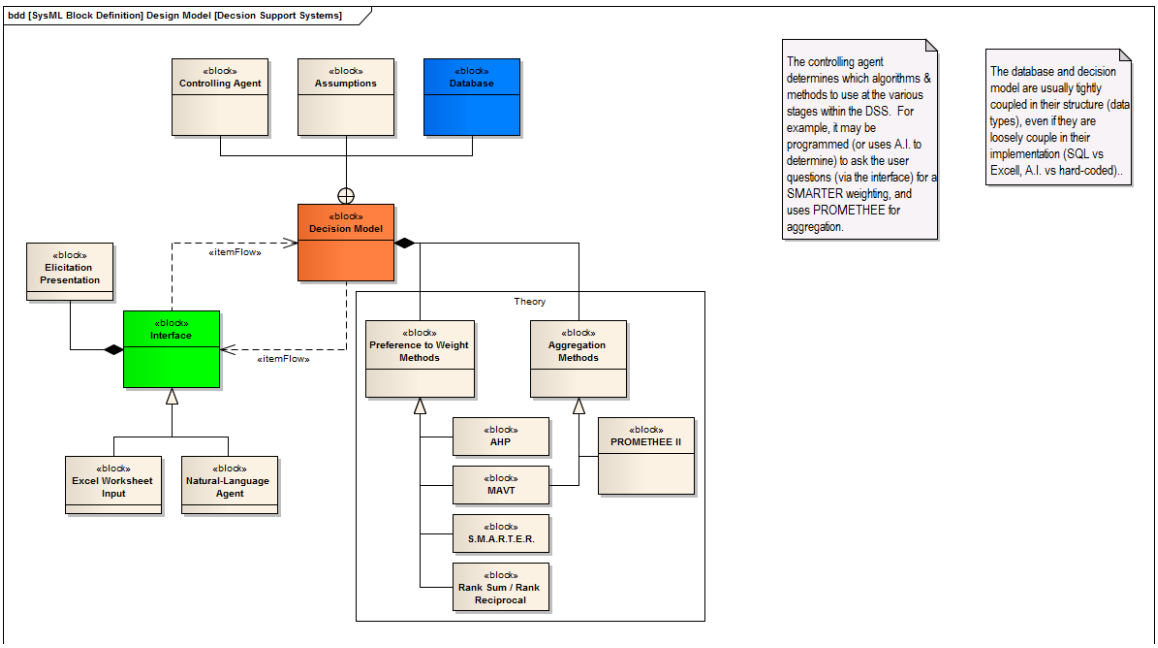


Figure 1 - General architecture for a Decision Support System. Figure was derived from coursework and follows the general structure outlined in Intelligent Decision-making Support Systems by Gupta et al.

3.2 DATABASE & ASSOCIATED STRUCTURES

Decision Support Systems have some form of database at their foundation. The database contains raw measurements that are used by the other pieces in the architecture. Sometimes the database is updated via client interaction, but often the information is purchased, generated, or mined. For the purposes of DSS design, what the data contains is more important than how the database is implemented. Databases can be as simple as Excel tables or as complex as Google's search engine server farm.

3.3 CONTROLLING AGENT & DECISION MODEL

Each decision support system is generally tailored to the problem it is meant to solve; that is, no one DSS is generic enough to make multiple separate decisions. This stems from multiple factors, including non-transitivity of criteria in different problem contexts and assumptions that are valid for on problem but not another. Thus, we present a generic framework and process for deriving the decision model for any given problem.

3.3.1 BRIEFING ON DECISION AIDING THEORY

Once the individual parts of a problem are identified, the next step is to categorize each Object/Stake as a criterion. Additional factors may be pulled in as additional criteria based upon the rest of the problem breakdown. The problem can then be represented with a multiplicative sum for each alternative: each criterion has a weight of important and a measurement for an alternative. For qualitative criteria, a 'utility' in the form of an ordinal may be used.
There are multiple methods for deriving both the weights and qualitative utilities, which are explained below.

3.3.1.1 MULTI-ATTRIBUTE UTILITY THEORY (MAUT)

MAUT gathers user preferences and creates a graph representing the goodness of each criterion. The process is a 4-step method.

Step 1: Elicit Customer Preferences on Criteria (Survey)
This step is best done in person so it is a conversation rather than a one-way elicitation. The surveyor may clarify the questions that the client has. This step is integral to the second step.

Step 2: Create Utility Curve for the Criteria
A Utility Curve attempts to measure the customer's preferences as an alternative theoretically goes from its worst-case scenario to its best-case scenario for a given criteria. For example, as the cost of a car increases, its utility to a client decreases since lower costs are preferred. The client may also have thresholds for criterion: he or she may not be able to afford any car over a certain price point, but may not care about cost if it falls below another price point.

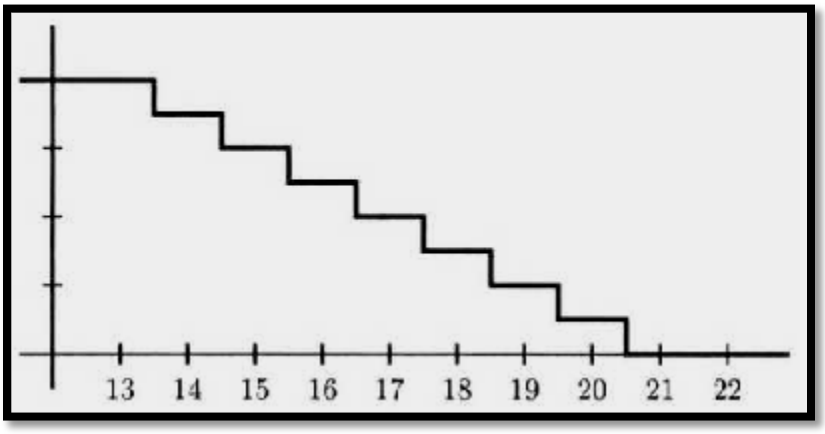


Figure 2- Sample MAUT Utility curve for cost. The x-axis is cost ($k) and the y-axis is Utility, scaling from 0.0 to 1.0 via an ordinal scale.

Step 3: Evaluate Input Data on Alternatives
Each alternative will have a measured evaluation for a given criteria, whether it is an ordinal scale or quantitative scale. For example, multiple cars may have different prices. Each price should be normalized between 0 and 1.

For each alternative within a measurement, the normalized measurement is the difference between the measurement and the worst alternative's measurement, divided by the range. For example, if there are 4 cars with prices {$10k, $13k, $14k, and $16k}, then the normalized measurements become {1.0, 0.5, 0.33, and 0.0} respectively.

Step 4: Aggregate the Options to Achieve a Summary Value
Each measurement is multiplied by its corresponding criterion weight and then summarized with the other measurement-weight pairs for a given alternative.

3.3.1.2 ANALYTIC HIERARCHY PROCESS (AHP)

AHP allows the use of qualitative as well as quantitative criteria in evaluation and is primarily a way for determining weights for an aggregated decision. It was founded by Saaty in the 1980s[9] and can be applied to a wide range of applications. The theory gathers user preferences via a

pair-wise comparison, and creates weights using linear algebra and matrices; finding eigenvalues, eigenvectors, etc. This method has built in checks to ensure the customer's preferences are consistent.

AHP is sometimes not highly recommended since the calculations can be cumbersome. In addition, if there are a large number of criteria, the customer may not have time nor want to sit through pair-wise comparison of all criteria. A model with n decision criterion requires 2^n questions. The process is a 5-step method.

Step 1: Elicit Customer Preferences on Criteria
Each criterion is evaluated against each other. A score is given to the preferred criterion, usually a scale from 1 to 9, with 1 meaning that both criteria are equally preferred and 9 meaning one is 'definitely preferred' to the other.

Step 2: Create Preference Matrix
The criteria measurements (1-9) are then put into a symmetric matrix. Each column I represents a criterion; row j represents the same criterion. The diagonal of the matrix consists of all 1's since a criterion is always indifferent to itself. Then, based upon the elicitation, each column i has it's pairwise measurement inserted; if criterion i is preferred to criterion j, then the measurement (1-9) is inserted; if criterion j is preferred to criterion i, then the reciprocal (e.g. 1/9) is inserted.

Step 3: Compute the Normalized Eigenvector
Using basic linear algebra, the weights are computed by generating the eigenvector of the symmetric matrix.

Step 4: Normalize the Input Values
For each alternative within a measurement, the normalized measurement is the difference between the measurement and the worst alternative's measurement, divided by the range. For example, if there are 4 cars with prices {$10k, $13k, $14k, and $16k}, then the normalized measurements become {1.0, 0.5, 0.33, and 0.0} respectively.

Step 5: Perform the Multiplicative Sum
Each measurement is multiplied by its corresponding criterion weight, and then summed with the other measurement-weight pairs for a given alternative.

3.4 INTERFACE TO A USER

Decision support systems need an interface in order for user input such as personal information and preferences. It is up to the model to convert preferences to weights and information to measurements. Some more complex interfaces are able to use natural-language "agents" that translate a human's natural language into the information required by the database.

4 DECISION SUPPORT SYSTEM

4.1 INTRODUCTION

4.1.1 REPRESENTATION OF THE PROBLEM SITUATION

A problem (P) consists of three major dimensions: Actors (A), Objects (O), and Resources (R) and can be denoted: P = {A, O, S}. By presenting the problem in this manner, we were able to see which decisions the Prostate Cancer Treatment DSS was able to support and which decisions it should have little part in.

Actors (A)	Objects (O) aka stakes	Resources (S)
Patient	Cancer Reduction	Medical Equipment
Doctors	Minimize Side Effects	Medical Supplies
Nurses	Minimize Cost	Doctor Skills
Family Members	Minimize Time of Treatment	Funding, Monetary Sources
Insurance Agents	Minimize Time of Recovery	

Table 4 - Problem breakdown

Furthermore, we did not want to create a DSS that could not be supported by our dataset and the problem structure helped identify additional data that we needed.

4.1.2 PROBLEM USE CASE

We then created a use case diagram for the Prostate Cancer Treatment DSS based on our problem structure. The use case diagram stipulates a couple of things on the surface, which helped derive some of our assumptions. The use case can be seen in the figure below.

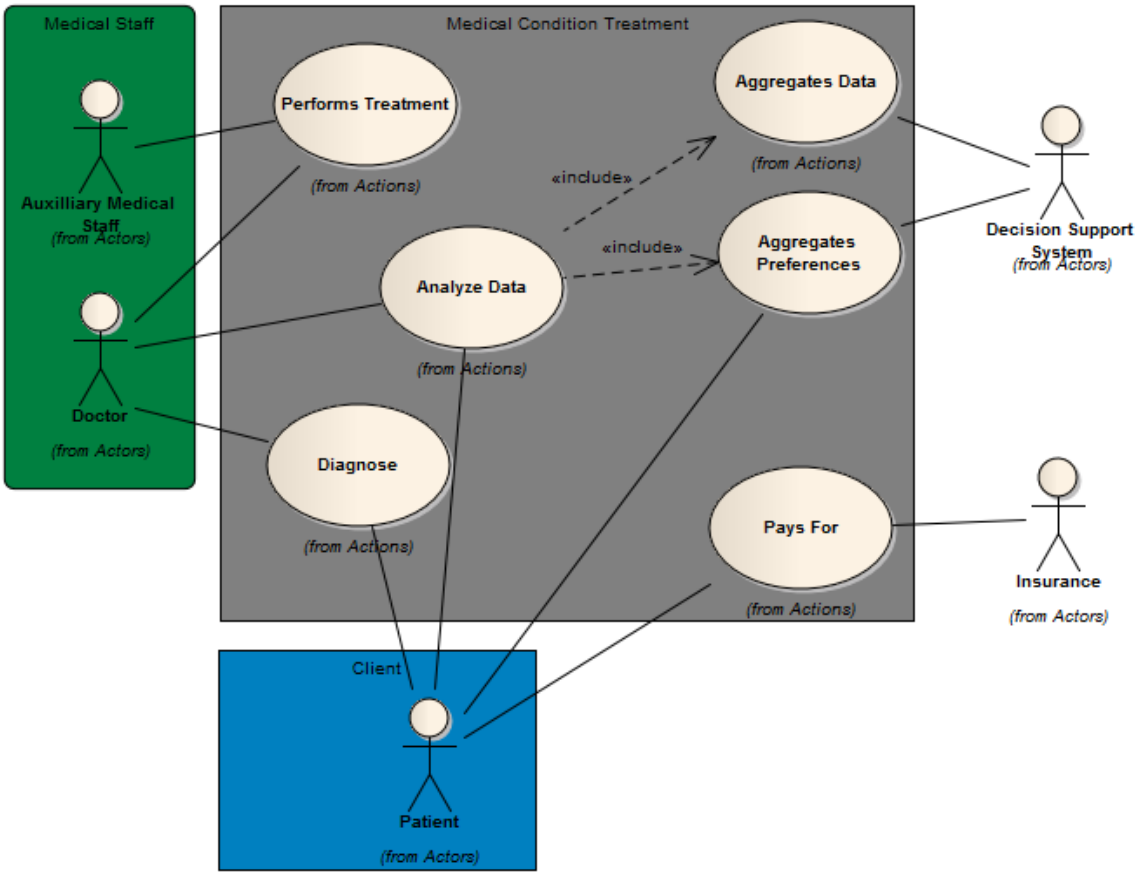


Figure 3 - PTDSS high level use case

4.1.3 DSS STRUCTURE

The Prostate Cancer Treatment DSS consists of three major components: database, model, and user interface. The figure below shows the interaction between the three components.

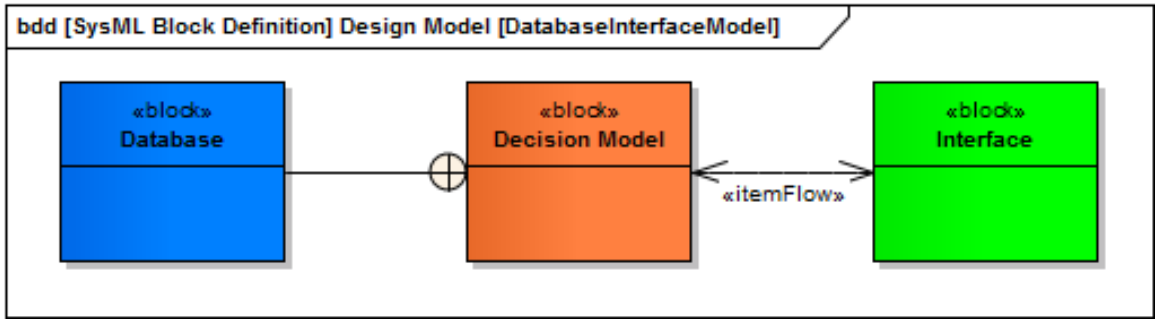


Figure 4: Structure of the PTDSS

4.2 GROUND RULES AND ASSUMPTIONS

The following ground rules and assumptions were used in this DSS:

- The user prefers the side effects of prostate cancer treatment to having prostate cancer
- Age is representative of overall health status – the older you are, the worse your health is

4.3 DATABASE

The database component includes all the information and data that is necessary to perform the analysis on the decision at hand. This entails data entry, storage, and retrieval.

4.3.1 RAW DATA

Andromeda Systems provided a database that contained over 1,000 lines of self-reported data. Because the exact source of the data is unknown, we made the assumption that the data was valid. The dataset included several key characteristics that were tabulated through. However, before any analysis could be done we first had to perform some 'cleanup' of the data in order to properly parse it.

4.3.1.1 DATA CLEANUP

There were several instances of data in which either ambiguous or nonsense terms were input. For example, a user entered "Lost no man-points" under side effects, which does not tie to any specific prostate cancer treatment side effect. These ambiguous or nonsense terms were discarded from the dataset. In addition, there were multiple terms for the same treatment or side effects. For example, "Active Surveillance" and "Watchful Waiting" are the same treatment. Similarly, "Taking Cialis" and "Need Viagra" both represent indicate the patient suffers from erectile dysfunction. For these cases, additional key words were added to the filter when categorizing side effects and treatments. Furthermore, there were misspellings of side effects and treatments. To account for misspellings, segments of the desired terms were used in the filter. The following filters were used for each side effect and treatment.

Treatment/Side Effect	Search term
Androgen Deprivation Treatment (ADT)	ADT
Laparoscopic Surgery	LR
Active Surveillance / Watchful Waiting	Active Surv
Electron Beam Radiation Treatment (EBRT)	EBRT
Chemotherapy	Chemo
Proton Beam	Proton Beam
Brachytherapy	Brach
Prostatectomy	Surgery – LR ("Surgery" captures both surgery and LR surgery therefore need to remove LR to account for just surgery)
Cryotherapy / Cryosurgery	Cryo
High Intensity Focused Ultrasound (HIFU)	HIFU
Intensity Modulated Radiation Therapy (IMRT)	IMRT
Image Guided Radiation Therapy (IGRT)	IGRT
Climacturia	Climac
Leakage	Leak,
Erectile Dysfunction	ED, Viagra, Cialis
Incontinence	Incon
Urinary Issues (infection, difficulty)	Urin, Flomax, Bladder
Strictures	Strict
Proctitis	Proct
Prostatis	Prost
Peyronies Disease	Peyr

Table 5 - Treatment and Side Effect parsing

These filters reduced the data set from 1,046 to 803 data usable data points.

4.3.1.2 MISSING SIDE EFFECTS

The database provided by Andromeda Systems captured a majority of the side effects from prostate cancer treatments. However, due to the lack of data for some treatments not all the side effects were listed. For example, the chemotherapy patients in the dataset did not include hair loss. Therefore, we researched each treatment and the possible side effects from the treatment and included the missing side effects. The following side effects were added:

- Hair loss
- Weight gain / Loss of muscle mass
- Infertility
- Hot flashes
- Nausea / Vomiting
- Fatigue

4.3.1.3 DATA AGGREGATION

We tracked the number of data points for each treatment, side effect, age group, and stage.

TREATMENTS

The figure below shows the frequency of the treatments in the dataset.

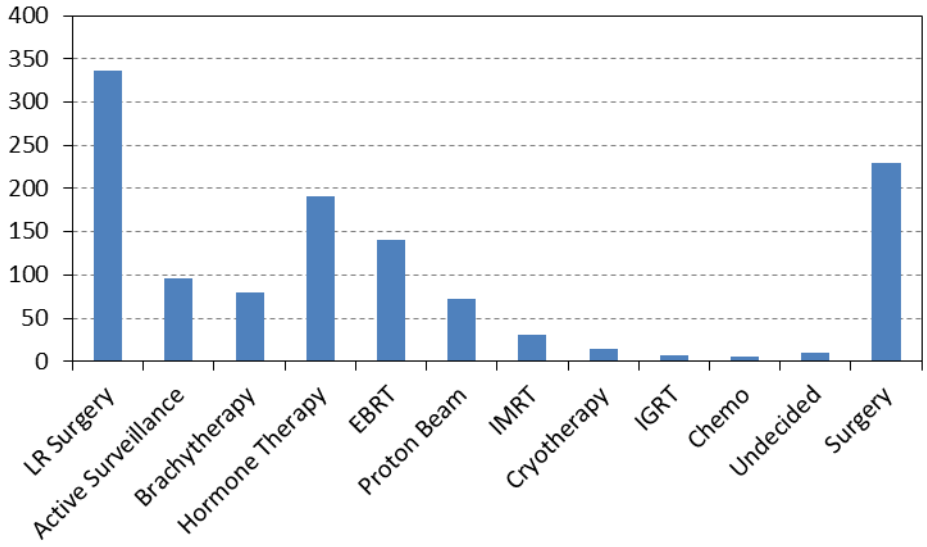


Figure 5: Frequency for each specific treatment in the PTDSS

As you can see in the figure above, treatment decisions were not evenly distributed in the dataset with surgery being the predominant form of treatment in the dataset. In order to increase the number of data points behind treatment options, we combined specific treatments into more generic terms. However, we were careful to only combine similar treatments that also had similar side effects. For example, Proton Beam, EBRT, IMRT, and IGRT are all forms of radiation therapy that also have similar side effects. Thus, these treatments were grouped together as "Radiation Therapy". Brachytherapy and Chemotherapy are also forms of radiation, but they were kept separate because their side effects are unique. The figure below shows the frequency of the aggregated treatments.

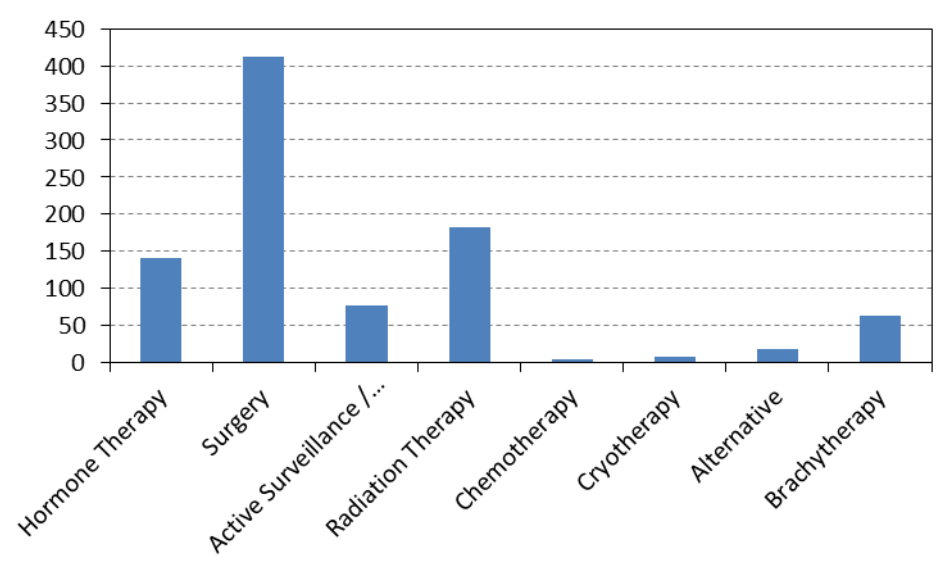


Figure 6: Frequency after combination of treatments in the PTDSS.

SIDE EFFECTS

Side effects had a similar distribution as treatments. There were over 400 occurrences of erectile dysfunction but the next most frequent side effect, incontinence, only had 50 occurrences. The figure below shows the frequency of the side effects in the dataset.

