The Doctor/Patient Relationship in End-Of-Life Care: a Game Theoretic Model

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THE DOCTOR/PATIENT RELATIONSHIP IN END-OF-LIFE CARE: A GAME
THEORETIC MODEL

by
Stephan Alexander Castellanos

A thesis submitted to the faculty of the University of Mississippi in partial fulfillment to
the requirements of the Sally McDonnell Barksdale Honors College

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ABSTRACT
STEPHAN ALEXANDER CASTELLANOS: The Doctor/Patient Relationship in End-of-Life Care: A Game Theoretic Model

End-of-life care is a sensitive subject because it deals with life and death, as well as dealing with the nature of that death. In its most basic form, end-of-life care can be divided into two distinct pathways: aggressive treatment and methods, or palliative treatment and care. This paper explores the history surrounding these two routes and the implications that surround them. A review of the literature reveals that in many cases palliative care can increase in quality-of-life. An important part of the decision between aggressive and palliative care are the patient’s and the doctor’s feelings towards certain aspects of end-of-life care. This paper incorporates the literature into a game theoretic model of the doctor/patient relationship at the end of life. Seven different scenarios are analyzed which illuminate the influence that factors like patient respect for the doctor and counseling can have on what type of care is realized for the patient. In particular, the model implies that patients who undergo end-of-life counseling and create advanced directives are more inclined to undergo palliative care and have generally better outcomes than those who do not. This paper calls for an increase in the awareness about the benefits of counseling and advanced directives so that patients may make the best decisions possible regarding their quality-of-life when faced with end-of-life care choices.
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<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>$A$</td>
<td>Aggressive Recommendation by the “Good” Doctor</td>
</tr>
<tr>
<td>$a$</td>
<td>Aggressive Selection by the Patient when Recommended A or A’</td>
</tr>
<tr>
<td>$A'$</td>
<td>Aggressive Recommendation by the “Okay Doctor</td>
</tr>
<tr>
<td>$a'$</td>
<td>Aggressive Selection by the patient when Recommended P or P’</td>
</tr>
<tr>
<td>$AAMM$</td>
<td>Active and Aggressive Medical Management</td>
</tr>
<tr>
<td>$a^g_d$</td>
<td>&quot;Good&quot; Doctor Payoff for Patient Undergoing Aggressive Care</td>
</tr>
<tr>
<td>$a^g_x$</td>
<td>Patient Payoff for Undergoing Aggressive Care with &quot;Good&quot; Doctor</td>
</tr>
<tr>
<td>$a^o_d$</td>
<td>&quot;Okay&quot; Doctor Payoff for Patient Undergoing Aggressive Care</td>
</tr>
<tr>
<td>$a^o_x$</td>
<td>Patient Payoff for Undergoing Aggressive Care with &quot;Okay&quot; Doctor</td>
</tr>
<tr>
<td>$BN$</td>
<td>Baseline Scenario, No Respect</td>
</tr>
<tr>
<td>$BR$</td>
<td>Baseline Scenario, Respect</td>
</tr>
<tr>
<td>$CPM$</td>
<td>Conservative Palliative Medicine</td>
</tr>
<tr>
<td>$D, d$</td>
<td>The Doctor</td>
</tr>
<tr>
<td>$DLN$</td>
<td>Deceit-is-Likely Scenario, No Respect</td>
</tr>
<tr>
<td>$DLR$</td>
<td>Deceit-is-Likely Scenario, Respect</td>
</tr>
<tr>
<td>$DNR$</td>
<td>Do Not Resuscitate Order</td>
</tr>
<tr>
<td>$DUN$</td>
<td>Deceit-is-Unlikely Scenario, No Respect</td>
</tr>
<tr>
<td>$DUR$</td>
<td>Deceit-is-Unlikely Scenario, Respect</td>
</tr>
<tr>
<td>$MQOL$</td>
<td>McGill Quality-of-Life Questionnaire</td>
</tr>
<tr>
<td>$P$</td>
<td>Palliative Recommendation by the “Good” Doctor</td>
</tr>
<tr>
<td>$p$</td>
<td>Palliative Selection by the Patient when Recommended A or A’</td>
</tr>
</tbody>
</table>
P' Palliative Recommendation by the “Okay” Doctor

p' Palliative Selection by the Patient when Recommended P or P’

PCT Palliative Care Team

p^g_d "Good" Doctor Payoff for Patient Undergoing Palliative Care

p^o_d "Okay" Doctor Payoff for Patient Undergoing Palliative Care

p_x Patient Payoff for Undergoing Palliative Care with Any Doctor

QOL Quality-of-Life

r_d Doctor Payoff for Patient Respecting Her Recommendation

r_x Patient Payoff for Respecting the Doctor's Recommendation

X, x The Patient

α Probability that the Doctor will be “Good”

γ Patient Perception that the Doctor will be "Good" given a Palliative Recommendation

μ Patient Perception that the Doctor will be "Good" given an Aggressive Recommendation
1. Introduction to End-of-Life Care

The nature end-of-life care is an important topic that needs to be discussed. As of 2005, Medicare was spending 27-30% of its total costs on patients in their last year of life, and Medicare costs were 276% higher among patients who died compared to other enrollees of the same age who remain alive [1]. The 2010 *American Journal of Managed Care* article “Impact of Predictive Model-Directed End-of-Life Counseling for Medicare Beneficiaries” asserts that those same costs for decedents have now risen to be six times those of survivors and this trend appear to be trending upward at a faster rate than ever before [3]. If this is true, it is fair to say that a good portion of the rising health care costs are due to end-of-life health care utilization.