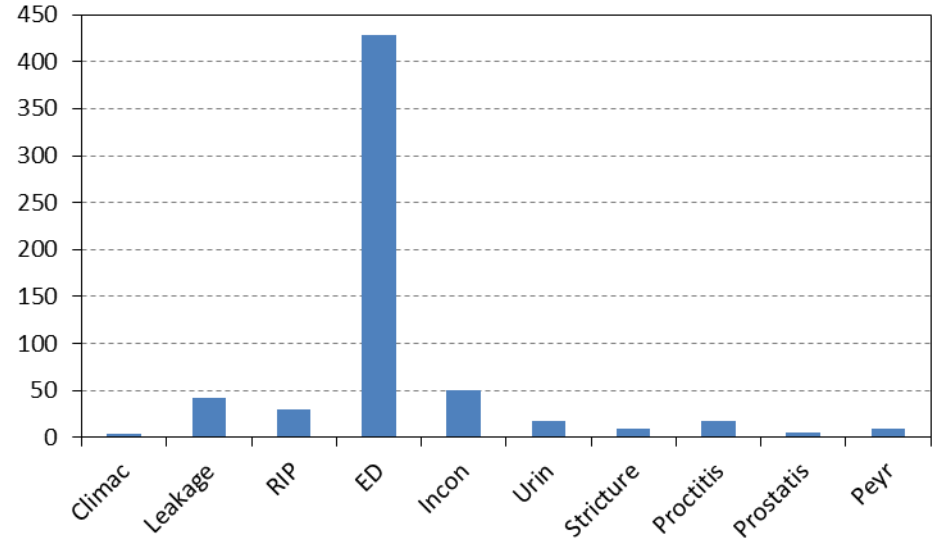


Figure 7: - Individual side effect counts

By grouping similar side effects, we were able to increase the amount of data significantly in some cases. Several medical research papers used a similar strategy because of the rarity of some side effects [10]. Additionally, since the raw data does not specify that a patient passed away due to prostate cancer or the treatment, we decided to eliminate 'RIP' altogether from the possible side effects. The figure below shows the frequency of the grouped side effects.

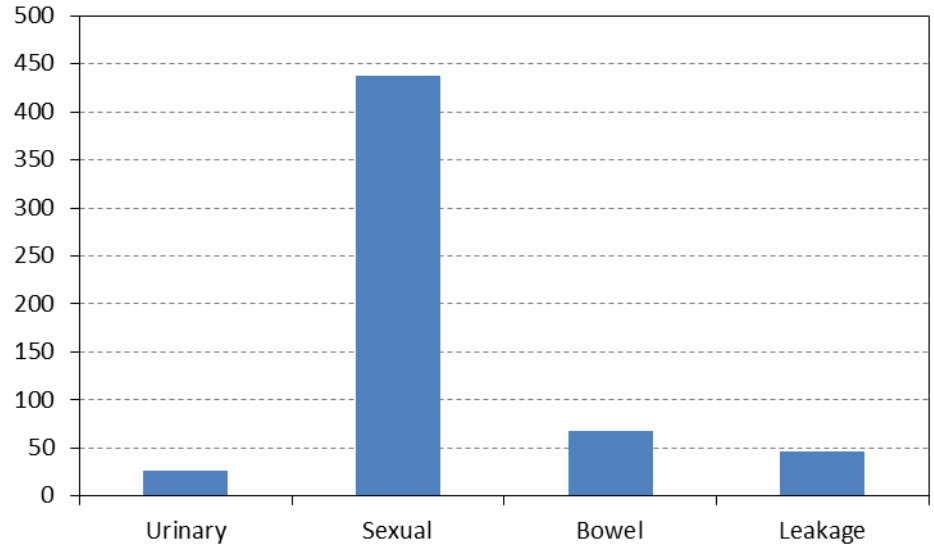


Figure 8: Combined side effect data count

AGE

The following table presents the distribution of the raw data by age. As you can see in the table below, the data was normally distributed.

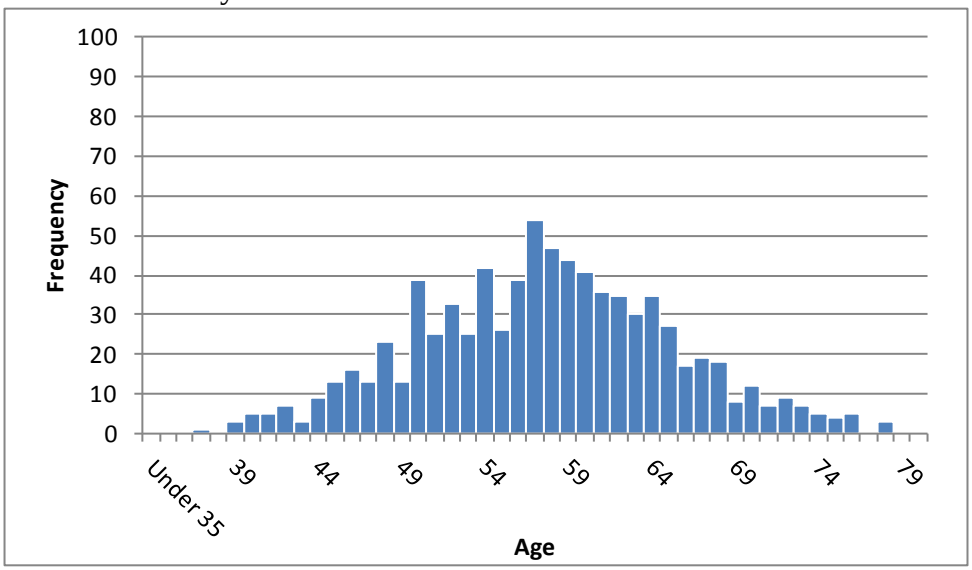


Figure 9- Histogram of Raw Data by Age

Due to the lack of data for some years, especially towards the bounds of the data set, we decided to aggregate the data in groups of 5 years (e.g. 50-54). The figure below shows the distribution of the data within the data sets defined.

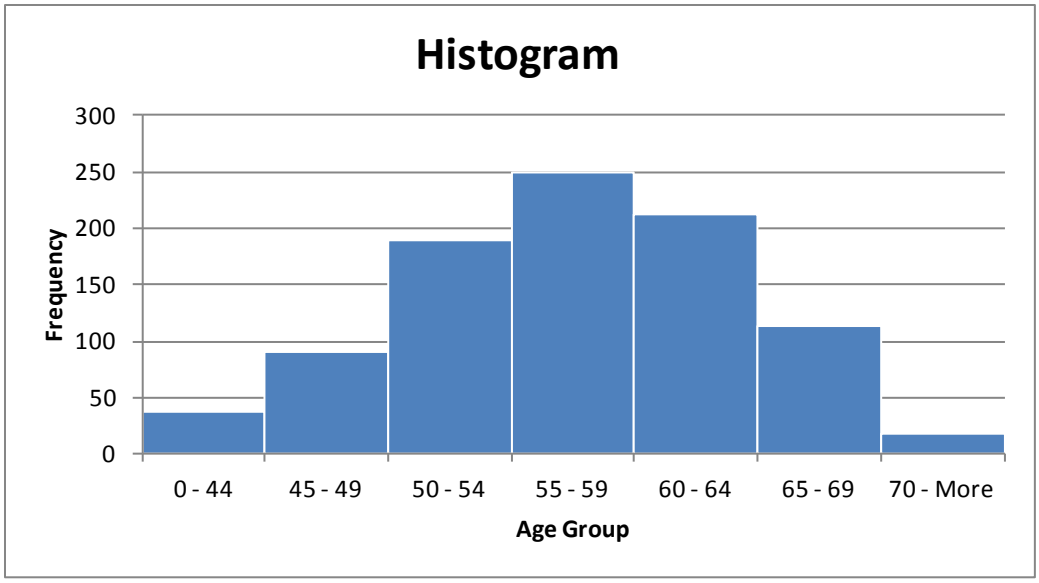


Figure 10 - Histogram of Raw Data by Age Group

By grouping the data in 5 year increments, we were able to increase the number of data points for the age field significantly.

STAGE

Fortunately, the raw data had a field labeled 'Stage'. Unfortunately, this field was not the Prostate Cancer stage, instead it was the TNM system staging. Therefore, we needed to determine the Prostate Cancer Stage for each entry based off the PSA level, Gleason Score, and TNM system. The table below presents the distribution of data by prostate cancer stage.

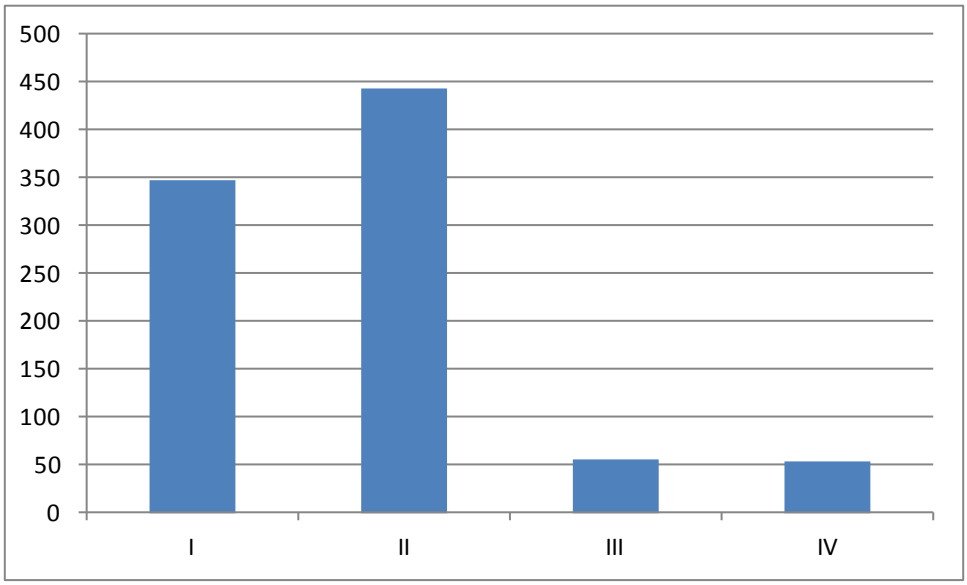


Figure 11 - Histogram of Raw Data by Stage of Prostate Cancer

4.3.1.4 DATA TABLES

There were four data tables that the model pulls from to perform calculations.

- Occurrences of a treatment by age and stage

- PSA before treatment by age, stage, and treatment
- PSA after treatment by age, stage, and treatment
- Occurrences of a side effect for each treatment

Age Range	Hormone Therapy	Surgery	Active Surveillance / Watchful Waiting	Radiation Therapy	Chemotherapy	Cryotherapy	Alternative	Brachytherapy
0 - 44	0.0	0.2	1.2	0.0	0.0	0.0	0.0	0.0
0 - 44	0.0	1.0	0.0	2.5	0.0	0.0	0.0	0.0
0 - 44	20.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0 - 44	17.9	9.2	0.0	0.1	0.0	0.0	0.0	0.0
0 - 44	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0 - 44	37.9	10.5	1.2	2.5	0.0	0.0	0.0	0.0
45 - 49	0.0	0.1	3.9	2.9	0.0	0.0	0.0	1.8
45 - 49	0.1	0.2	23.0	2.4	0.0	0.0	0.0	0.1
45 - 49	1.8	0.0	0.0	0.1	0.0	0.0	0.0	0.0
45 - 49	506.8	0.0	0.0	0.0	433.0	0.0	0.0	0.0
45 - 49	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0
45 - 49	508.6	0.4	26.9	5.4	433.0	0.0	0.0	1.9

Figure 12: Part of Data Table for Average PSA before Treatment

The model will pull from these data tables to complete the necessary calculations.

4.3.2 ADDITIONAL DATA

The raw data did not contain all the necessary information to create the DSS. The following subsections will discuss the additional data we required.

4.3.2.1 COST DATA

There were no costs associated with the treatments in the database. Therefore, we needed to research online to find the costs for each treatment. This was difficult because there are many factors that play a role in cost such as:

- Does the patient have insurance?
- If so, what does his insurance cover?
- What is his geographic location?

In an attempt to minimize the variability in the cost factors, we were able to find a research paper that listed the cost for the majority of the treatments. Thus, the assumptions were the same in determining the costs for these treatments. For the remaining treatments, we were able to confirm the validity of the costs based on a relative scale. Using multiple sources, these treatments were consistently either larger or smaller in cost than another treatment. The costs for each treatment can be seen in the table below.

Treatment	Cost [source]
Hormone Therapy	$69,244 [9]
Surgery	$36,888 [9]
Active Surveillance / Watchful Waiting	$32,135 [9]
Radiation Therapy	$59,455 [9]
Chemotherapy	$41,000 [10]
Cryotherapy	$43,108 [9]
Alternative	$75,000 [11]
Brachytherapy	$35,143 [9]

Table 6 – Prostate Cancer Treatment Costs

4.3.2.2 RECOVERY TIME DATA

Similar to cost, there were no recovery times from treatments in the database. Furthermore, recovery times can also vary patient to patient based on current health, quality of treatment, etc. Again it was important that we found a single source for a majority of the treatment recovery times. The recovery times can be seen in the following table.

Treatment	Recovery Time, weeks [source]
Hormone Therapy	0 [13]
Surgery	2 [13]
Active Surveillance / Watchful Waiting	0 [13]
Radiation Therapy	1 [12]
Chemotherapy	12 [12]
Cryotherapy	1 [13]
Alternative	0 [13]
Brachytherapy	0.5 [13]

Table 7 - Prostate Cancer Treatment Recovery Times

4.3.3 GENERAL DATABASE NOTES

The database was designed to allow for easy entry of additional data points. As more data points are added, the data will automatically be grouped into the corresponding age, prostate cancer stage, side effects, and treatment categories and the corresponding recurrence and side effects calculations will be updated. Thus, the database will include the new data points in when it provides data to the model in future runs.

4.4 DECISION MODEL

The decision model is a collection of decision analysis tools that are used to support decision-making. The decision model and database communicate directly to feed the models the necessary information and data.

4.4.1 VALUE MODEL

4.4.1.1 TIER 1 ADDITIVE CHARACTERISTICS

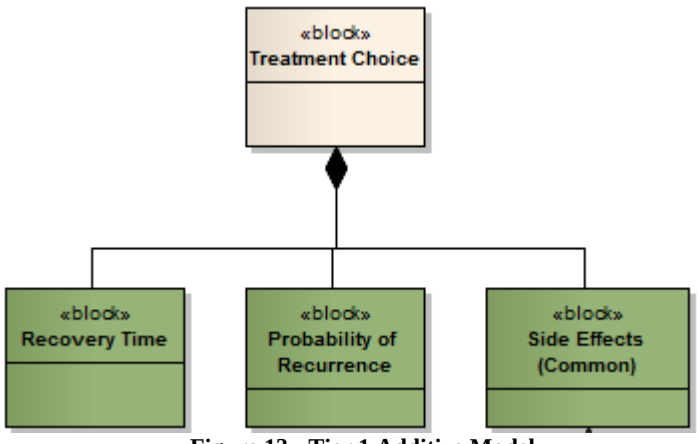


Figure 13 - Tier 1 Additive Model

Based on prostate cancer treatment papers, we narrowed our decision criteria from the initial problem breakdown to the following top-tier objectives:

- Recovery Time
- Probability of Recurrence
- Side Effects

We then determined the measures for each objective.

- Recovery Time – number of weeks it takes to return to work
- Probability of Recurrence – the percentage of improvement in PSA level from treatment
  - Derived from the data tables PSA before treatment and PSA after treatment
  - Formula: *% Improvement = (PSA before – PSA after) / PSA before*
- Side Effects – this could be broken down further (See Tier 2 section)

Next, the objective measures were normalized on a scale of 0 to 1 using the following equation.

$$S(x) = \frac{x-worst}{best-worst}, with\ 0 = worst, 1 = best, and\ x = raw\ score \text{ (Equation 1)}$$

To calculate the weights for each objective, we used the Rank Reciprocal method. This method required that the patient rank the objectives in order to present the objectives on an ordinal scale. The ranks are then transformed into normalized weighted values using the rank reciprocal formula.

$$w_i = \frac{1/R_i}{\sum_j 1/R_j} \text{ (Equation 2)}$$

The overall value of each treatment alternative can now be calculated using the following formula.

$$V(x_i) = \sum_i s(x_i) * w_i \text{ (Equation 3)}$$

4.4.1.2 TIER 2:

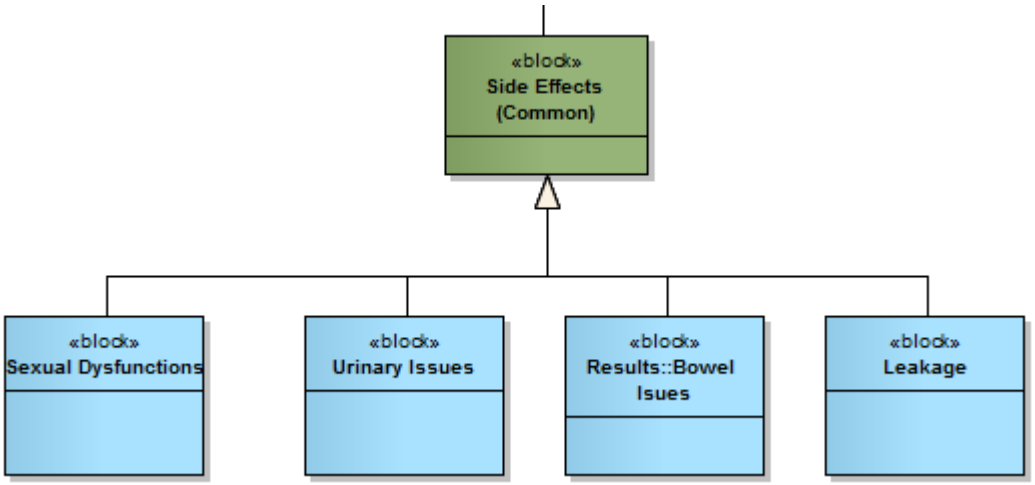


Figure 14 - Side Effect additive model

The second-tier breaks the respective top-level criteria down further. In this case, 'Side Effects' is a roll up of all the potential side effects from prostate cancer. If you recall, the following side effects are a result of prostate cancer treatment.

- Sexual Dysfunction
- Leakage
- Urinary Issues
- Bowel Issues
- Physical Illness
- Infertility
- Change in Physical Appearance

The measure was the probability of not having the side effect. The probabilities were derived from the database using the equation: *1 – (# of occurrences of a side effect for a treatment / # of occurrences of a treatment)*. Again, these measures were normalized on a scale of 0 to 1 using the equation 1.

The Rank Reciprocal method was used again to calculate the weights for each side effect. The patient was required to rank the side effects to present the side effects on an ordinal scale so the weights could be calculated using equation 2.

The value of the side effects for each treatment can now be calculated using the formula 3. It is important to note that this value will become the Tier 1 Side Effect measure for the overall value calculation.

4.4.1.3 VALUE HIERARCHY

The value hierarchy can be seen in the figure below.

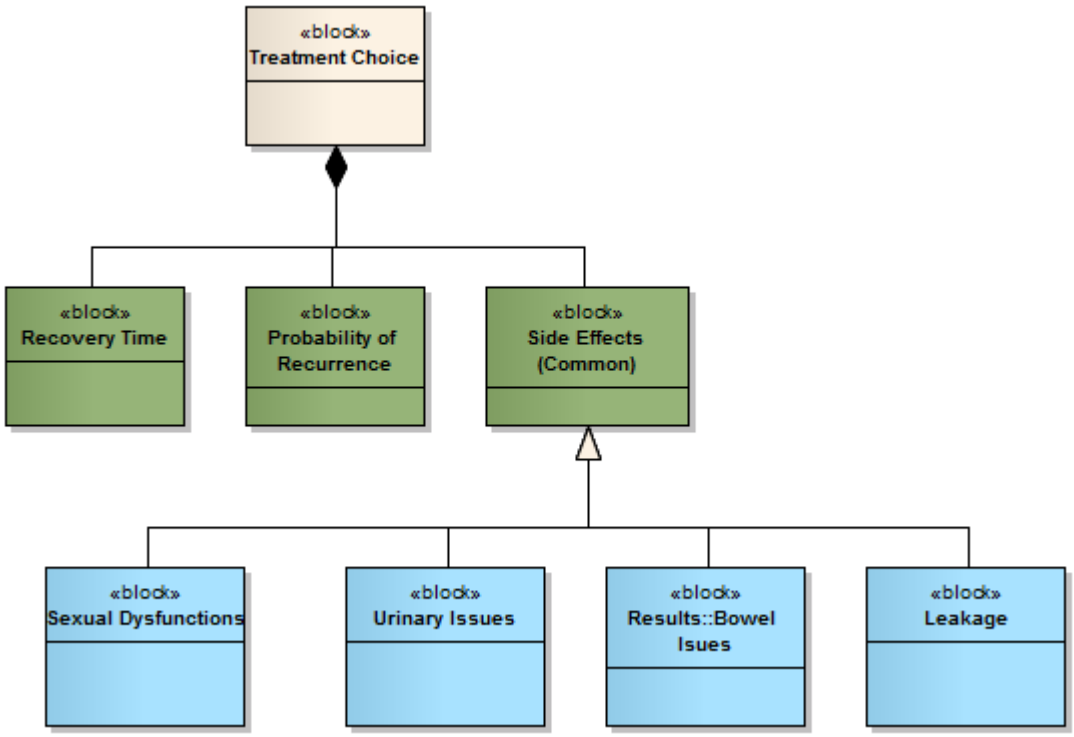


Figure 15 - Combined Additive Model

It is important to note that each tier has its own set of weights that sum to 1.

4.4.2 ELIMINATING FACTORS

There is evidence that overall health and the stage of prostate cancer can narrow a patient's number of available treatments. For example, a patient with Stage IV prostate cancer would most likely not choose to pursue Watchful Waiting or Active Surveillance given the severity of his cancer. Because the dataset did not include the overall health of the patient, we made the assumption that age was representative of the patient's health. When calculating the measures for the decision objectives derived from the dataset (Probability of Recurrence and Probability of a Side Effect) we filtered the data on both prostate cancer stage and age. However, we decided to include the age group above and below the patient's age group to account for the loss of data from the filter. For example, a 55-year-old patient would be bucketed in the '55-59' age group. In this case, the model would pull from the '50-54', '55-59', and '60-64' buckets for calculation purposes. Since each prostate cancer stage is so unique, we decided to only filter on the patient's stage.

In addition, cost can be a possible deciding factor in a patient's course of action. As mentioned in the cost data section, it is not only hard to find for the purpose of implementing in the model but a patient sitting down to use this model would probably not know all the details of their insurance coverage that would be required. For the sake of simplicity, we normalized the cost and presented it in a Pareto chart with the utility. Thereby, still incorporating cost in the decision process, while keeping the patient's inputs straightforward.

4.4.3 OVERALL DECISION ARCHITECTURE

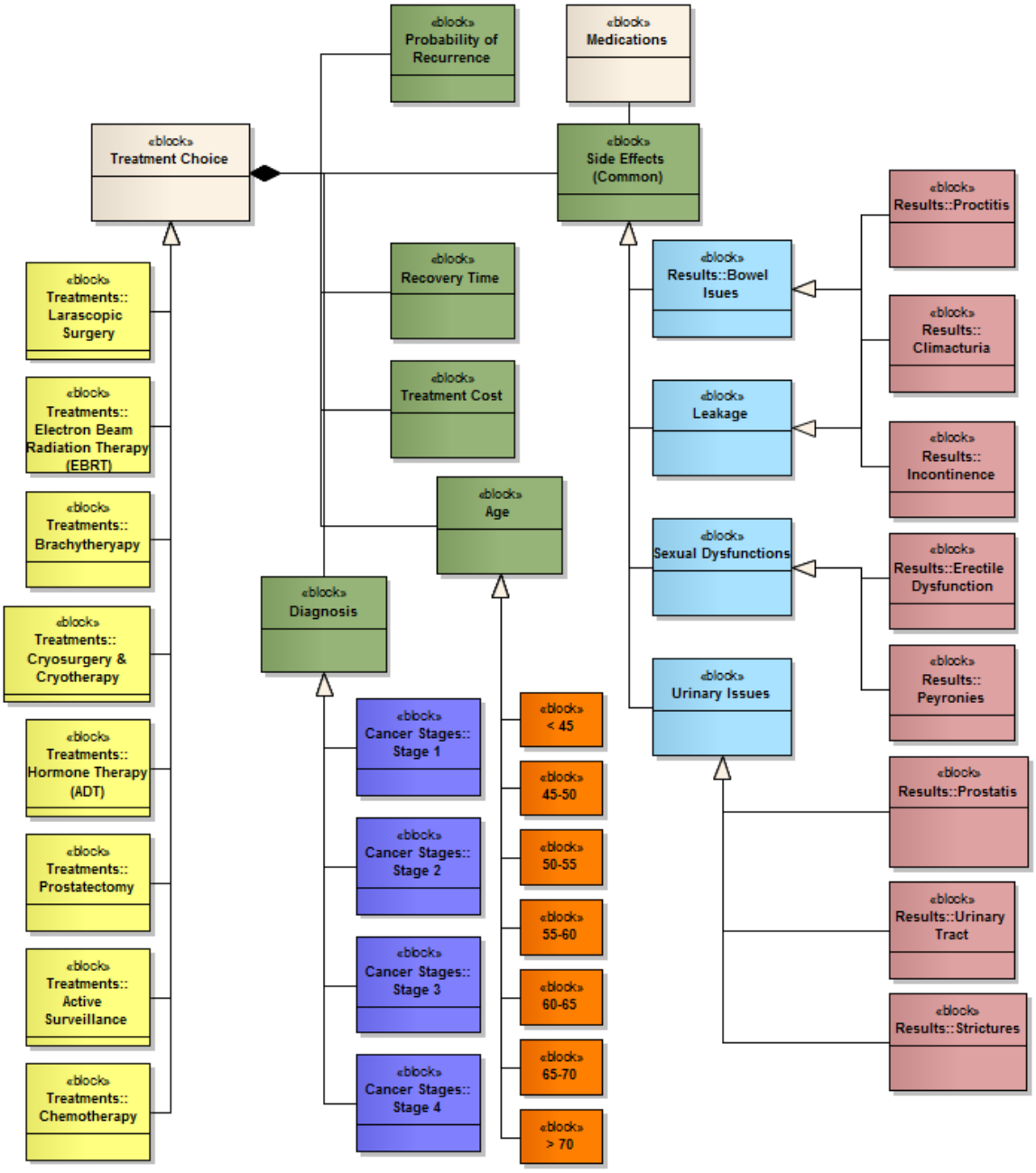


Figure 16 - Overall Decision Architecture

4.5 USER INTERFACE

The user interface is a key component of a decision support system. This defines the level of flexibility of the system and its user-friendliness. The user interface is responsible for communication from the user to the system. It communicates with the model to determine the data needed from the database.

4.5.1 ELICITATION

Eliciting the user's preferences correctly is integral to the model. If the elicitation is not done properly, the weights for each criterion will be wrong, and the results will not represent the user's preferences. Because the elicitation for this model was non-interactive it was important to keep the elicitation method simple. The goal of this tool is to be self-contained and not require the user to need additional help/information while completing it. Thus, we chose a ranking method to derive the user's preferences. Two elicitations were required for this model, one for the preference of side effects and the other for the higher-level decision criteria. The same method is used for each elicitation.

4.5.1.1 SIDE EFFECT PREFERENCES

For the case of the side effects, the user is presented the worst case for all the potential side effects from prostate cancer treatments. The user is then asked which side effect he would prefer to improve to its best case (not having the side effect) allowing for ties. At the conclusion, the user will have ranked all the possible side effects and the model will calculate a weight for each. Since there is no interaction with the patient, it was important to display these weights to him to ensure they are representative of his preferences. Here, the user is given the opportunity to alter the weights for each criterion if they are misrepresentative of his preferences. This is an important check in the weight determination since the elicitation is not face-to-face.

4.5.1.2 TIER 1 PREFERENCES

The Tier 1 ranking was setup similar to the side effect elicitation. The user was provided a description of each decision criteria and asked to rank the criteria from the most important to least important. The weights calculated in the model are then displayed back to the user for confirmation. Again, the user can alter the weights according with his preferences of the criteria.

4.5.2 OUTPUT

The purpose of the output is to present the results from the model to the user an easy to understand manner that will allow them to have informed discussions with their doctor. We split the output into three parts: Data Summary, Pareto Frontier, and a Treatment Ranking.

4.5.2.1 DATA SUMMARY

This section of the output just provides the user with where they fall in the dataset and how many of the patients in the database have a similar health profile (age and stage). It also reiterates their most important and least important attribute.

4.5.2.2 PARETO FRONTIER

The Pareto Frontier provides the patient with a visual display of treatment utility vs. cost. From this chart, the patient can conclude,

- The most/least cost effective treatment
- The treatment that lines up with their preferences the best (treatment highest vertically on the chart)
- The treatment that costs the most (treatment furthest to the right of the chart)

Again, the intention of this chart is to not make the decision for the patient but to provide them with a visualization of the options available and how they compare to one another given their preferences for some decision criteria.

4.5.2.3 SUMMARY OF RESULTS

The summary of results displays some quick information including the most cost effective treatment, the least cost effective treatment, the best treatment for their most important attribute, and the worst treatment for their most important attribute. It also orders the available treatments from most preferable (highest utility) to least preferable. The treatments that are under a certain threshold for the number of data points are highlighted to indicate to the user that there is not much data behind the results.

5 PROTOTYPE

5.1 OVERVIEW

The model was built using Microsoft Excel 2007 and is compatible with Microsoft 2010.

5.2 Design

5.2.1 CONOPS

We first created an operational concept diagram to depict the general idea of the system. The diagram shows how the system interacts with the environment and external systems. Our operation concept is shown in Figure 17 - Prototype CONOPS. First, the doctor diagnoses the patient with cancer. Once the patient knows they have the cancer, they will be given some literature to enhance their knowledge of the subject. The patient is now ready to use the DSS for suggested treatments. After completing the program, the patient can take their results and go over them with their doctor to finalize their treatment decision. Lastly, the patient will undergo the treatment they've decided on.

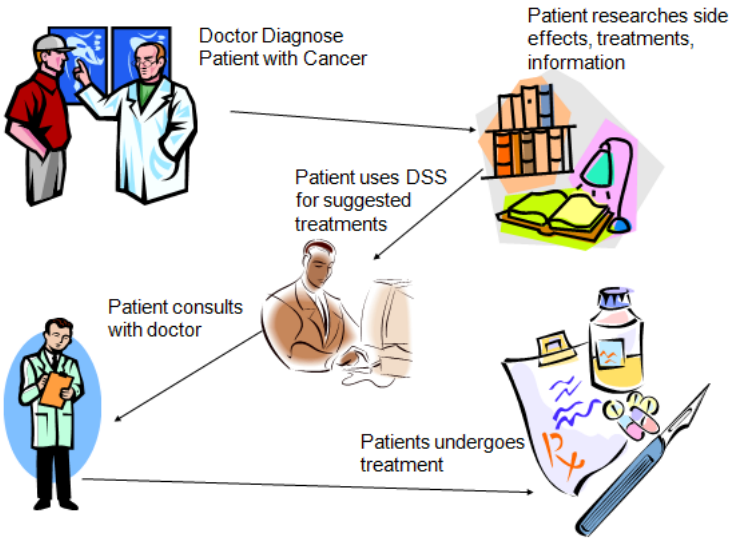


Figure 17 - Prototype CONOPS

5.2.2 Design Diagrams

After the concept of operations was created, we formed a couple of use cases to represent the interaction between the system and a user. Each use case achieves a specific goal for the user. In our first use case DSS shown in figure 18, we illustrate how the user will achieve a treatment decision. This involves a user interacting with a doctor, entering answers to questions, and showing an output of results.

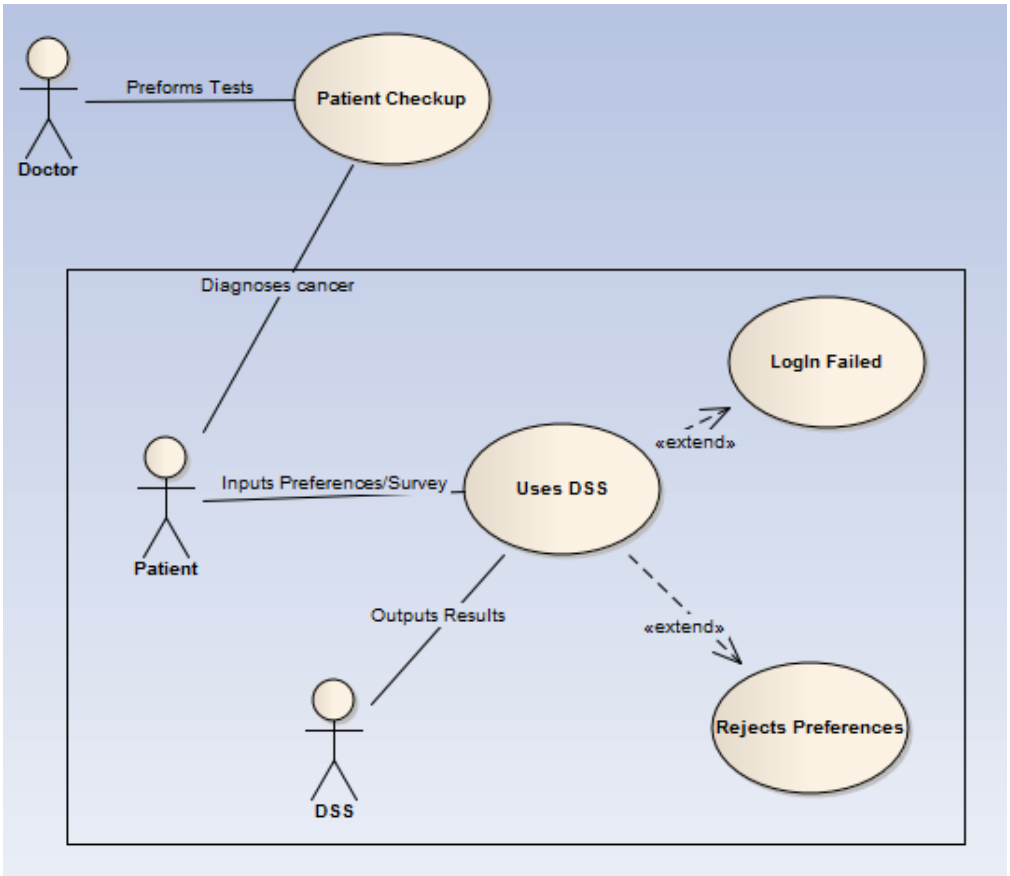


Figure 18: Prototype Use Case

While designing the use cases, the formation of requirements evolved. We took some time to further create a requirements list that can be traced through the architecture of the system. Some higher level requirement categories include stakeholder requirements, system wide requirements, and qualification requirements. A sample of the requirements is shown in the figure below and the full detailed requirements are located in Appendix B.

1.0 Steakholders Requirements:

- 1.1 The system shall provide an interface to view results
- 1.2 The system shall provide a means of inputting customer preferences.
- 1.3 The system shall provide an electronic file with customer's information.
- 1.4 The system shall provide a means of navigating through the program.

2.0 System Wide Requirements :

- 2.1 The system shall provide safety for the customer from identity thieves.
- 2.2 The system shall provide a 24hr availability.
- 2.3 The system shall provide supportability for the new questionnaires.

3.0 Qualification Requirements:

- 3.1 The system shall provide preference weights within 10 seconds of input by customer
- 3.2 The system shall store customer data within 15 seconds of completion of the first page
- 3.3 The system shall provide a decision within 30 minutes of customer initiation.
- 3.4 The system shall provide a means of debugging the system

Figure 19: Requirements sample

Next, we decided to create some class diagrams. This would be a good starting point because the class diagrams set up swim lanes for sequences diagrams, and the classes for each state machine diagram. The class diagrams show the flow information and data using attributes, and operations.

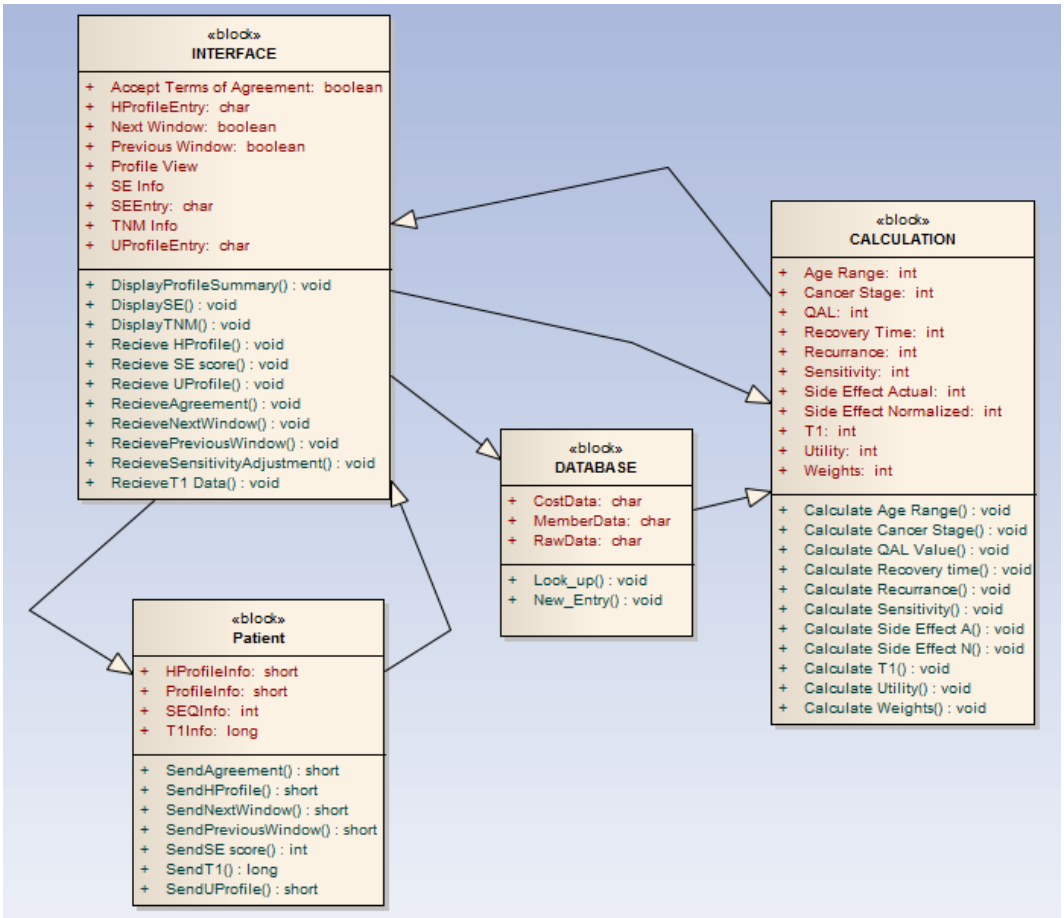


Figure 20: Class Diagram

Afterwards the behavior of the system was modeled. These diagrams include state machine and sequence. The state machine diagrams represent a series of events and the possible states. Each class is represented by a separate diagram. Below are the state machine diagrams for our prototype.

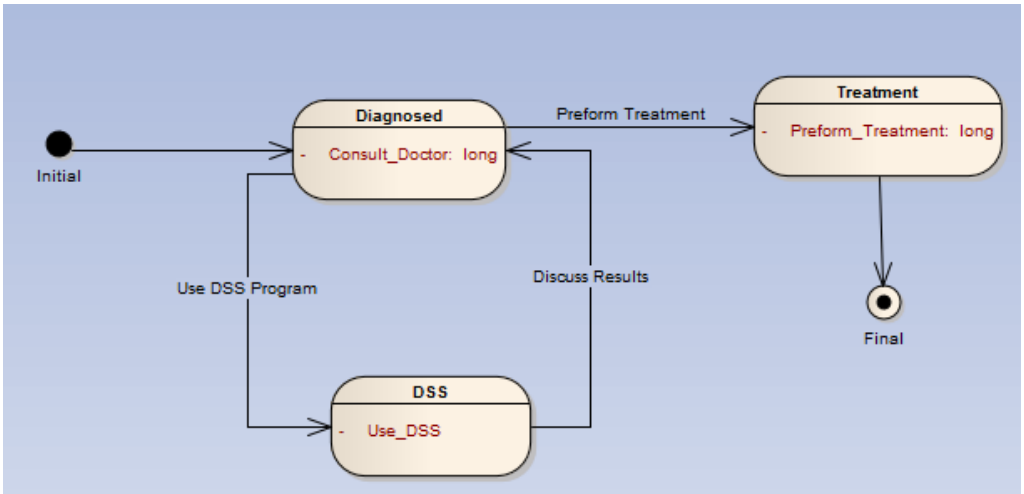


Figure 21: Patient State Machine

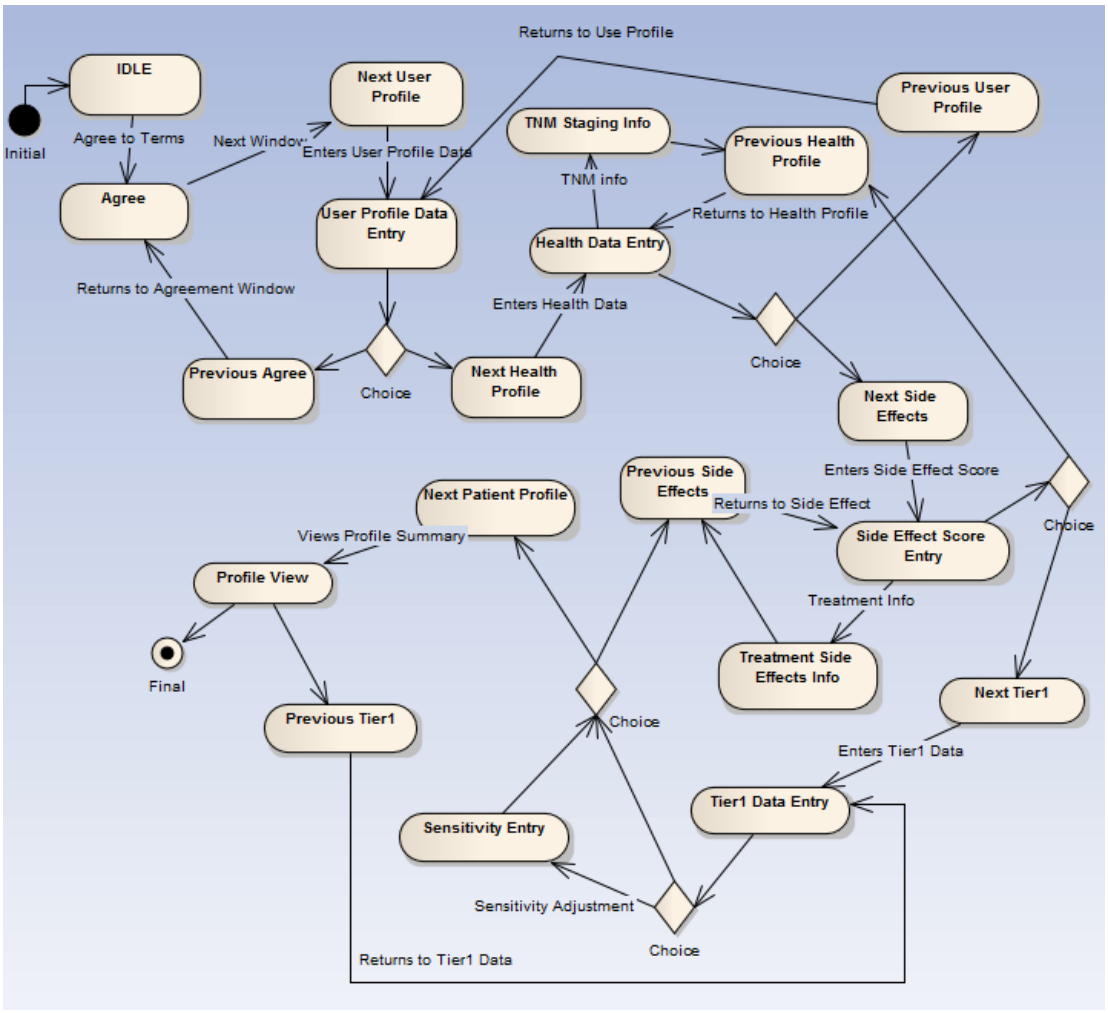


Figure 22: Interface State Machine

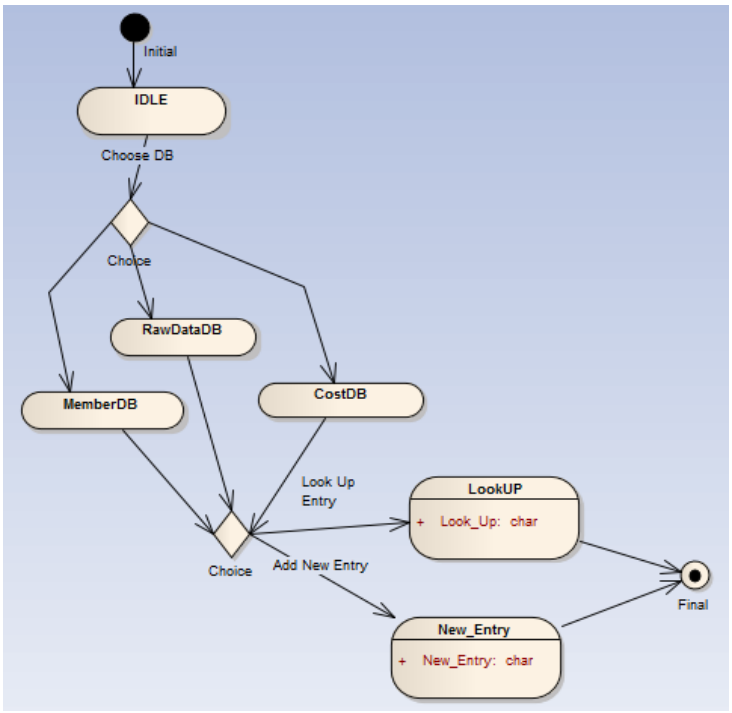


Figure 23: Database State Machine

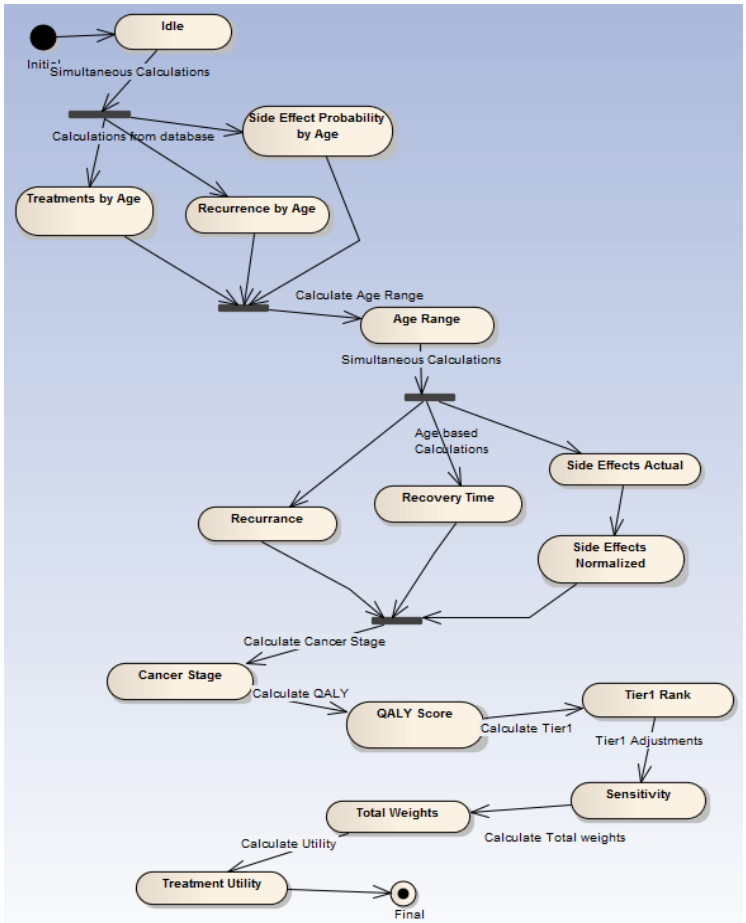


Figure 24: Calculation State Machine

The sequence diagrams were created in order to show the how the prototype works from one step to the next. The lifelines are Patient, Interface, Database, and Calculation. The sequence starts at the patient reading the welcome page and ends on the interface displaying the results.

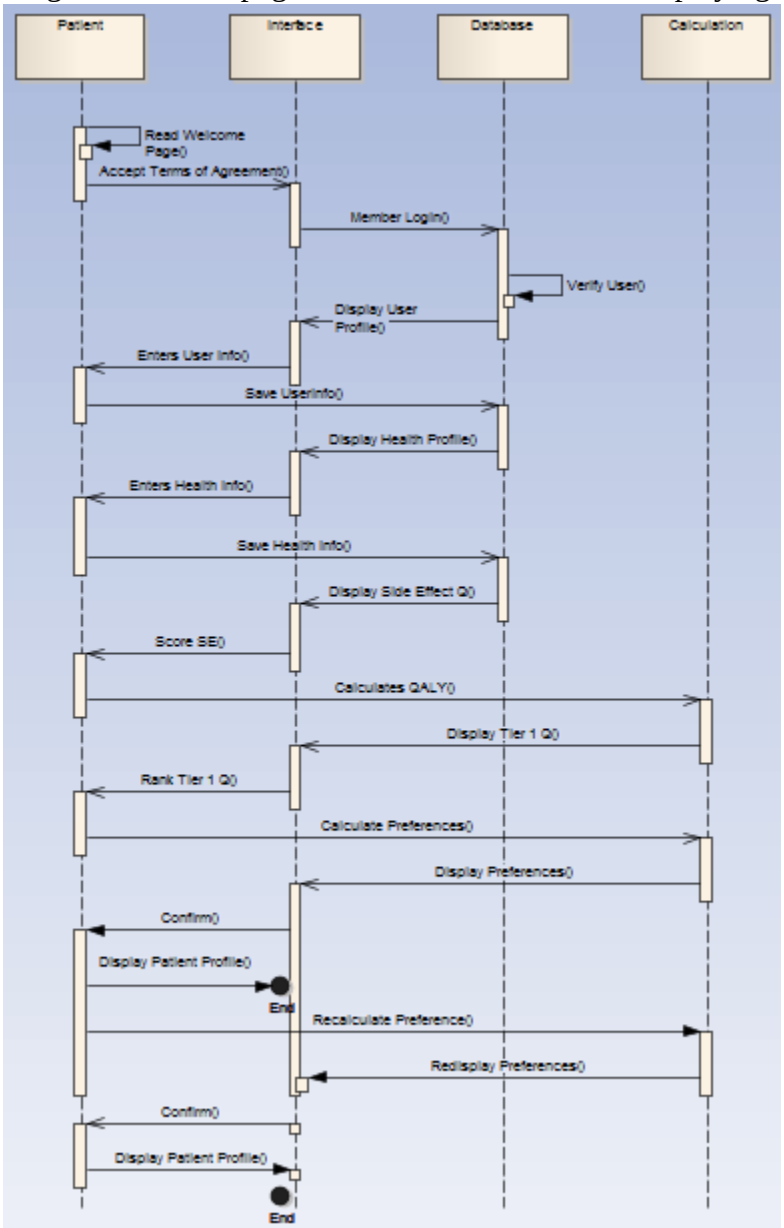


Figure 25: Sequence Diagram

After all the diagrams were completed, we reviewed each diagram individually to ensure they all have concordance and work as intended by the requirements. The system cannot be described by using a single diagram, but collectively they represent the whole system.

5.3 WALK-THROUGH

There are a total of six windows that the user can navigate through using the arrows at the top of each window: Introduction, User Profile, Health Profile, Side Effects, Tier 1 Questions, and Patient Profile. In addition, there are three more windows to provide the user with some

supporting information. Lastly, there are three back-end tabs where the "guts" of the model exist. Each tab will be discussed in detail.

5.3.1 WELCOME SCREEN

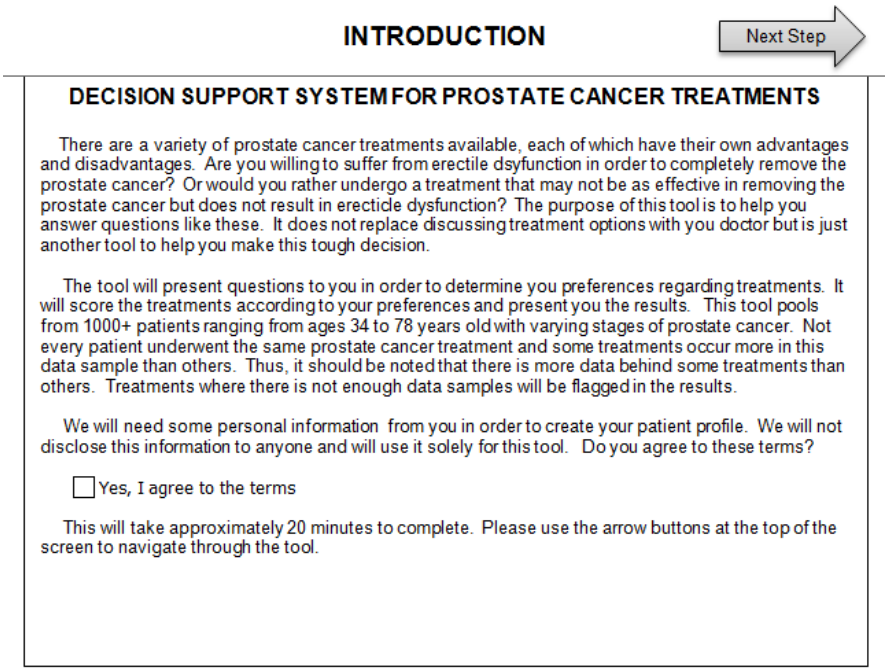


Figure 26: Welcome Screen

An introduction is displayed to the user once the model opened. Here we explain the purpose of the tool, the scope of the tool, how it works, and the approximate time for completion. In addition, there is a disclaimer stating the tool requires some personal and health information that will not be disclosed to anyone.

5.3.2 USER INPUT

The next two windows are where the user inputs general background information and information about their health.

USER PROFILE

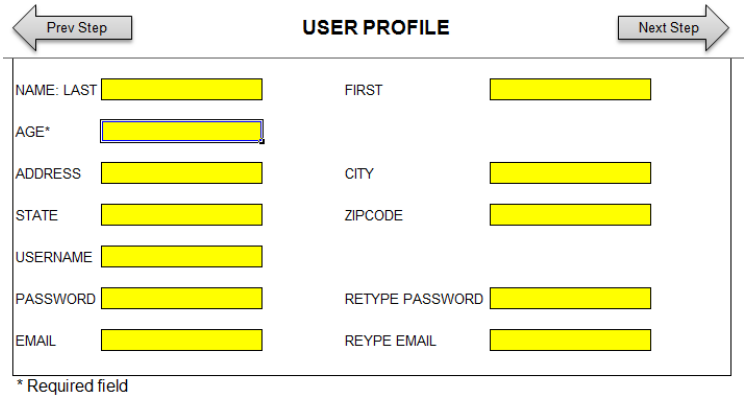


Figure 27: User Profile

The User Profile tab is designed to save personal information about the patient. The only field that is required on this tab in order for the model to run is the patient's age. In this tab the patient can create a username and password for future retrieval of information. However, this feature has not yet been implemented.

HEALTH PROFILE

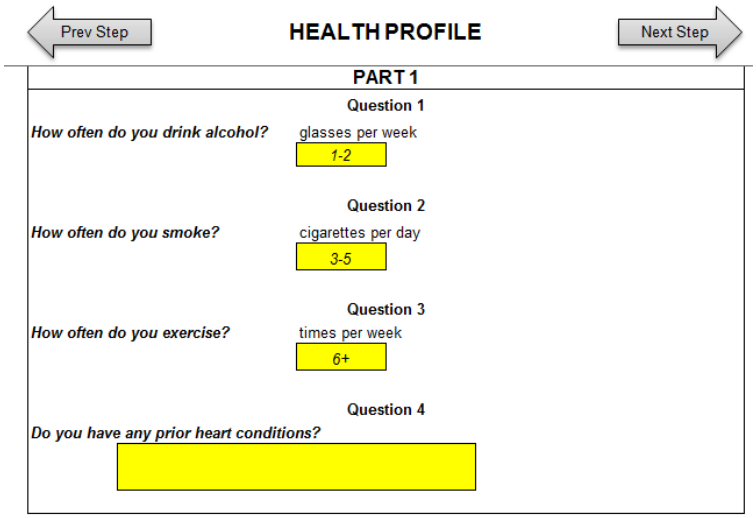


Figure 28: Health Profile Part 1

The Health Profile tab is split into two sections: General Health and Prostate Cancer Information. The General Health section can be used to gauge the patient's overall health. The patient can answer the questions listed in this section using the drop down choices.

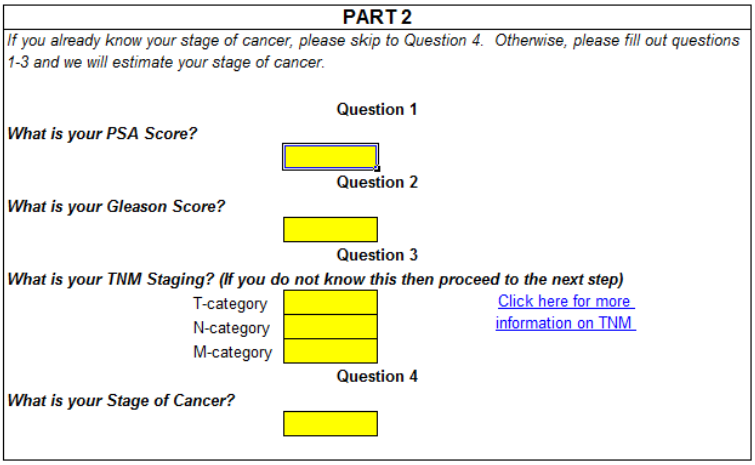


Figure 29: Health Profile Part 2

The second section determines the patient's stage of prostate cancer. This section is required for the model to run. The patient can enter their prostate cancer stage if they already know it. If not, their stage can be computed based off their PSA level, Gleason Score, and TNM staging. For patients unfamiliar with TNM staging system, there is a link to a tab with explanations.

5.3.3 ELICIATION

The following two windows elicit the patient's preferences for side effects and prostate cancer treatment criteria.

SIDE EFFECT

Prev Step **SIDE EFFECTS QUESTIONNAIRE** Next Step

Rank the following side effects in order of side effects you would like to improve from the worst case to the best case (no longer have the side effect). Ties are allowed. Click links for additional information on side effect.

#	Side Effect	Worst Case
1	Sexual Dysfunction	Sexual dysfunction includes Erectile Dysfunction and Peyronies disease (uncommon). You will have permanent impotentence and pain during sexual activity.
2	Urinary Issues	Urinary Issues refer to Urinary Tract Infections, Strictures, and Prostatitis. You will have severe pain and difficulty during urination.
3	Leakage	Leakage includes both urinary and fecal incontinence and Climacturia. You will have total leakage of urination and waste.
4	Bowel Issues	Bowel issues refers to Proctitis. You will have bloody stools and severe pain during bowel movements.
5	Physical Illness	You will suffer from a nausea and vomitting, fatigue, and hot flashes.
6	Infertility	You will not be able to conceive a child.
7	Change in Appearance	You will lose all your hair, lose muscle mass, and gain weight.

Figure 30: Side Effect Information

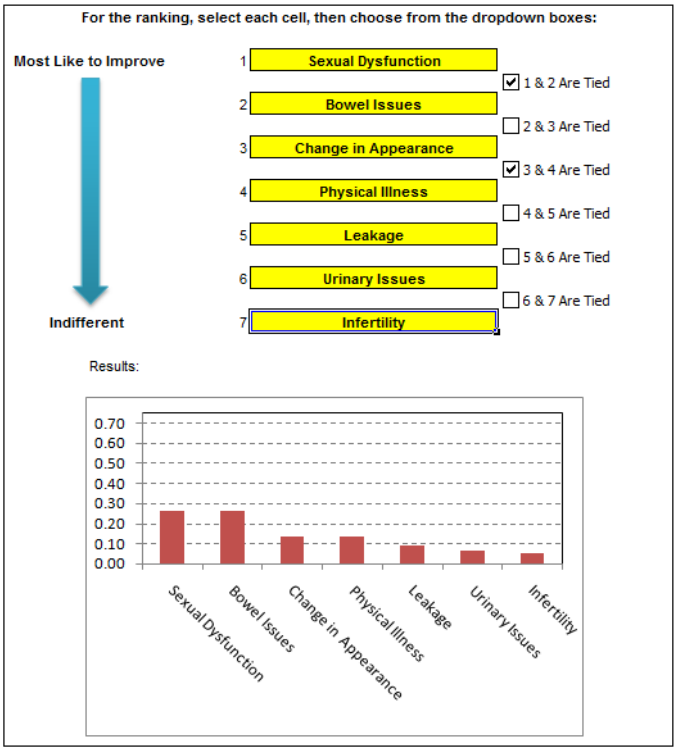


Figure 31: Side Effect Ranking and Graph

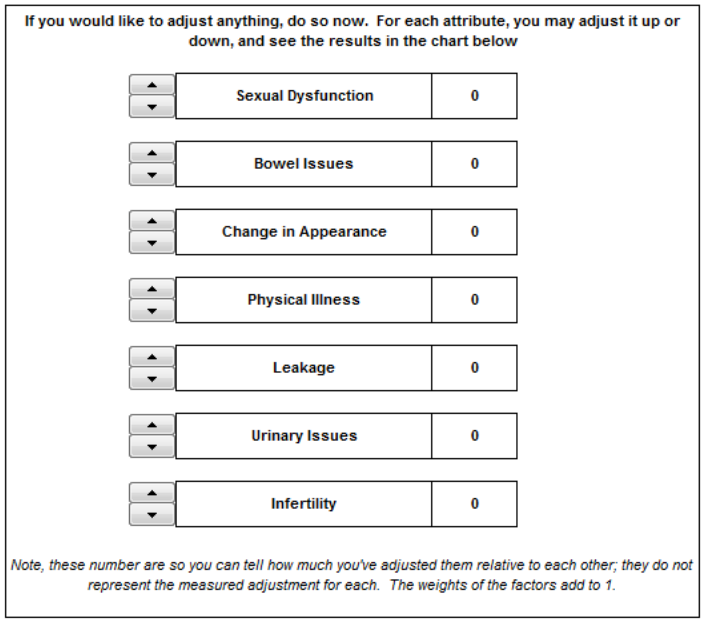


Figure 32: Side Effect Adjustments

This tab is where the patient ranks their preferences for side effects of prostate cancer treatments. The worst case scenario for each side effect is displayed, see Figure 30. In addition, the user can click on the side effect which is linked to a table in order to get more information. The patient can rank these using the drop down menus shown in Figure 31. Once the user ranks the side effects, a graph will be populated that displays the weights of each side effect. The user can then tweak the relative weights if the graph does not represent their preferences shown in Figure 32.

TIER 1 QUESTIONS

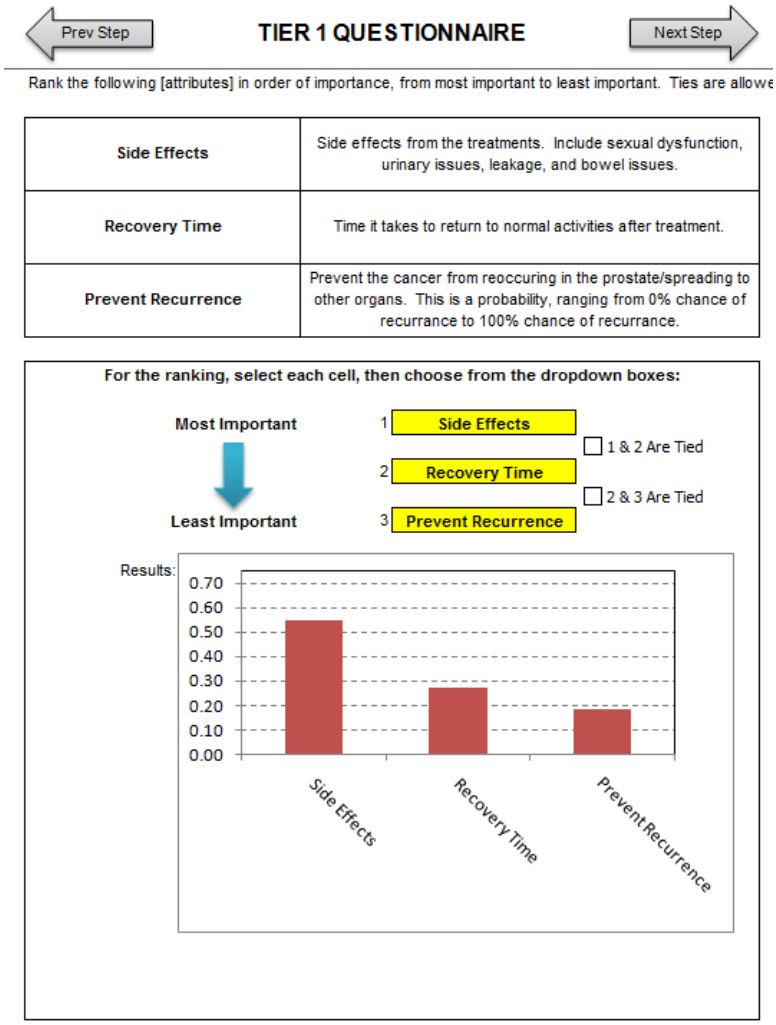


Figure 33: Tier 1 Questions

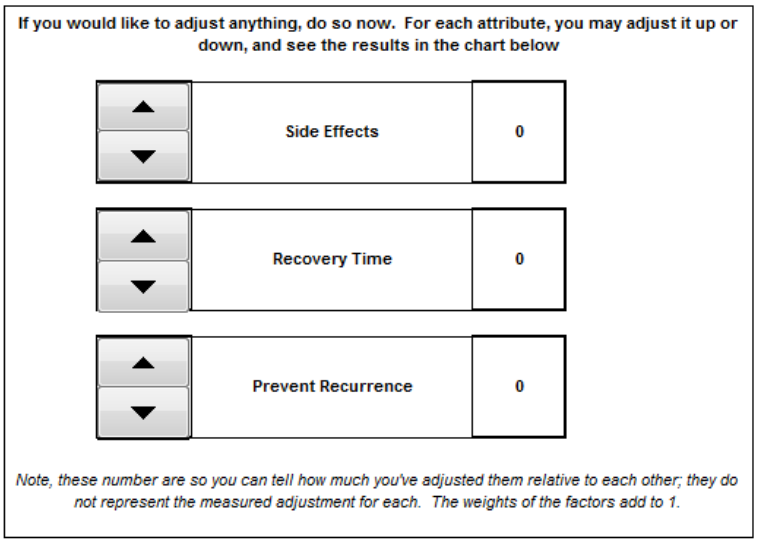


Figure 34: Tier 1 Adjustments

The Tier 1 tab elicits the patient's preference for the following: Recurrence, Side Effects, and Recovery Time. The same method as in the 'Side Effect' tab is used. The user ranks their preferences and then a graph is displayed. The user can then alter the graph to ensure their preferences are accurately portrayed in the model.

5.3.4 ADDITIONAL INFORMATION

There are three additional information tabs in the model to define/provide more information on certain areas to the user. The purpose of these tabs is to prevent the user from having to look up information outside this tool.

TNM STAGING INFORMATION

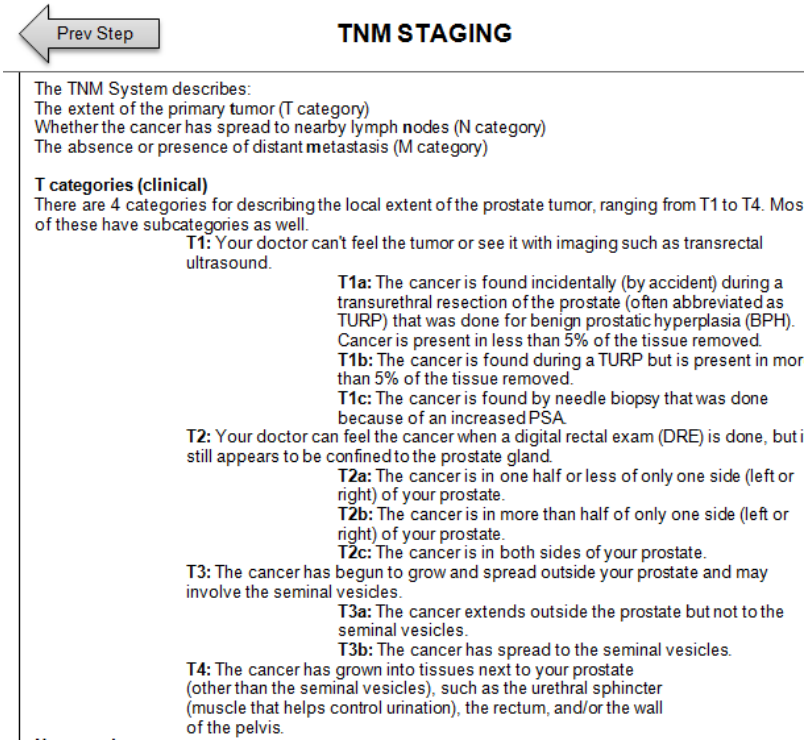


Figure 35: TNM Staging Info

The TNM Staging Info tab defines the TNM staging to assist users in inputting the correct T, N, and M stage.

SIDE EFFECTS INFORMATION

Prev Step

TREATMENT SIDE EFFECTS

Category I - Sexual Dysfunction		
Condition	Description	Treatments
Erectile Dysfunction	Erectile dysfunction (impotence), is the inability to develop or sustain an erection satisfactory for sexual intercourse	Oral medications, such as Cialis, Levitra, or Viagra. Injections of medicine into the penis before intercourse, penile implants, or surgery
Peyronies Disease	Peyronies disease is an abnormal bend of the penis that occurs during erection. It is due to scar tissue that develops under the skin of the penis. It can result in difficulty of peneration or pain during sexual activity.	Some or all of the symptoms may improve over time or may not get worse. Treatments include medicine, radiation therapy, injections, or Vitamin E.
Category II - Urinary Issues		
Condition	Description	Treatments
Urinary Tract Infection	Urinary Tract Infection is a bacterial infection that effects the urinary system. This infection can cause pain during urination, more frequent urge to urinate, and/or cloudy urine.	This infection is generally treated with antibiotics.
Strictures	Urethral stricture is the narrowing of the urethra which can make urination difficult.	Treatment by many physicians involves frequent "dilation" of the strictured area, but this may end up being only temporary. A more permanent treatment is surgery.
Prostatitis	Prostatitis is the inflammation of the prostate gland. It is usually characterized by difficulty or painful urination, frequent urination, fever, low-back pain, ED, low libido, or pain in the penis and/or testicles. There are 2 forms of prostatitis: acute and chronic baterial. Both are caused by an infection of the prostate.	Treatment is based on the cause. Antiobiotics are used to treat prostatitis that is caused by an infection (several weeks or a few months). Severe cases may lead you to go to the hospital for treatment with fluids and antiobiotics. Prostatitis not caused by an infection is more difficult. Treatments for this case are aimed at making your feel better.

Figure 36: Side Effects Category 1-2

The Side Effects Info tab includes additional information about conditions such as their definition, range of severity, and treatment options.

TREATMENT INFORMATION

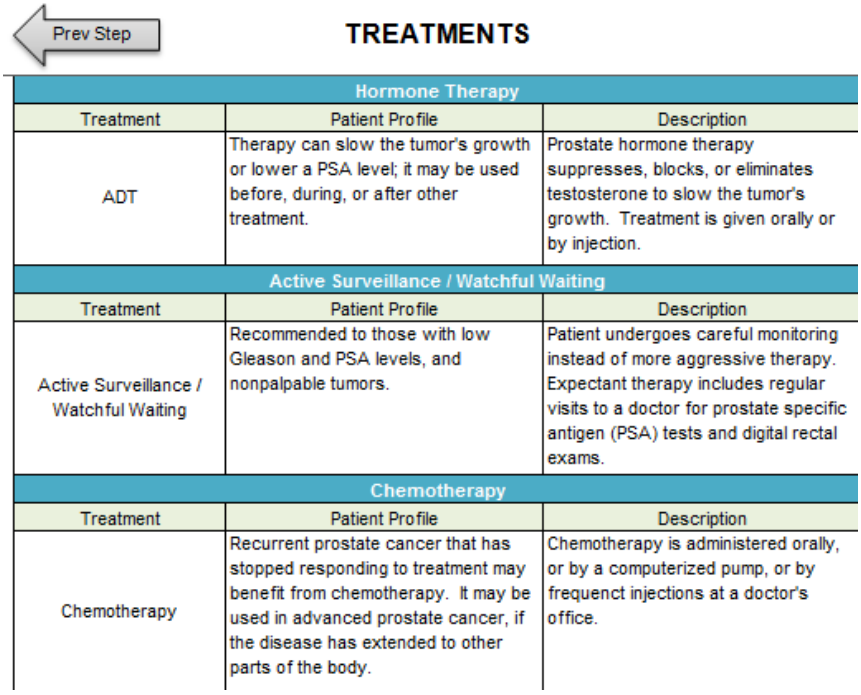


Figure 37: Treatment information

This tab presents additional information on treatments including the health profile for potential patients and a more in-depth description of the treatment.

5.3.5 BACK-END

FORMAT

This sheet contains all the formatting for the tabs that the user interfaces with. It includes the lists for drop down menus and the titles/descriptions displayed to users.

RAW DATA

This sheet includes the raw prostate cancer data provided by Andromeda Systems. In addition, it implements error-checking to fix mistakes in data entry.

AGGREGATION

The Aggregation tab filters the raw data into the following data tables:

- Number of patients that underwent a given treatment by age group and prostate cancer stage
- Average patient starting PSA level by age group and prostate cancer stage
- Average patient PSA level by age group and prostate cancer stage after a given treatment
- Number of occurrences for a side effect for a given treatment by age group

CALCULATIONS

The Calculations tab uses the data tables from the Aggregation tab to calculate the probability of recurrence and probability of side effects for each treatment given the patient's prostate cancer stage and age. In addition, the weight, normalization, and utility score calculations are completed on this tab.

5.3.6 RESULTS

Prev Step

HEALTH PROFILE

Patient Summary

Age Group:	45 - 49
Stage of Prostate Cancer:	Stage 2
Most Important Attribute:	Side Effects
Least Important Attribute:	Prevent Recurrence

Where do you fall in the data set?

Total # of data pts that match your age and stage of cancer:	0
Total # of data pts in the data set (all ages & stages):	803

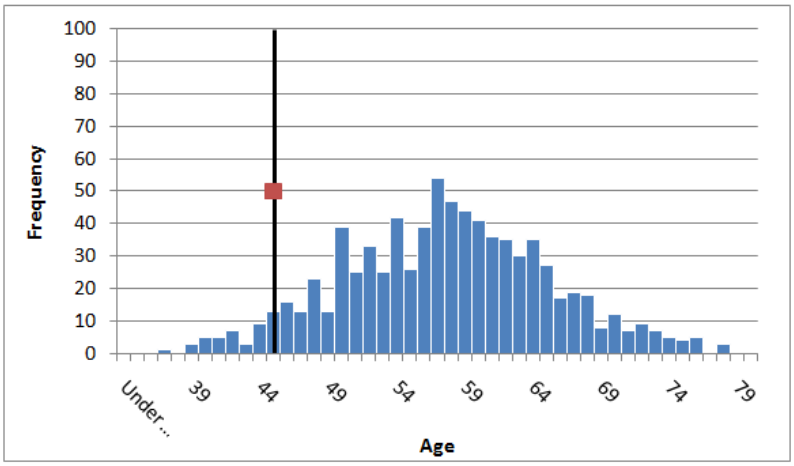


Figure 38: Summary and Data set position

Value Analysis

The chart below displays the treatments utility vs the cost. The further northwest you move in the plot, the more cost effective the treatment is compared to the others (more utility per dollar). The further to the right you move - the more costly treatments are and the further up you move - the more preferrable the treatment is based on the questions you answered in the previous parts. This is not an end all be all recommendation but rather a starting point for discussions with your doctor about possible treatments and your preferences.

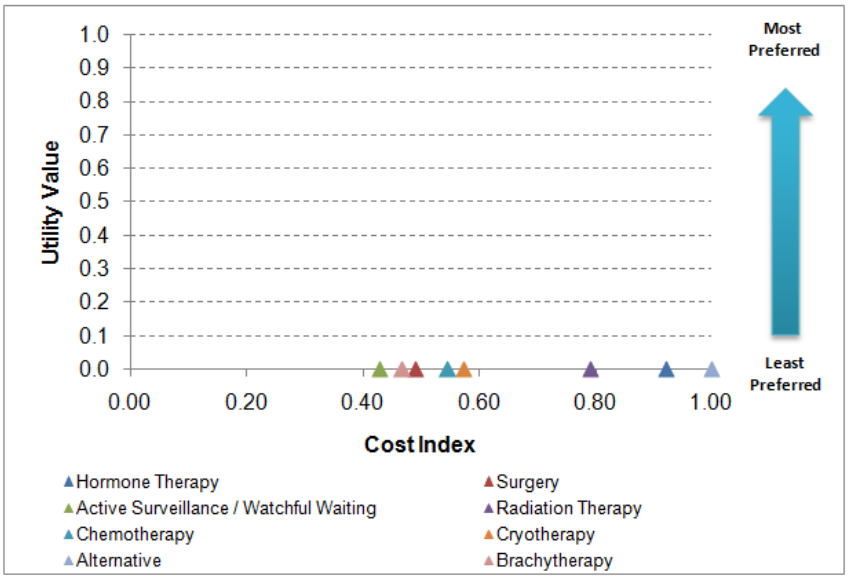


Figure 39: Value Analysis

Summary of Results

Most Cost Effective Treatment	**Active Surveillance / Watchful Waiting**
Least Cost Effective Treatment	**Radiation Therapy**
Most Treatment, Based solely on Side Effects	**Active Surveillance / Watchful Waiting**
Least Treatment, Based solely on Side Effects	**Surgery**

Order Based on Overal Utility (1 = Most Preferrable)

Rank	Treatment	Description
1	Active Surveillance / Watchful Waiting	You and your doctor closely monitor your prostate cancer for any changes. No medical treatment is provided.
2	Brachytherapy	Insertion of radioactive seeds into the prostate gland.
3	Alternative	Non-invasive ttreatment - high energy focused ultrasound beam is concetrated on the prostate gland to warm and terminate the prostate cancer.
4	Cryotherapy	Freezes the prostate tissue causing cancer cells to die.
5	Hormone Therapy	Treatment to stop your body from producing testosterone causing the cancer cells to die or to grow more slowly.
6	Surgery	Surgery to remove the prostate and its cancer. Surgery can either be an open surgery or done through small incisions.
7	Chemotherapy	Uses medicine to weaken and destroy cancer cells in the body. If is a systemic therapy that affects the whole body by going through the bloodstream.
8	Radiation Therapy	Uses high levels of radiation to kill prostate cancer cells or keep them from growing and dividing.

*Red highlights denotes treatments that have less than 20 data pts for your given age and stage of cancer. The lack of data behind the treatment may be because the treatment is not appropriate for your stage of cancer and/or stage of cancer. However, this should be discussed with your doctor.

Figure 40: Treatment Summary Results

The User Profile displays the results of DSS. Treatments highlighted in red indicate the number of data points for the treatment in the database does not meet a certain threshold. Thus, the patient should be aware of the lack of data used in calculating the utility of the treatment.

5.4 USER FEEDBACK

Fortunately, we were able to provide the prototype for a couple of people to test. Their feedback was very valuable and allowed us to improve the tools user interface.

- Doctor never told the user their stage of prostate cancer
    - To account for this, the model can calculate the user's stage based off their PSA level, Gleason Score, and TNM stage (default entered if they don't know what this is)
- User did not know any information about the side effects (what strictures is)
    - An information tab was added to explain all medical terms/conditions to the user
- User did not feel the model was complete. Was aware of side effects not listed in the model.

    - The model was originally based only on the data from the raw database we were provided by Andromeda Systems. This resulted in researching additional side effects such as hair loss, weight gain/loss of muscle, infertility, hot flashes, nausea / vomiting, and fatigue
- Questions were hard to score and understand
- Quality of Adjusted Life Years (QALY) method for ranking side effects was difficult to understand. This was a proven elicitation method in the medical field; however the users had difficulty grasping the concept of giving up years of their life for side effects they have not experienced.
    - Simplified the elicitation method to ranking the side effects rather than setting a score.
- In addition, the users also pointed out broken links, locked cells, missing drop down box selections, and repeated questions.

5.5 SENSITIVITY ANALYSIS

The sensitivity analysis was used as one method to validate the model. We wanted to ensure that each treatment would have a wide range of possible rankings. Additionally, we also wanted to ensure that no single treatment would always rank as the most or least preferred treatment.

To perform the analysis we ran a Microsoft Excel plugin called Crystal Ball to run Monte Carlo simulations on our inputs. The following distributions were applied to each input.

Input	Distribution
Prostate Cancer Stage	U(0, 4)
Age	N(57, 8^2)
Rank for Side Effects	U(1, 7)
Rank for Tier 1 Factors	U(1, 3)

Table 8: Distribution of possible inputs for Crystal Ball

1,000 iterations were then run on this model and the outputs utility for each treatment was recorded. The graph below shows the range of utilities for each individual treatment.

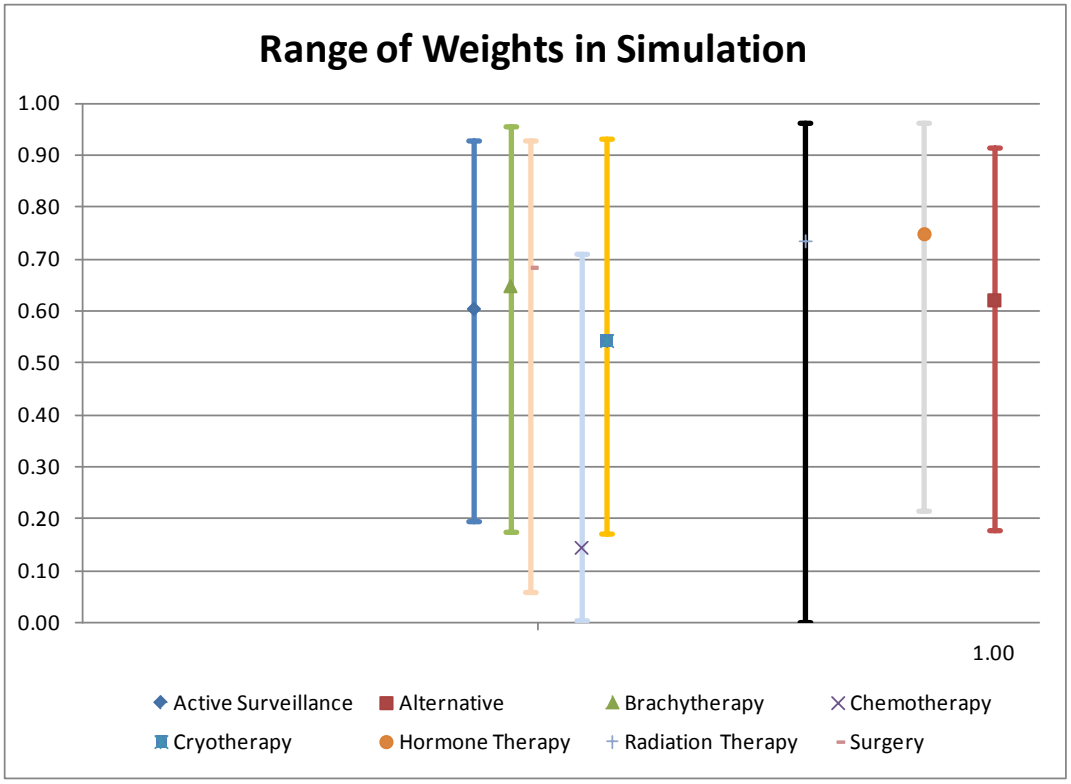


Figure 41: Utility range of all treatments in the PTDSS.

Each vertical bar represents the range of utility. Each bar's placement on the x-axis represents the respective treatment's cost index. In this way, we're able to show the possible ranges for the Pareto frontier as well as the range of each treatment's utility. If additional cost data were available, the data bars could be turned into ellipses, with the width of each ellipse representing the range of cost and the height representing the range of utility.

6 CONCLUSION

6.1 SUMMARY OF WORK

We presented a model and prototype decision support system for determination of a prostate cancer treatment. The system primarily informs a patient of his options and the varying things to know about prostate cancer and its possible treatments. Where a patient may not know about certain information (such T,N,M scores), the system serves the purpose of informing the patient so he fully understands the magnitude of his situation. It also incorporates a patient's preferences concerning side effects and other factors into the resulting rank of treatments. The resulting rank can then become a point of conversation with the patient's doctor, which will then ensure that the patient is more confident about the decision he and his doctor make about the treatment.

6.2 LESSONS LEARNED

There were many lessons learned while defining, designing, and implementing the Prostate Cancer DSS prototype.

- User feedback is integral in the designing and development of the decision support system. Feedback from users identified areas in the model that were unclear and needed improvement.
- Eliciting the user's preferences is very difficult without back and forth communication.
- Important to provide a background to the user to set expectations of the model.

6.3 FUTURE WORK

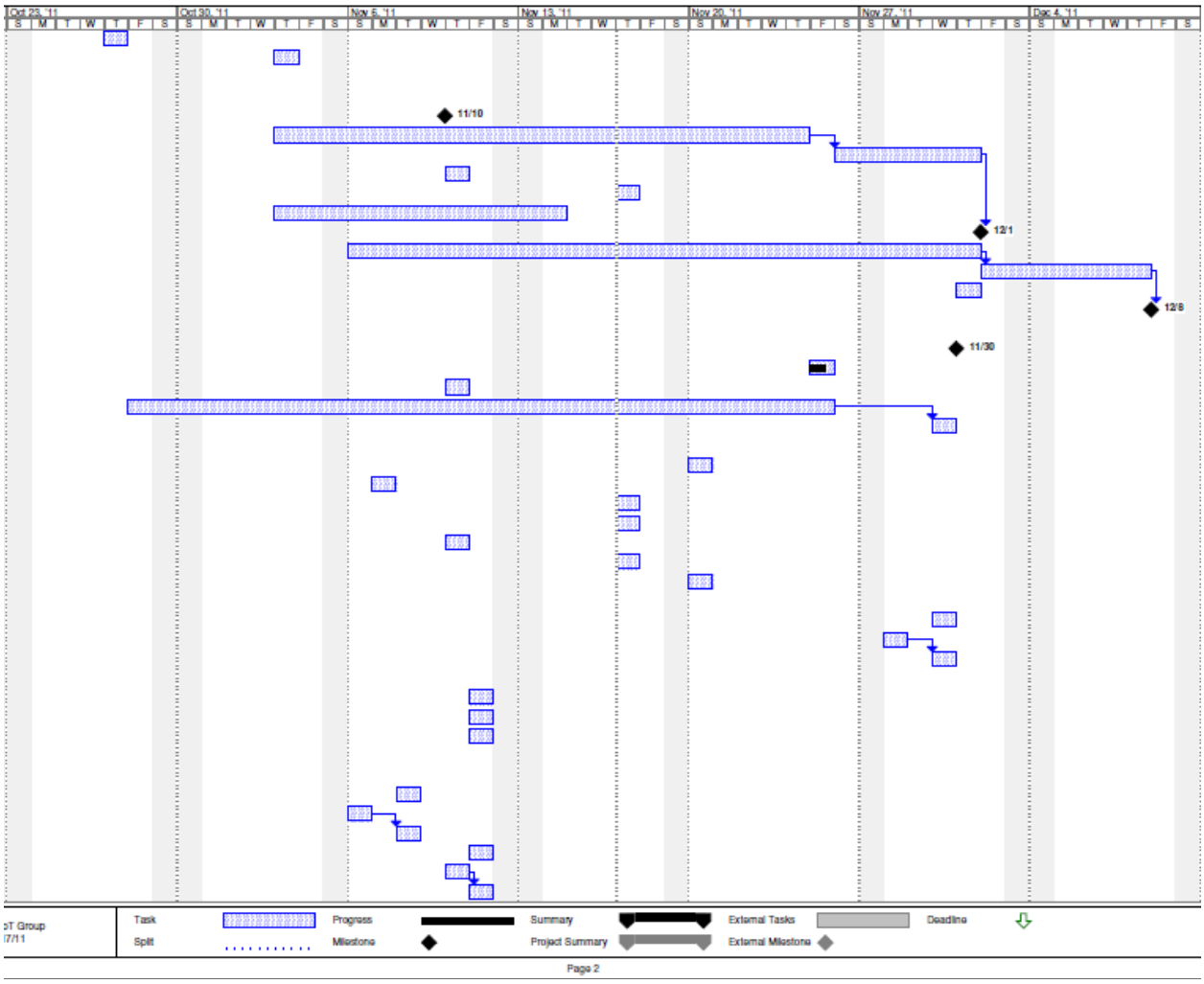
Although the prototype is a good start in developing a Prostate Cancer Treatment DSS, it is not a final product. There are some areas of the model that can be improved and built upon.

- It is important to add more prostate cancer data to the database. The current database was reduced to 803 entries after the initial data cleanup and was reduced further once the data was filtered on the patient's health profile. Additional data will improve the results of the system by providing more representative measures for the treatment criteria (probability of recurrence, probability of side effect, etc).
- Similarly, additional information may provide data behind side effects that were not reported in the current database (e.g. fatigue, muscle loss, infertility).
- Testing/Validation process with a larger set of patients. To avoid going down the human factors road, we limited the number of users we had test the model. Having more users with varying backgrounds will be important in determining the effectiveness of the model.
- The database will eventually need to be moved to Access or another program because of the data constraints Excel has (cannot have more than 1 million rows of data and loss of speed as worksheets grow larger and larger).

7 Appendix A: Schedule

The schedule of project was created in Microsoft Project. The first half shows the basic course outline with milestones. Mid-way through our project, we refined our schedule to reflect more detail steps. This helped with keeping completing tasks on time and preventing us from falling behind.

ID	Task Name	Duration	Start	Finish
1	Group Meeting	1 day	Thu 10/27/11	Thu 10/27/11
2	Meeting with Instructor	1 day	Thu 11/3/11	Thu 11/3/11
3				
4				
5	Draft Final Paper	0 days	Thu 11/10/11	Thu 11/10/11
6	Final Paper	18 days?	Thu 11/3/11	Thu 11/24/11
7	Edit Review Final Paper	5 days?	Sat 11/26/11	Thu 12/1/11
8	Group Meeting	1 day	Thu 11/10/11	Thu 11/10/11
9	Group Meeting	1 day?	Thu 11/17/11	Thu 11/17/11
10	Website	9 days?	Thu 11/3/11	Mon 11/14/11
11	Final Report	0 days	Thu 12/1/11	Thu 12/1/11
12	Presentation Slides	22 days?	Sun 11/6/11	Thu 12/1/11
13	Practice Presentation	5 days?	Fri 12/2/11	Thu 12/8/11
14	In Class Practice Final Presentation	1 day	Thu 12/1/11	Thu 12/1/11
15	Final Presentation	0 days	Thu 12/8/11	Thu 12/8/11
16				
17	Paper	0 days	Wed 11/30/11	Wed 11/30/11
18	citations	1 day?	Fri 11/25/11	Fri 11/25/11
19	outline	1 day?	Thu 11/10/11	Thu 11/10/11
20	draft	23 days	Fri 10/28/11	Fri 11/25/11
21	final	1 day?	Wed 11/30/11	Wed 11/30/11
22				
23	Aggregation	1 day?	Sun 11/20/11	Sun 11/20/11
24	Problem Space	1 day?	Mon 11/7/11	Mon 11/7/11
25	Methods	1 day?	Thu 11/17/11	Thu 11/17/11
26	Tools (Excel)	1 day?	Thu 11/17/11	Thu 11/17/11
27	Explanations	1 day?	Thu 11/10/11	Thu 11/10/11
28	Tradeoffs	1 day?	Thu 11/17/11	Thu 11/17/11
29	Chart & Graphic Generation	1 day?	Sun 11/20/11	Sun 11/20/11
30				
31	Presentation	1 day?	Wed 11/30/11	Wed 11/30/11
32	Draft	1 day?	Mon 11/28/11	Mon 11/28/11
33	Final	1 day?	Wed 11/30/11	Wed 11/30/11
34				
35	Data Composition	1 day?	Fri 11/11/11	Fri 11/11/11
36	Tier 1 Measurements of Probability	1 day?	Fri 11/11/11	Fri 11/11/11
37	Tier 2 Measurements of probability	1 day?	Fri 11/11/11	Fri 11/11/11
38				
39	Elicitation	1 day?	Sun 9/18/11	Sun 9/18/11
40	Initial	1 day?	Tue 11/8/11	Tue 11/8/11
41	Compose	1 day?	Sun 11/6/11	Sun 11/6/11
42	Perform	1 day?	Tue 11/8/11	Tue 11/8/11
43	Follow Up	1 day?	Fri 11/11/11	Fri 11/11/11
44	Initial	1 day?	Thu 11/10/11	Thu 11/10/11
45	Compose	1 day?	Fri 11/11/11	Fri 11/11/11


Oct 23, '11
Oct 30, '11
Nov 6, '11
Nov 13, '11
Nov 20, '11
Nov 27, '11
Dec 4, '11
11/10
12/1
12/8
11/30
Task
Split
Progress
Milestone
Summary
Project Summary
External Tasks
External Milestone
Deadline
Page 2

8 Appendix B: Requirements

1. Stakeholders Requirements:
   1.1. The system shall provide an interface to view results
   1.2. The system shall provide a means of inputting customer preferences.
   1.3. The system shall provide an electronic file with customer's information.
   1.4. The system shall provide a means of navigating through the program.
   1.5. The system shall operate with window XP, Vista, and 7
   1.6. The system shall operate in excel 2007 and 2010
   1.7. The system shall be useable by December 1st
   1.8. The system shall store patient's information securely
   1.9. The system shall allow data to be expandable
      1.9.1. The system shall be able to auto update statistics with future raw data
   1.10. The system shall provide tech support
   1.11. The system shall provide a means of debugging the system

2. System Wide Requirements :
   2.1. The system shall provide safety for the customer from identity thieves.
   2.2. The system shall provide a 24hr availability.
   2.3. The system shall provide supportability for the new questionnaires.
   2.4. The system shall describe side effects
   2.5. The system shall define treatments
   2.6. The system shall provide a printable summary of patient information.
   2.7. The system shall be user friendly
   2.8. The system shall not use macros
   2.9. The treatments shall be graphed with cost.
   2.10. The results shall be displayed in a graphical form

3. Qualification Requirements:
   3.1. The system shall provide preference weights within 10 seconds of input by customer
   3.2. The system shall store customer data within 15 seconds of completion of the first page
   3.3. The system shall verify unique identification within 15 seconds of input by customer.
      The system cost shall not exceed $100
   3.4. The system shall adjust preferences within 1 second of patient input
   3.5. The system shall be completed within 20 minutes
      3.5.1. The tier 1 questions shall be completed by user within 5 minutes
      3.5.2. The user profile shall be completed by user within 3 minutes
      3.5.3. The health profile shall be completed by user within 3 minutes
      3.5.4. The tier 1 adjustments shall be completed by the user within 4 minutes
      3.5.5. The Side effect questions shall be completed by user within 10 minutes
   3.6. The side effect questions shall not exceed 10
   3.7. The Tier 1 questions shall not exceed 5.

9 Appendix C: Use Case 1: Use DSS

Characteristic Information

The following defines information that pertains to this particular use case. Each piece of information is important in understanding the purpose behind the Use Case.

Goal In Context:	Reach a suggested prostate cancer treatment
Scope:	DSS
Level:	Sea level
Pre-Condition:	Doctor must diagnose patient with prostate cancer
Success End Condition:	Patient has a suggested treatment
Minimal Guarantees:	Patient dies, Patient has no cancer, Patient currently in treatment
Primary Actor:	Patient: person in need of a treatment and the user of the DSS
Trigger Event:	Patient informed of having prostate cancer

Main Success Scenario

This Scenario describes the steps that are taken from trigger event to goal completion when everything works without failure. It also describes any required cleanup that is done after the goal has been reached. The steps are listed below:

Step	**Actor**	**Action Description**
1	Doctor	Informs employee of having prostate cancer
2	Patient	Logs into DSS using unique ID and Password
3	Patient	Enters Prostate condition (PSA score, Gleason score, aggressiveness)
4	Patient	Enters Medical History (frequency of smoking, drinking, previous health conditions)
5	Patient	Selects Survey Topic
6	Patient	Enters answers to all survey questions
7	Patient	Clicks submit
8	DSS	Gathers all patient information
9	DSS	Calculates preferences
10	DSS	Displays Preferences
11	Patient	Confirms Preferences are correct

12	DSS	Displays Suggested treatment
13	Patient	Learns about treatment

Scenario Extensions

This is a listing of how each step in the Main Success Scenario can be extended. Another way to think of this is how can things go wrong. The extensions are followed until either the Main Success Scenario is rejoined or the Failed End Condition is met. The Step refers to the Failed Step in the Main Success Scenario and has a letter associated with it. I.E if Step 3 fails the Extension Step is 3a.

Step	**Condition**	**Action Description**
2a	Log in failed	Patient requests password change
3a		Return to step 2
11a	Patient rejects preferences	Patient Adjusts one preference
12a		DSS recalculates preference
13a		Return to step 10

Scenario Variations

If a variation can occur in how a step is performed it will be listed here.

Step	**Variable**	**Possible Variations**
12	Softcopy of Treatment	Treatment sent to email or phone

10 Appendix D Format Tab Screen Shots:

FORMAT TAB

PATIENT PROFILE

Input	Choices
	0
	1-2
	3-5
	6+

Input	Choices
T	T1
	T1a
	T1b
	T1c
	T2
	T2a
	T2b
	T2c
	T3
	T3a
	T3b
	T4
N	N0
	N1
M	M0
	M1
	M1a
	M1b
	M1c
Stage	I
	II
	III
	IV

SIDE EFFECTS QUESTIONNAIRE

ID	Side Effect	Display Description
1	Sexual Dysfunction	Sexual dysfunction includes Erectile Dysfunction and Peyronies disease. T
2	Urinary Issues	Urinary Issues refer to Urinary Tract Infections, Strictures, and Prostatitis.
3	Leakage	Leakage includes both urinary and fecal incontinence and climacturia. The
4	Bowel Issues	Bowel issues refers to Proctitis. The effects can be as minor as constipati

Search Key	Side Effect	Category
Climac	Climacturia	Leakage
Leakage	Leakage	Leakage
ED	Erectile Dsyfunction	Sexual Dysfunction
Incon	Incontinence	Leakage
Urin	Urinary Tract	Urinary Issues
Stricture	Stricture	Urinary Issues
Proctitis	Proctitis	Rectal Bleeding
Prostatitis	Prostatitis	Urinary Issues
Peyr	Peyronies Disease	Sexual Dysfunction

TIER 1 COMBINATORICS

Displayed Description:

Choice	Description
Quality of Life	Quality of life encompasses side effects and their complications. Ongoing pain, discomfort, and medications are also included.
Recovery Time	Time it takes to return to normal activities.
Prevent Recurrence	Prevent the cancer from reoccuring, either by spreading to other organs or by recurring in the prostate. This is a probability, ranging from 0% chance of recurrance to 100% chance of recurrance.

Drop Down Menu:

ID	Description	After First Choice	After Second Choice
1	Quality of Life	Quality of Life	Prevent Recurrence
2	Recovery Time	Prevent Recurrence	
3	Prevent Recurrence		

First Choice		
1	1	Quality of Life
0	1	Recovery Time
1	2	Prevent Recurrence

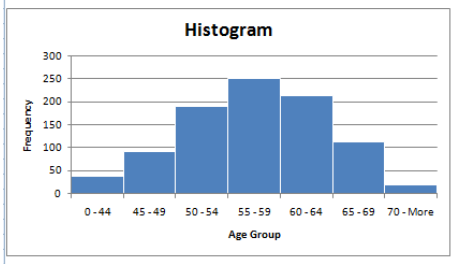
Second Choice		
0	0	Quality of Life
0	0	Recovery Time
1	1	Prevent Recurrence

Third Choice		
0	0	Quality of Life
0	0	Recovery Time
0	0	Prevent Recurrence

11 Append E: Calculations Tab Screen Shots

DATA SUMMARY

Range	Hormone Therapy	Surgery	Active Surveillance / Watchful Waiting	Radiation Therapy	Chemotherapy	Cryotherapy	Alternative	Brachytherapy	Total
0 - 44	8	24	1	4	0	0	0	0	37
45 - 49	10	53	9	15	1	0	0	3	91
50 - 54	29	93	12	37	1	2	5	10	189
55 - 59	39	122	18	46	0	4	4	17	250
60 - 64	31	86	21	51	0	2	6	16	213
65 - 69	24	30	15	22	2	1	3	16	113
70 - More	1	5	2	8	0	0	0	2	18



http://www.protons.com/proton-therapy/conditions-treated/prostate-
http://www.prostateimplant.com/treatment_options

Age	# Occurances	For Bar
Under 35	0	-100
35	0	-100
36	0	-100
37	1	-100
38	0	-100
39	3	-100
40	5	-100
41	5	-100
42	7	-100
43	3	-100
44	9	-100
45	13	-100
46	16	-100
47	13	-100
48	23	-100
49	13	-100
50	39	-100
51	25	-100
52	33	-100
53	25	-100
54	42	-100
55	26	-100
56	39	-100
57	54	-100
58	47	-100

PATIENT INFORMATION

Cancer Stage:

PSA	0
Gleason	0
T Category	0
N Category	0
M Category	0

Cancer Stage	II	(User)

Stage Criteria:

Score	Stage	T	N	M	PSA	Gleason	T	N	M	PSA	Gleason
2	I	T1	N0	M0	<10	<=6	0	0	0	1	1
2	I	T2a	N0	M0	<10	<=6	0	0	0	1	1
2	II	T1	N0	M0	<20	<=7	0	0	0	1	1
1	II	T1	N0	M0	>=10, <20	<=6	0	0	0	0	1
2	II	T2a	N0	M0	<20	<=7	0	0	0	1	1
2	II	T2b	N0	M0	<20	<=7	0	0	0	1	1
2	II	T2c	N0	M0	any	any	0	0	0	1	1
1	II	T1	N0	M0	>=20	any	0	0	0	0	1
1	II	T2	N0	M0	>=20	any	0	0	0	0	1
1	II	T1	N0	M0	any	>=8	0	0	0	1	0
1	II	T2	N0	M0	any	>=8	0	0	0	1	0
2	III	T3	N0	M0	any	any	0	0	0	1	1
2	IV	any	N1	M0	any	any	0	0	0	1	1
2	IV	any	any	M1	any	any	0	0	0	1	1

Age Range:

Patient Age	65

	Age Range	Hormone Therapy	Surgery	Active Surveillance / Watchful Waiting	Radiation Therapy	Chemotherapy	Cryotherapy	Alternative	Brachytherapy
Band Below	60 - 64	14	48	5	27	0	1	5	5
Patient Range	65 - 69	8	16	4	10	2	0	3	8
Band Above	At upper bound	0	0	0	0	0	0	0	0
Total		22	64	9	37	2	1	8	13

RECURRANCE

	Hormone Therapy	Surgery	Active Surveillance / Watchful Waiting	Radiation Therapy	Chemotherapy	Cryotherapy	Alternative	Brachytherapy
PSA Before	352.36	38.28	28.93	58.37	727.60	7.50	16.11	25.86
PSA After	7.33	2.86	16.90	205.14	0.00	0.00	0.73	2.03
% Improvement	97.9%	92.5%	41.6%	-251.5%	100.0%	100.0%	95.5%	92.2%

RECOVERY TIME

	Hormone Therapy	Surgery	Active Surveillance / Watchful Waiting	Radiation Therapy	Chemotherapy	Cryotherapy	Alternative	Brachytherapy
Typical Recovery Time (weeks)	0	1	0	1	12	1	2	1.5
Normalized	1.00	0.92	1.00	0.92	0.00	0.92	0.83	0.88

TREATMENT COSTS

Treatment	Cost	
Hormone Therapy	$69,244	**
Surgery	$36,888	**
Active Surveillance / Watchful Waiting	$32,135	**
Radiation Therapy	$59,455	**
Chemotherapy	$41,000	http://www.kaycircle.com/What-is-the-average-cost-of-chemotherapy-for-prostate-cancer-per-year-in-2010
Cryotherapy	$43,108	**
Alternative	$75,000	*** per treatment
Brachytherapy	$35,143	**
		** denotes 5.5 yr

SIDE EFFECTS

Search Key	Side Effect	Category
Climac	Climacturia	Leakage
Leakage	Leakage	Leakage
ED	Erectile Dsyfunction	Sexual Dysfunction
Incon	Incontinence	Leakage
Urin	Urinary Tract	Urinary Issues
Stricture	Stricture	Urinary Issues
Proctitis	Proctitis	Rectal Bleeding
Prostatitis	Prostatitis	Urinary Issues
Peyr	Peyronies Disease	Sexual Dysfunction

Rank Calculation:

	Tie	Rank	Reciprocal	SMARTER	Rank Sum	Rank Reciprocal
Sexual Dysfunction		1	1.00	0.54	0.28	0.26
Bowel Issues	TRUE	1	1.00	0.40	0.28	0.26
Change in Appearance	FALSE	2	0.50	0.25	0.22	0.13
Physical Illness	TRUE	2	0.50	0.18	0.22	0.13
Leakage	FALSE	3	0.33	0.11	0.17	0.09
Urinary Issues		4	0.25	0.06	0.11	0.07
Infertility	FALSE	5	0.20	0.03	0.06	0.05

	Weight 1 Adj	Weight 2 Adj	Weight 3 Adj	Weight 4 Adj	Weight 5 Adj	Weight 6 Ad	Weight 7 Adj
User Change	5	5	5	5	5	5	5
% Change	0.00	0.00	0.00	0.00	0.00	0.00	0.00

			0.26	0.26	0.13	0.13	0.09	0.07	0.05	
	Original Weights		0.26	0.26	0.13	0.13	0.09	0.07	0.05	Weights for Graph
Sexual Dysfunction		0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26
Bowel Issues		0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26
Change in Appearance		0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13
Physical Illness		0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13
Leakage		0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
Urinary Issues		0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
Infertility		0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05

Probability of Avoiding Side Effect

Side Effect	Hormone Therapy	Surgery	Active Surveillance / Watchful Waiting	Radiation Therapy	Chemotherapy	Cryotherapy	Alternative	Brachytherapy	Weight
Sexual Dysfunction	0.51	0.26	0.97	0.59	0.50	0.33	0.56	0.66	0.26
Urinary Issues	0.98	0.98	1.00	0.99	1.00	1.00	0.67	0.88	0.07
Leakage	0.95	0.78	0.97	0.92	1.00	1.00	1.00	0.88	0.09
Bowel Issues	0.18	-0.15	0.94	0.30	0.00	-0.33	0.11	0.22	0.26
Physical Illness	0.50	0.50	1.00	0.50	0.50	1.00	1.00	1.00	0.13
Infertility	1.00	0.00	1.00	0.50	0.50	0.00	1.00	0.50	0.05
Change in Appearance	0.50	1.00	1.00	1.00	0.50	1.00	1.00	1.00	0.13
Weight Score	0.52	0.36	0.98	0.61	0.44	0.42	0.63	0.66	

Normalized

Side Effect	Hormone Therapy	Surgery	Active Surveillance / Watchful Waiting	Radiation Therapy	Chemotherapy	Cryotherapy	Alternative	Brachytherapy
Sexual Dysfunction	0.35	0.00	1.00	0.46	0.34	0.10	0.42	0.56
Urinary Issues	0.95	0.95	1.00	0.96	1.00	1.00	0.00	0.63
Leakage	0.76	0.00	0.88	0.63	1.00	1.00	1.00	0.44
Bowel Issues	0.40	0.15	1.00	0.50	0.26	0.00	0.35	0.43
Physical Illness	0.00	0.00	1.00	0.00	0.00	1.00	1.00	1.00
Infertility	1.00	0.00	1.00	0.50	0.50	0.00	1.00	0.50
Change in Appearance	0.00	1.00	1.00	1.00	0.00	1.00	1.00	1.00
Weight Score	0.38	0.23	0.99	0.53	0.34	0.45	0.61	0.63

TIER 1 QUESTIONNAIRE

Rank Calculation:

	Tie	Rank	Reciprocal	SMARTER	Rank Sum	Rank Reciprocal
Side Effects		1	1.00	0.61	0.50	0.55
Recovery Time	FALSE	2	0.50	0.28	0.33	0.27
Prevent Recurrence	FALSE	3	0.33	0.11	0.17	0.18

Sensitivity Analysis:

	0%			50%			150%				200%	
	0	0	0	0.5	0.5	0.5	1.5	1.5	1.5	2	2	2
	0.00	0.00	0.00	0.27	0.14	0.09	0.60	0.41	0.27	0.82	0.55	0.36
Original Weights	0.55	0.27	0.18	0.55	0.27	0.18	0.55	0.27	0.18	0.55	0.27	0.18
0.55	0.00	0.75	0.67	0.27	0.65	0.61	0.60	0.44	0.48	0.82	0.34	0.42
0.27	0.60	0.00	0.33	0.44	0.14	0.30	0.24	0.41	0.24	0.11	0.55	0.21
0.18	0.40	0.25	0.00	0.29	0.22	0.09	0.16	0.15	0.27	0.07	0.11	0.36

Chart Adjustment

	Weight 1 Adj	Weight 2 Adj	Weight 3 Adj
User Change	5	5	5
% Change	0.00	0.00	0.00

	0.55	0.27	0.18	
Original Weights	0.55	0.27	0.18	Weights for Graph
0.55	0.55	0.55	0.55	0.55
0.27	0.27	0.27	0.27	0.27
0.18	0.18	0.18	0.18	0.18

WEIGHTING

Treatment	Side Effects	Recover Time	Recurrance	Treatment
Hormone Therapy	0.38	1.00	0.98	Hormone Therapy
Surgery	0.23	0.92	0.93	Surgery
Active Surveillance / Watchful Waiting	0.99	1.00	0.42	Active Surveillance / Watchful Waiting
Radiation Therapy	0.53	0.92	-2.51	Radiation Therapy
Chemotherapy	0.34	0.00	1.00	Chemotherapy
Cryotherapy	0.45	0.92	1.00	Cryotherapy
Alternative	0.61	0.83	0.95	Alternative
Brachytherapy	0.63	0.88	0.92	Brachytherapy

Weights	0.55	0.27	0.18

Rank	Utility	Cost Index	Utility/$	Treatment	MAX	MIN	Avg	S1 A70	S4 A70	S2 A58	S3 A58	S3 A55	S4 A65	S2 A65
5	0.66	0.92	0.71	Hormone Therapy	0.804212556	0.661745862	0.740878	0.749841479	0.66175	0.73062	0.80205	0.786292314	0.6958545	0.7483774
6	0.55	0.49	1.11	Surgery	0.735177534	0.373444246	0.591626	0.710151627	0.41953	0.45889	0.73236	0.734142074	0.4195301	0.6451089
1	0.89	0.43	2.07	Active Surveillance / Watchful Waiting	0.878770976	0.526872247	0.679768	0.771100661	0.52687	0.8262	0.53186	0.526872247	0.5268722	0.878771
8	0.08	0.79	0.10	Radiation Therapy	0.892008372	0.076303029	0.73195	0.785894523	0.87383	0.49294	0.89201	0.891238482	0.8746138	0.076303
7	0.37	0.55	0.67	Chemotherapy	0.445656962	0.010572687	0.13208	0.025479348	0.01057	0.44566	0.01556	0.010572687	0.0105727	0.3355892
4	0.68	0.57	1.17	Cryotherapy	0.745136938	0.472393539	0.576778	0.646948737	0.47239	0.69733	0.47738	0.472393539	0.4723935	0.7451369
3	0.73	1.00	0.73	Alternative	0.862351185	0.46020558	0.6318	0.812245478	0.46021	0.77132	0.46519	0.46020558	0.4602056	0.7672099
2	0.75	0.47	1.60	Brachytherapy	0.800568779	0.466299559	0.612964	0.800568779	0.4663	0.70869	0.47128	0.466299559	0.4662996	0.7873066

12 Appendix F: Aggregations tab screen shots

TREATMENTS

Treatment Key	Treatment	Category
ADT	Androgen Deprivation Therapy	Hormone Therapy
LR Surgery	Laparoscopic Surgery	Surgery
Active Surv	Active Surveillance	Active Surveillance / Watchful Waiting
EBRT	External Beam Radiation Therapy	Radiation Therapy
Chemo	Chemotherapy	Chemotherapy
Proton Beam	Proton Beam Radiation Therapy	Radiation Therapy
Brach	Brachytherapy	Brachytherapy
Surgery	Surgery	Surgery
Cryotherapy	Cryotherapy	Cryotherapy
HIFU	High Intensity Focused Ultrasound	Alternative
IMRT	Intensity-Modulated Radiation Therapy	Radiation Therapy
IGRT	Image Guided Radiation Therapy	Radiation Therapy

Hormone Therapy
Surgery
Active Surveillance / Watchful Waiting
Radiation Therapy
Chemotherapy
Cryotherapy
Alternative
Brachytherapy

Grouping source: http://www.prostate-cancer.com

0

SAMPLES

# of Samples with Responses 0

First	Last	Age Range	Treatment	ADT	LR Surgery	Active Surv	EBRT	Chemo	Proton Beam	Brach	Surgery	Cryotherapy	HIFU	IMRT	IGRT
0	44	0 - 44	I	0	4	1	0	0	0	0	8	0	0	0	0
0	44	0 - 44	II	2	8	0	1	0	2	0	3	0	0	0	0
0	44	0 - 44	III	1	0	0	0	0	0	0	0	0	0	0	0
0	44	0 - 44	IV	5	1	0	1	0	0	0	0	0	0	0	0
0	44	0 - 44	Uncat	0	0	0	0	0	0	0	0	0	0	0	0
0	44	0 - 44	TOTAL	8	13	1	2	0	2	0	11	0	0	0	0
45	49	45 - 49	I	0	22	6	2	0	5	2	12	0	0	1	0
45	49	45 - 49	II	3	12	3	2	0	2	1	5	0	0	1	0
45	49	45 - 49	III	3	0	0	2	0	0	0	1	0	0	0	0
45	49	45 - 49	IV	4	0	0	0	1	0	0	0	0	0	0	0
45	49	45 - 49	Uncat	0	0	0	0	0	0	0	1	0	0	0	0
45	49	45 - 49	TOTAL	10	34	9	6	1	7	3	19	0	0	2	0
50	54	50 - 54	I	0	22	8	2	0	7	5	13	2	2	0	0
50	54	50 - 54	II	15	33	4	17	1	3	5	21	0	3	3	0
50	54	50 - 54	III	4	1	0	2	0	0	0	2	0	0	0	0
50	54	50 - 54	IV	9	0	0	3	0	0	0	1	0	0	0	0
50	54	50 - 54	Uncat	1	0	0	0	0	0	0	0	0	0	0	0
50	54	50 - 54	TOTAL	29	56	12	24	1	10	10	37	2	5	3	0
55	59	55 - 59	I	2	37	13	1	0	9	6	14	1	1	0	0
55	59	55 - 59	II	19	29	4	20	0	6	11	37	3	3	5	0
55	59	55 - 59	III	5	1	0	3	0	0	0	1	0	0	1	0
55	59	55 - 59	IV	11	0	0	0	0	0	0	0	0	0	0	0
55	59	55 - 59	Uncat	2	0	1	1	0	0	0	3	0	0	0	0
55	59	55 - 59	TOTAL	39	67	18	25	0	15	17	55	4	4	6	0
60	64	60 - 64	I	3	22	15	7	0	5	11	14	1	1	2	3
60	64	60 - 64	II	14	23	5	16	0	6	5	25	1	5	4	1
60	64	60 - 64	III	6	0	0	4	0	0	0	2	0	0	1	1
60	64	60 - 64	IV	7	0	0	0	0	0	0	0	0	0	0	0
60	64	60 - 64	Uncat	1	0	1	1	0	0	0	0	0	0	0	0
60	64	60 - 64	TOTAL	31	45	21	28	0	11	16	41	2	6	7	5
65	69	65 - 69	I	1	5	11	4	0	1	6	5	1	0	3	0
65	69	65 - 69	II	8	12	4	7	2	1	8	4	0	3	2	0
65	69	65 - 69	III	6	1	0	3	0	0	2	2	0	0	0	0
65	69	65 - 69	IV	9	0	0	1	0	0	0	0	0	0	0	0
65	69	65 - 69	Uncat	0	0	0	0	0	0	0	1	0	0	0	0
65	69	65 - 69	TOTAL	24	18	15	15	2	2	16	12	1	3	5	0
70	More	70 - More	I	0	0	0	0	0	0	0	0	0	0	0	0
70	More	70 - More	II	0	0	0	0	0	0	0	0	0	0	0	0
70	More	70 - More	III	0	0	0	0	0	0	0	0	0	0	0	0
70	More	70 - More	IV	0	0	0	0	0	0	0	0	0	0	0	0
70	More	70 - More	Uncat	0	0	0	0	0	0	0	0	0	0	0	0
70	More	70 - More	TOTAL	0	0	0	0	0	0	0	0	0	0	0	0

RECURRENCE:

Average PSA Before

First	Last	Age Range	Treatment	ADT	LR Surgery	Active Surv	EBRT	Chemo	Proton Beam	Brach	Surgery	Cryotherapy	HIFU	IMRT	IGRT
0	44	0 - 44	I	0.0	2.9	1.4	0.0	0.0	0.0	0.0	3.8	0.0	0.0	0.0	0.0
0	44	0 - 44	II	15.1	7.3	0.0	19.8	0.0	5.7	0.0	8.1	0.0	0.0	0.0	0.0
0	44	0 - 44	III	144.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0	44	0 - 44	IV	720.4	20.2	0.0	5.7	0.0	0.0	0.0	20.2	0.0	0.0	0.0	0.0
0	44	0 - 44	Uncat	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0	44	0 - 44	TOTAL	472.0	6.9	1.4	12.8	0.0	5.7	0.0	6.4	0.0	0.0	0.0	0.0
45	49	45 - 49	I	0.0	4.3	4.3	3.6	0.0	3.5	5.7	4.3	0.0	0.0	3.6	0.0
45	49	45 - 49	II	12.3	11.0	29.3	17.1	0.0	3.9	29.5	11.0	0.0	0.0	4.5	0.0
45	49	45 - 49	III	92.0	0.0	0.0	98.0	0.0	0.0	0.0	158.0	0.0	0.0	0.0	0.0
45	49	45 - 49	IV	506.8	0.0	0.0	0.0	433.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
45	49	45 - 49	Uncat	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.8	0.0	0.0	0.0	0.0
45	49	45 - 49	TOTAL	234.0	6.7	12.6	39.6	433.0	3.6	13.6	9.3	0.0	0.0	4.1	0.0
50	54	50 - 54	I	0.0	4.6	3.8	7.2	0.0	4.8	4.7	4.8	4.6	4.3	0.0	0.0
50	54	50 - 54	II	38.3	6.2	7.6	29.8	18.4	10.4	20.3	7.8	0.0	8.0	49.8	0.0
50	54	50 - 54	III	165.2	9.0	0.0	150.5	0.0	0.0	0.0	11.5	0.0	0.0	0.0	0.0
50	54	50 - 54	IV	677.7	0.0	0.0	108.9	0.0	0.0	0.0	80.3	0.0	0.0	0.0	0.0
50	54	50 - 54	Uncat	375.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50	54	50 - 54	TOTAL	265.8	5.6	5.1	47.9	18.4	6.5	12.5	7.6	4.6	6.5	49.8	0.0
55	59	55 - 59	I	4.5	4.8	4.2	7.5	0.0	5.0	6.2	4.9	2.5	7.8	0.0	0.0
55	59	55 - 59	II	23.8	10.2	14.0	16.0	0.0	6.3	22.0	11.3	6.0	5.9	25.5	0.0
55	59	55 - 59	III	146.9	4.2	0.0	177.1	0.0	0.0	0.0	9.5	0.0	0.0	76.4	0.0
55	59	55 - 59	IV	582.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
55	59	55 - 59	Uncat	180.5	0.0	2.2	12.0	0.0	0.0	0.0	6.6	0.0	0.0	0.0	0.0
55	59	55 - 59	TOTAL	204.3	7.1	6.3	34.9	0.0	5.5	16.4	8.4	5.1	6.4	34.0	0.0
60	64	60 - 64	I	6.0	5.6	4.4	5.9	0.0	4.7	5.7	5.6	4.6	8.5	6.7	5.0
60	64	60 - 64	II	158.5	6.6	8.0	8.2	0.0	5.7	11.9	10.0	7.5	5.9	16.6	5.8
60	64	60 - 64	III	103.6	0.0	0.0	29.0	0.0	0.0	0.0	6.3	0.0	0.0	1.5	1.5
60	64	60 - 64	IV	450.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
60	64	60 - 64	Uncat	48.0	0.0	7.3	48.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
60	64	60 - 64	TOTAL	195.4	6.1	5.4	12.0	0.0	5.2	7.7	8.1	6.1	6.3	11.6	4.4
65	69	65 - 69	I	6.8	6.1	5.1	5.4	0.0	6.9	4.7	5.0	1.9	0.0	4.2	0.0
65	69	65 - 69	II	193.9	11.4	20.9	15.8	727.6	2.5	13.9	10.2	0.0	10.2	3.8	0.0
65	69	65 - 69	III	32.1	13.6	0.0	15.0	0.0	0.0	12.4	44.9	0.0	0.0	0.0	0.0
65	69	65 - 69	IV	309.9	0.0	0.0	145.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
65	69	65 - 69	Uncat	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.2	0.0	0.0	0.0	0.0
65	69	65 - 69	TOTAL	189.1	10.1	9.3	21.5	727.6	4.7	10.3	12.0	1.9	10.2	4.0	0.0
70	74	70 - 74	I	5.6	5.4	5.8	4.5	0.0	4.9	8.0	6.2	0.0	0.0	5.6	0.0
70	74	70 - 74	II	21.7	7.5	4.1	20.4	0.0	5.9	4.1	7.1	0.0	0.0	9.4	6.2
70	74	70 - 74	III	25.7	0.0	0.0	27.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
70	74	70 - 74	IV	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
70	74	70 - 74	Uncat	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
70	74	70 - 74	TOTAL	21.1	6.8	5.2	19.6	0.0	5.3	5.4	6.8	0.0	0.0	8.2	6.2
75	79	75 - 79	I	0.0	0.0	0.0	0.0	0.0	5.6	4.5	0.0	0.0	0.0	0.0	0.0
75	79	75 - 79	II	11.4	3.8	9.9	11.4	0.0	0.0	8.0	3.8	15.0	0.0	1.4	0.0
75	79	75 - 79	III	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
75	79	75 - 79	IV	1892.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
75	79	75 - 79	Uncat	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
75	79	75 - 79	TOTAL	280.1	3.8	9.9	11.4	0.0	5.6	6.3	3.8	15.0	0.0	1.4	0.0
80	More	80 - More	I	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
80	More	80 - More	II	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
80	More	80 - More	III	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
80	More	80 - More	IV	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
80	More	80 - More	Uncat	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
80	More	80 - More	TOTAL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Average PSA After

First	Last	Age Range	Treatment	ADT	LR Surgery	Active Surv	EBRT	Chemo	Proton Beam	Brach	Surgery	Cryotherapy	HIFU	IMRT	IGRT
0	44	0 - 44	I	0.0	0.0	1.2	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0
0	44	0 - 44	II	0.0	0.0	0.0	0.0	0.0	2.5	0.0	1.0	0.0	0.0	0.0	0.0
0	44	0 - 44	III	20.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0	44	0 - 44	IV	17.9	4.6	0.0	0.1	0.0	0.0	0.0	4.6	0.0	0.0	0.0	0.0
0	44	0 - 44	Uncat	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0	44	0 - 44	TOTAL	13.7	0.4	1.2	0.0	0.0	2.5	0.0	0.8	0.0	0.0	0.0	0.0
45	49	45 - 49	I	0.0	0.1	3.9	0.8	0.0	0.5	1.8	0.1	0.0	0.0	1.5	0.0
45	49	45 - 49	II	0.1	0.0	23.0	0.1	0.0	2.3	0.1	0.2	0.0	0.0	0.0	0.0
45	49	45 - 49	III	1.8	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
45	49	45 - 49	IV	506.8	0.0	0.0	0.0	433.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
45	49	45 - 49	Uncat	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
45	49	45 - 49	TOTAL	203.3	0.1	10.3	0.3	433.0	1.0	1.2	0.1	0.0	0.0	0.8	0.0
50	54	50 - 54	I	0.0	0.1	3.3	1.7	0.0	1.1	1.0	2.5	1.5	1.3	0.0	0.0
50	54	50 - 54	II	17.5	1.4	7.2	6.8	3.5	1.2	0.2	47.4	0.0	2.5	31.2	0.0
50	54	50 - 54	III	63.6	0.0	0.0	20.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50	54	50 - 54	IV	173.1	0.0	0.0	10.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50	54	50 - 54	Uncat	375.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50	54	50 - 54	TOTAL	84.5	0.9	4.6	8.0	3.5	1.1	0.6	28.4	1.5	2.0	31.2	0.0
55	59	55 - 59	I	0.0	0.4	3.3	0.3	0.0	1.0	1.2	0.3	2.7	0.2	0.0	0.0
55	59	55 - 59	II	8.6	0.3	5.0	7.2	0.0	0.7	12.5	0.6	3.5	0.2	0.9	0.0
55	59	55 - 59	III	26.7	0.0	0.0	0.2	0.0	0.0	0.0	0.2	0.0	0.0	0.1	0.0
55	59	55 - 59	IV	435.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
55	59	55 - 59	Uncat	0.4	0.0	2.2	0.0	0.0	0.0	0.0	2.4	0.0	0.0	0.0	0.0
55	59	55 - 59	TOTAL	130.5	0.4	3.6	5.8	0.0	0.9	8.5	0.5	3.3	0.2	0.7	0.0
60	64	60 - 64	I	0.2	0.0	4.8	0.5	0.0	1.4	0.6	0.4	0.8	0.8	0.2	0.8
60	64	60 - 64	II	7.0	0.5	8.7	4.9	0.0	195.6	1.5	2.0	0.0	0.4	0.3	0.2
60	64	60 - 64	III	36.6	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
60	64	60 - 64	IV	363.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
60	64	60 - 64	Uncat	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
60	64	60 - 64	TOTAL	92.3	0.3	5.5	3.0	0.0	107.3	0.9	1.3	0.4	0.5	0.2	0.5
65	69	65 - 69	I	2.7	0.0	7.5	1.3	0.0	1.0	1.0	0.0	1.1	0.0	0.7	0.0
65	69	65 - 69	II	0.4	0.1	8.2	0.9	0.0	2.4	0.5	0.3	0.0	0.3	0.9	0.0
65	69	65 - 69	III	1.5	0.0	0.0	0.1	0.0	0.0	0.1	0.2	0.0	0.0	0.0	0.0
65	69	65 - 69	IV	176.2	0.0	0.0	20.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
65	69	65 - 69	Uncat	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.2	0.0	0.0	0.0	0.0
65	69	65 - 69	TOTAL	66.7	0.0	7.7	2.1	0.0	1.7	0.6	0.5	1.1	0.3	0.8	0.0
70	More	70 - More	I	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
70	More	70 - More	II	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
70	More	70 - More	III	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
70	More	70 - More	IV	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
70	More	70 - More	Uncat	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
70	More	70 - More	TOTAL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

SIDE EFFECTS

Side Effect Key	Side Effect	Category
No response		
Climac	Climacturia	
Leakage	Leakage	Urinary
RIP	Death	Death
ED	Erectile Dysfunction	Sexual
Incon	Incontinence	Bowel
Urin	Urinary Tract	Urinary
Stricture	Stricture	Sexual
Proctitis	Proctitis	Bowel
Prostatitis	Prostatitis	
Peyr	Peyronies	

PROBABILITY OF SIDE EFFECT

# of Occurences

First	Last	Age Range	Treatment	ADT	LR Surgery	Active Surv	EBRT	Chemo	Proton Beam	Brach	Surgery	Cryotherapy	HIFU	IMRT	IGRT
0	44	0-44	No response	0	5	0	0	0	0	0	5	0	0	0	0
0	44	0-44	Climac	0	0	0	0	0	0	0	0	0	0	0	0
0	44	0-44	Leakage	0	3	0	0	0	0	0	2	0	0	0	0
0	44	0-44	RIP	0	0	0	0	0	0	0	1	0	0	0	0
0	44	0-44	ED	2	10	0	1	0	0	0	5	0	0	0	0
0	44	0-44	Incon	0	1	0	0	0	0	0	0	0	0	0	0
0	44	0-44	Urin	0	0	0	0	0	0	0	0	0	0	0	0
0	44	0-44	Stricture	0	0	0	0	0	0	0	0	0	0	0	0
0	44	0-44	Proctitis	0	0	0	0	0	0	0	0	0	0	0	0
0	44	0-44	Prostatitis	0	0	0	0	0	0	0	0	0	0	0	0
0	44	0-44	Peyr	0	0	0	0	0	0	0	0	0	0	0	0
45	49	45-49	No response	1	7	1	1	0	1	0	4	0	0	0	0
45	49	45-49	Climac	0	1	0	0	0	0	0	0	0	0	0	0
45	49	45-49	Leakage	0	2	0	0	0	0	0	2	0	0	0	0
45	49	45-49	RIP	4	0	1	0	1	0	0	0	0	0	0	0
45	49	45-49	ED	8	25	1	6	1	2	1	13	0	0	2	0
45	49	45-49	Incon	1	2	0	2	0	0	1	2	0	0	0	0
45	49	45-49	Urin	0	0	0	0	0	0	0	0	0	0	0	0
45	49	45-49	Stricture	0	0	0	0	0	0	0	1	0	0	0	0
45	49	45-49	Proctitis	2	2	0	1	0	2	0	0	0	0	2	0
45	49	45-49	Prostatitis	0	0	0	0	0	0	0	0	0	0	0	0
45	49	45-49	Peyr	0	3	0	0	0	0	0	2	0	0	0	0
50	54	50-54	No response	3	14	3	4	0	1	1	6	0	0	0	0
50	54	50-54	Climac	0	1	0	0	0	0	0	0	0	0	0	0
50	54	50-54	Leakage	0	5	0	0	0	0	0	1	0	0	0	0
50	54	50-54	RIP	5	0	0	0	0	0	0	0	0	0	0	0
50	54	50-54	ED	10	38	0	8	0	1	4	14	0	1	0	0
50	54	50-54	Incon	0	9	0	0	0	0	1	2	0	0	0	0
50	54	50-54	Urin	0	0	0	1	0	0	2	1	0	1	0	0
50	54	50-54	Stricture	0	0	0	0	0	0	0	0	0	0	0	0
50	54	50-54	Proctitis	0	0	0	0	0	0	0	0	0	0	0	0
50	54	50-54	Prostatitis	0	0	0	0	0	0	0	0	1	0	0	0
50	54	50-54	Peyr	0	1	0	0	0	0	0	0	0	0	0	0
55	59	55-59	No response	5	15	2	4	0	1	3	6	0	1	1	0
55	59	55-59	Climac	0	1	0	0	0	0	0	0	0	0	0	0
55	59	55-59	Leakage	0	8	0	0	0	0	0	1	0	0	0	0
55	59	55-59	RIP	6	0	1	1	0	0	0	0	0	0	0	0
55	59	55-59	ED	14	55	2	7	0	3	3	23	4	1	2	0
55	59	55-59	Incon	0	3	0	0	0	0	0	5	0	0	0	0
55	59	55-59	Urin	0	0	0	2	0	1	4	0	0	0	1	0
55	59	55-59	Stricture	0	0	0	0	0	0	0	2	0	0	0	0
55	59	55-59	Proctitis	0	0	0	0	0	0	1	0	0	0	0	0
55	59	55-59	Prostatitis	0	0	0	0	0	0	1	0	0	0	0	0
55	59	55-59	Peyr	1	0	0	1	0	0	1	0	0	0	0	0
60	64	60-64	No response	1	8	0	0	0	2	1	3	0	1	1	0
60	64	60-64	Climac	0	0	0	0	0	0	0	1	0	0	0	0
60	64	60-64	Leakage	0	7	1	0	0	0	0	4	0	0	0	0
60	64	60-64	RIP	3	0	0	0	0	0	0	0	0	0	0	0

60	64	60 - 64	ED	15	32	1	17	0	4	7	30	2	3	3	1
60	64	60 - 64	Incon	2	6	0	2	0	0	2	4	0	0	2	0
60	64	60 - 64	Urin	0	0	0	0	0	0	0	0	0	0	0	0
60	64	60 - 64	Stricture	1	0	0	1	0	0	1	0	0	1	0	0
60	64	60 - 64	Proctitis	1	0	0	2	0	2	2	0	0	0	0	0
60	64	60 - 64	Prostatitis	0	0	0	0	0	0	0	0	0	0	0	0
60	64	60 - 64	Peyr	0	1	0	0	0	0	0	0	0	0	0	0
65	69	65 - 69	No response	2	2	0	2	1	1	1	3	2	0	0	0
65	69	65 - 69	Climac	0	0	0	0	0	0	0	0	0	0	0	0
65	69	65 - 69	Leakage	1	1	0	2	0	0	2	0	0	0	0	0
65	69	65 - 69	RIP	6	0	0	0	0	0	0	1	0	0	0	0
65	69	65 - 69	ED	12	14	0	4	1	0	4	9	0	1	1	0
65	69	65 - 69	Incon	0	2	0	0	0	0	0	2	0	0	0	0
65	69	65 - 69	Urin	0	1	0	0	0	0	3	0	0	1	0	0
65	69	65 - 69	Stricture	0	0	0	0	0	0	0	1	0	1	0	0
65	69	65 - 69	Proctitis	0	0	0	0	0	0	0	0	0	0	0	0
65	69	65 - 69	Prostatitis	0	1	0	0	0	0	0	0	0	0	0	0
65	69	65 - 69	Peyr	0	0	0	0	0	0	0	0	0	0	0	0
70	More	70 - More	No response	0	0	0	0	0	0	0	0	0	0	0	0
70	More	70 - More	Climac	0	0	0	0	0	0	0	0	0	0	0	0
70	More	70 - More	Leakage	0	0	0	0	0	0	0	0	0	0	0	0
70	More	70 - More	RIP	0	0	0	0	0	0	0	0	0	0	0	0
70	More	70 - More	ED	0	0	0	0	0	0	0	0	0	0	0	0
70	More	70 - More	Incon	0	0	0	0	0	0	0	0	0	0	0	0
70	More	70 - More	Urin	0	0	0	0	0	0	0	0	0	0	0	0
70	More	70 - More	Stricture	0	0	0	0	0	0	0	0	0	0	0	0
70	More	70 - More	Proctitis	0	0	0	0	0	0	0	0	0	0	0	0
70	More	70 - More	Prostatitis	0	0	0	0	0	0	0	0	0	0	0	0
70	More	70 - More	Peyr	0	0	0	0	0	0	0	0	0	0	0	0

13 Appendix G. Monte Carlo Simulation Output

Crystal Ball Report - Forecasts
Simulation started on 12/4/2011 at 20:02:06
Simulation stopped on 12/4/2011 at 20:12:38

Run preferences:	
Number of trials run	1,000
Monte Carlo	
Random seed	
Precision control on	
Confidence level	95.00%
Run statistics:	
Total running time (sec)	631.44
Trials/second (average)	2
Random numbers per sec	19
Crystal Ball data:	
Assumptions	12
Correlations	0
Correlated groups	0
Decision variables	0
Forecasts	8

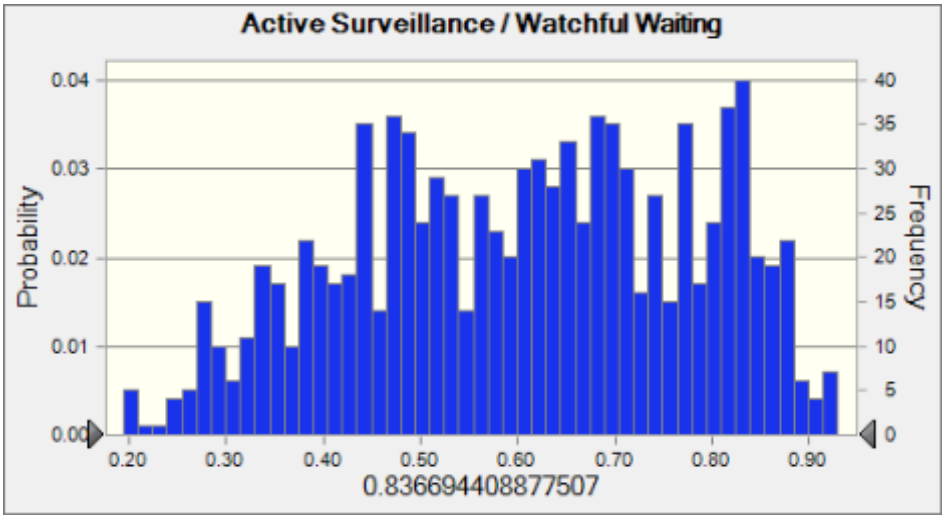
Forecasts

Worksheet: [Monte Carlo.xlsx]Calculations

Cell: B22

Forecast: Active Surveillance / Watchful Waiting **4**

Summary:
Entire range is from 0.19 to 0.93
Base case is 0.84
After 999 trials, the std. error of the mean is 0.01



Statistics:	Forecast values
Trials	999
Mean	0.61
Median	0.62
Mode	0.82
Standard Deviation	0.17
Variance	0.03
Skewness	-0.1816
Kurtosis	2.07
Coeff. of Variability	0.2836
Minimum	0.19
Maximum	0.93
Range Width	0.73
Mean Std. Error	0.01

Forecast: Active Surveillance / Watchful Waiting (cont'd)

Cell: B22
4

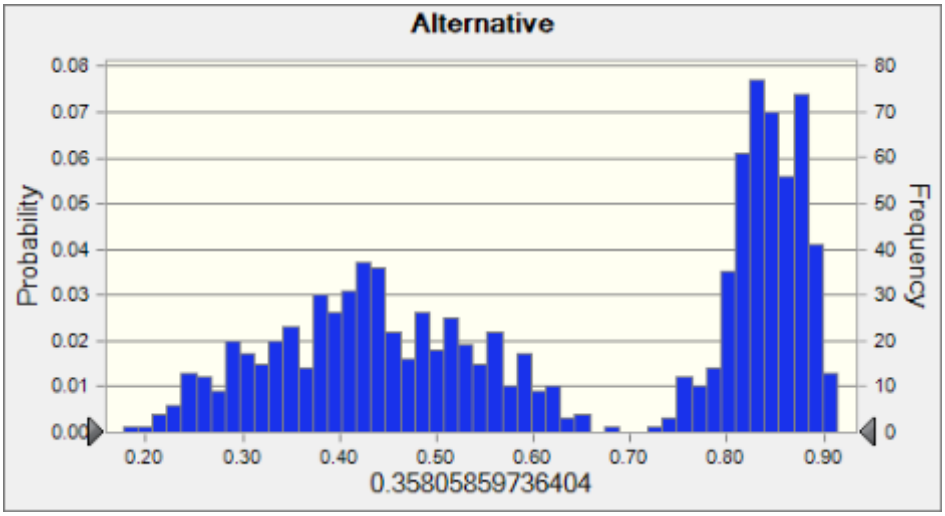
Percentiles:	Forecast values
0%	0.19
10%	0.37
20%	0.44
30%	0.49
40%	0.56
50%	0.62
60%	0.67
70%	0.71
80%	0.78
90%	0.83
100%	0.93

Forecast: Alternative

Cell: B22
8

Summary:

Entire range is from 0.18 to 0.91
Base case is 0.36
After 999 trials, the std. error of the mean is 0.01



Statistics:	Forecast values
Trials	999
Mean	0.62
Median	0.59
Mode	0.84
Standard Deviation	0.22
Variance	0.05
Skewness	-0.1668
Kurtosis	1.43
Coeff. of Variability	0.3551
Minimum	0.18
Maximum	0.91
Range Width	0.74
Mean Std. Error	0.01

Cell: B22
8

Forecast: Alternative (cont'd)

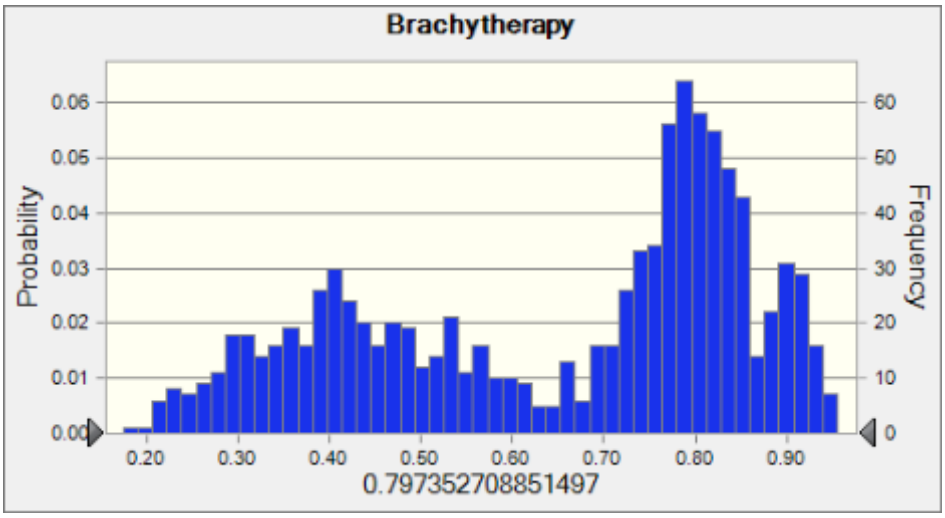
Percentiles:	Forecast values
0%	0.18
10%	0.33
20%	0.40
30%	0.44
40%	0.51

50%	0.59
60%	0.80
70%	0.83
80%	0.85
90%	0.87
100%	0.91

Cell: B22

Forecast: Brachytherapy **9**

Summary:
Entire range is from 0.18 to 0.96
Base case is 0.80
After 999 trials, the std. error of the mean is 0.01



Statistics:	Forecast values
Trials	999
Mean	0.65
Median	0.74
Mode	0.78
Standard Deviation	0.21
Variance	0.04
Skewness	-0.4843
Kurtosis	1.83
Coeff. of Variability	0.3192
Minimum	0.18
Maximum	0.96
Range Width	0.78
Mean Std. Error	0.01

Forecast: Brachytherapy (cont'd)

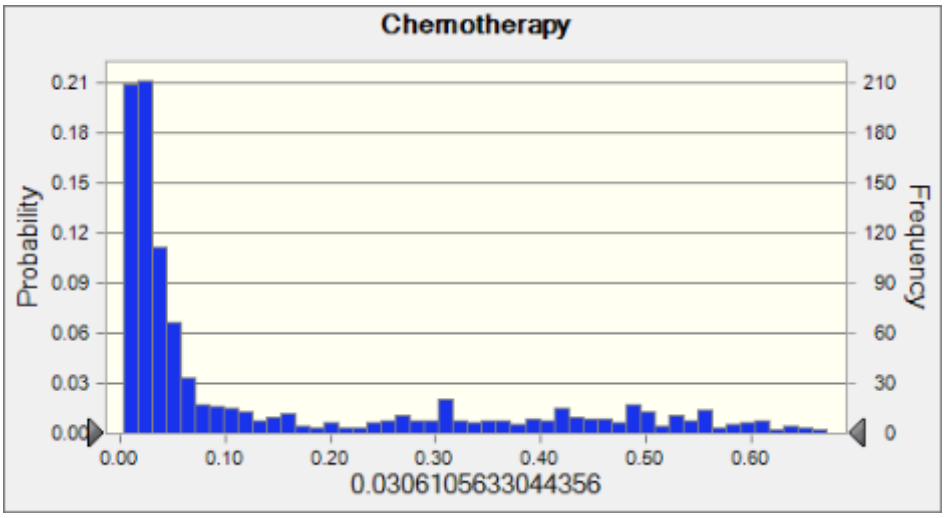
Cell: B22
9

Percentiles:	Forecast values
0%	0.18
10%	0.34
20%	0.41
30%	0.49
40%	0.62
50%	0.74
60%	0.78
70%	0.80
80%	0.83
90%	0.88
100%	0.96

Forecast: Chemotherapy

Cell: B22
6

Summary:
Entire range is from 0.00 to 0.71
Base case is 0.03
After 999 trials, the std. error of the mean is 0.01



Statistics:	Forecast values
Trials	999
Mean	0.15
Median	0.04
Mode	0.32

Standard Deviation	0.19
Variance	0.04
Skewness	1.31
Kurtosis	3.30
Coeff. of Variability	1.30
Minimum	0.00
Maximum	0.71
Range Width	0.71
Mean Std. Error	0.01

Cell: B22
6

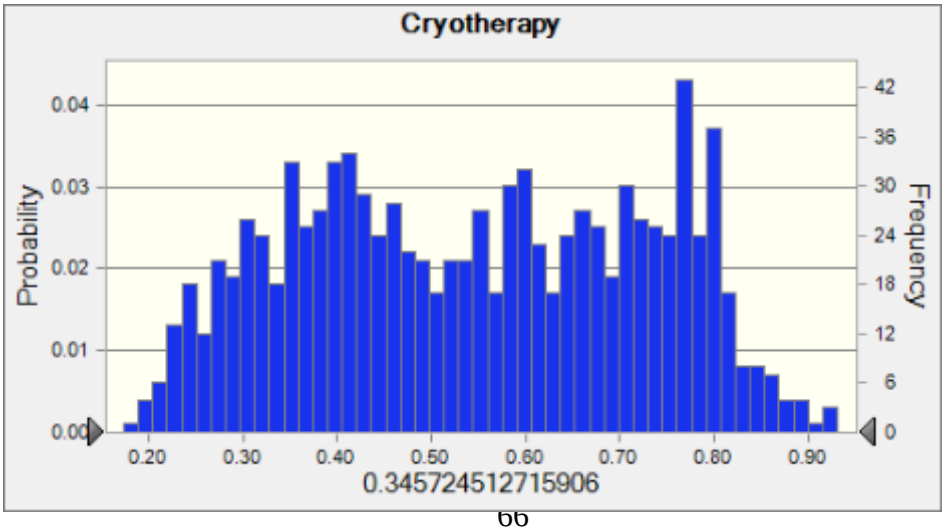
Forecast: Chemotherapy (cont'd)

Percentiles:	Forecast values
0%	0.00
10%	0.01
20%	0.02
30%	0.02
40%	0.03
50%	0.04
60%	0.06
70%	0.14
80%	0.32
90%	0.49
100%	0.71

Cell: B22
7

Forecast: Cryotherapy

Summary:
Entire range is from 0.17 to 0.93
Base case is 0.35
After 999 trials, the std. error of the mean is 0.01



Statistics:	Forecast values
Trials	999
Mean	0.54
Median	0.54
Mode	0.77
Standard Deviation	0.18
Variance	0.03
Skewness	0.00
Kurtosis	1.83
Coeff. of Variability	0.3333
Minimum	0.17
Maximum	0.93
Range Width	0.76
Mean Std. Error	0.01

Cell: B22
7

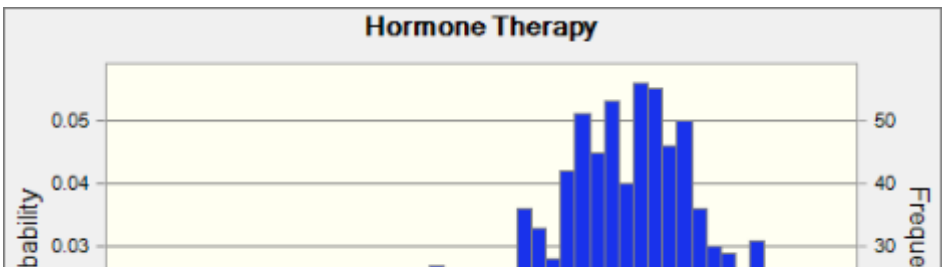
Forecast: Cryotherapy (cont'd)

Percentiles:	Forecast values
0%	0.17
10%	0.30
20%	0.36
30%	0.41
40%	0.47
50%	0.54
60%	0.60
70%	0.67
80%	0.73
90%	0.78
100%	0.93

Cell: B22
2

Forecast: Hormone Therapy

Summary:
Entire range is from 0.22 to 0.96
Base case is 0.32
After 999 trials, the std. error of the mean is 0.00



Statistics:	Forecast values
Trials	999
Mean	0.75
Median	0.78
Mode	0.84
Standard Deviation	0.13
Variance	0.02
Skewness	-1.49
Kurtosis	5.90
Coeff. of Variability	0.1691
Minimum	0.22
Maximum	0.96
Range Width	0.75
Mean Std. Error	0.00

Forecast: Hormone Therapy (cont'd)

Cell: B22
2

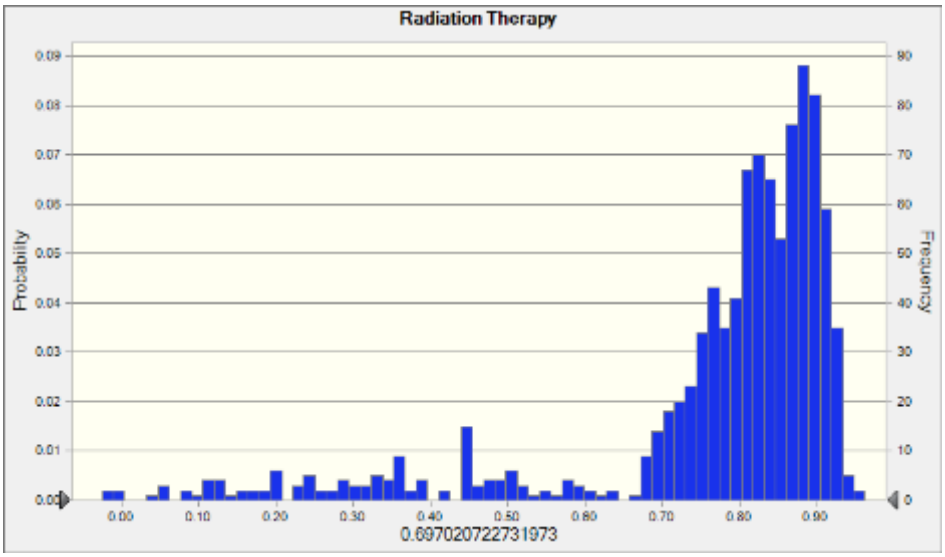
Percentiles:	Forecast values
0%	0.22
10%	0.60
20%	0.67
30%	0.72
40%	0.75
50%	0.78
60%	0.80
70%	0.82
80%	0.84
90%	0.88
100%	0.96

Forecast: Radiation Therapy

Cell: B22

5

Summary:
Entire range is from -1.22 to 0.96
Base case is 0.70
After 999 trials, the std. error of the mean is 0.01



Statistics:	Forecast values
Trials	999
Mean	0.74
Median	0.83
Mode	0.45
Standard Deviation	0.28
Variance	0.08
Skewness	-3.20
Kurtosis	15.95
Coeff. of Variability	0.3767
Minimum	-1.22
Maximum	0.96
Range Width	2.19
Mean Std. Error	0.01

Cell: B22
5

Forecast: Radiation Therapy (cont'd)

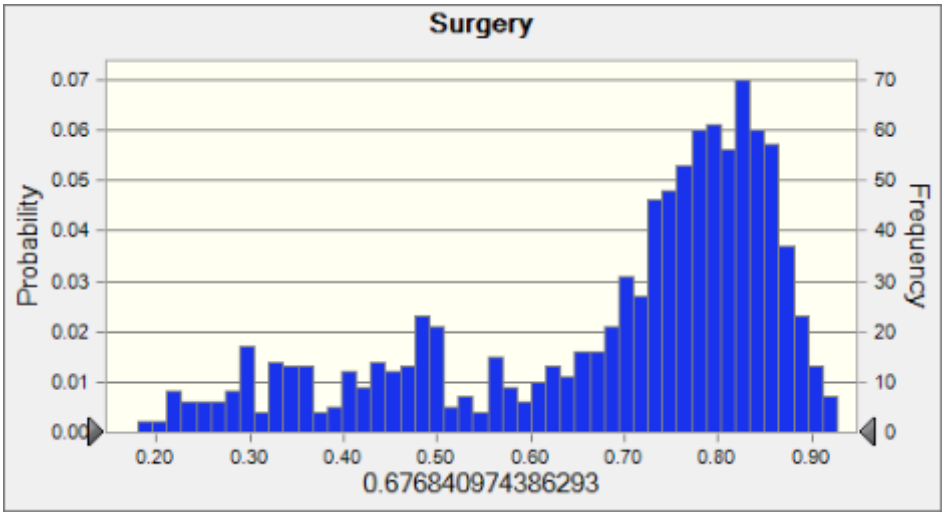
Percentiles:	Forecast values
0%	-1.22

10%	0.36
20%	0.71
30%	0.77
40%	0.80
50%	0.83
60%	0.85
70%	0.87
80%	0.89
90%	0.91
100%	0.96

Cell: B22
3

Forecast: Surgery

Summary:
Entire range is from 0.06 to 0.93
Base case is 0.68
After 999 trials, the std. error of the mean is 0.01



Statistics:	Forecast values
Trials	999
Mean	0.68
Median	0.75
Mode	0.49
Standard Deviation	0.19
Variance	0.03
Skewness	-1.06
Kurtosis	3.02
Coeff. of Variability	0.2712
Minimum	0.06

Maximum	0.93
Range Width	0.87
Mean Std. Error	0.01

Cell: B22

Forecast: Surgery (cont'd) **3**

Percentiles:	Forecast values
0%	0.06
10%	0.36
20%	0.49
30%	0.65
40%	0.72
50%	0.75
60%	0.78
70%	0.81
80%	0.83
90%	0.86
100%	0.93

End of Forecasts

14 Works Cited:

1] Cancer.org. 2011. American Cancer Society. <http://www.cancer.org/>

[2] Prostate Cancer Treatment Overview. 2010. Prostate Cancer Treatment Guide. <http://www.prostate-cancer.com/prostate-cancer-treatment-overview/prostate-cancer-treatment-overview.html>

[3] Harding, Anne. "Specialty may bias doctors' prostate cancer advice" Reuters. <http://www.reuters.com/article/2010/03/08/us-specialty-bias-idUSTRE6275XN20100308>

[4] "Patient Treatment Preferences in Localized Prostate Carcinoma: The Influence of Emotion, Misconception, and Anecdote," Thomas D. Denberg, Trisha V. Melhado, John F. Steiner, CANCER

[5] Prostate Cancer Health Center. 2011. WebMD <http://www.webmd.com/prostate-cancer/guide/default.htm>

[6] Stage of Prostate Cancer. 2011. National Cancer Institute <http://www.cancer.gov/cancertopics/pdq/treatment/prostate/Patient/page2>

[7] Table 5. Anatomic Stage/Prognostic Groups. 2011. National Cancer Institute <http://www.cancer.gov/cancertopics/pdq/treatment/prostate/HealthProfessional/Table5>

[8] - Prostate Cancer Treatment Guide. 2010. Media Clicks <www.prostate-cancer.com> http://www.prostate-cancer.com/

[9] Cumulative Cost Pattern Comparison of Prostate Cancer Treatments. 2006. American Cancer Society <http://abcnews.go.com/Health/story?id=4537744&page=1>

[10] Cost of Chemotherapy Treatment. 2011. Chemotherapy Guide. <http://www.chemo-therapy.info/cost-of-chemotherapy-treatment//>

[11] Controversial Cancer Treatment in Cancun. 2009. ABC News <http://abcnews.go.com/Health/story?id=4537744&page=1>

[12] Treatment Options for Prostate Cancer. 2011. Loma Linda University <http://www.protons.com/proton-therapy/conditions-treated/prostate-cancer/treatment-options.html>

[13] Prostate Cancer – Treatment Options. 2011. Chicago Prostate Cancer Center , http://www.prostateimplant.com/treatment_options>