In addition to the bottom line, it is important to consider how end-of-life care and its implementation affects both the patients and their families’ quality-of-life. Not many people relish the idea of thinking about how they would prefer to die. They would much rather contemplate how it is they are going to maintain their health. Are there methods or treatments that perhaps better account for these existential indicators than others?

While the field of end-of-life care certainly extends to all realms of medicine, this thesis focuses on cancer-related oncology practices. A game-theoretic analysis of end-of-life care is presented in a variety of situations, with particular emphasis on the relative benefits provided by both counseling and advanced directives.
Oncologic End-of-Life Care

With the advent of chemotherapy in the 1950s, medical oncology saw a renewed hope in its search for a cure for cancer. Doctors were now able to treat cancers that were previously seen as incurable and to prolong their patients’ lives. However, some saw it as drawing out their deaths [2]. The question of the prolonged-life versus a drawn-out-death would continue to be central in discussions of end-of-life care even today. Prior to chemotherapy, all treatment of advanced cancer had been considered to be palliative. In a 1956 paper, Hamburger defines this to include “any and all medical measures designed to alleviate, soothe, or moderate symptoms of cancer patients without really curing” [6]. With the availability of chemotherapy, oncology shifted towards more and more aggressive treatment. Chemotherapy grew in both its implementation and efficacy, and doctors became optimistic about the future patient outcomes.

David Karnofsky, a pioneering oncologist of the 1960s, was at the forefront of the aggressive treatment movement. He wrote two articles defending his stance: “Why Prolong the Life of a Patient with Advanced Cancer?” and “Rationale for Aggressive or Extraordinary Means of Treatment of Advanced Cancer” [4, 5]. In them, he calls on his fellow physicians to take action and not lose hope of patient survival: “any physician experienced in treating cancer can cite moribund patients, beyond reasonable hope of help, who responded almost miraculously to specific therapy. They occur often enough so that, for this reason alone, aggressive therapy is indicated” [5]. Additionally, he cites his belief that aggressive treatment not only bettered the patient, but also the entire medical community: “[t]he achievements and triumphs that may occur in the fight against cancer come from doctors who do too much—who continue to treat the patient when the odds
may appear overwhelming—and not from those who do too little” [4]. This idea of the physician-soldier waging war against cancer left the patients to play the doctor’s medical battlefield, sometimes at their own expense.

However, while aggressive-treatment-until-the-end became popular within the medical community, there still were groups of people seeking alternatives. In her article “One More Chemo or One Too Many? Defining the Limits of Treatment and Innovation in Medical Oncology,” Isabelle Baszanger informs readers of an alternative point of view regarding cancer treatment. Advocates of less invasive and less rigorous forms of treatment wanted to find alternatives to dying to “either at the margins of medicine (abandonment) or in a hyper-medicalized setting (contemporary hospitals)” [2]. Baszanger goes on to define what this new form of palliative care looked like:

“[…] hospices and palliative care were from their inception a concept and a set of practices that transformed the meaning of “palliation”, viz. all medical measures designed to alleviate, soothe, or moderate symptoms of cancer patients without curing. Unlike earlier meanings of terms like palliative medical therapy, palliative measure or simply palliation, as well as related ideas like “supportive care”, this new notion of palliative care referred to a set of principles, knowledge base and validated practices, aiming at alleviating pain and suffering at the end of life and accompanying patients through their dying process” [2].

This description still aptly describes how palliative care functions today. Although aggressive treatment was still the norm, by the mid-1970s palliative care had risen to sufficient prominence that it had to be addressed by modern oncology. Not surprisingly, many oncologists were openly against this alternative treatment route: “In seeking ‘death
with dignity’ we may overlook treatable disease and provide patients with the indignity of premature deaths” [7].

The subsequent decades would see increased acceptance of palliative care, but its implementation and efficacy are still of great debate today.

**A Dichotomy of Methods**

In his paper “Preferences for active and aggressive intervention among patients with advanced cancer”, Dr. Vincent Maida uses the phrase “active and aggressive medical management (AAMM)” to refer to prescriptive routes “consisting of all active medical treatments or active interventions that deal with physiologic derangements or medical complications experienced by the patient. The prime goal and intent of AAMM is to potentially sustain or prolong life” [8]. To contrast with AAMM, Maida presents “conservative palliative management (CPM)”, which “may be described as all efforts to maintain comfort, dignity, and quality of life through the use of pain and symptom management, and generally, without the use of potentially life-prolonging measures” [8]. Maida’s paper surveys a group of patients for their preferences between AAMM and CPM and then interprets those data while adjusting for other factors. His work contributed significantly to the *Parameter Value Rationale* below sections and is again referenced there. Here, his work provides perfect definitions for the dichotomy this paper plans to investigate: aggressive vs. palliative, AAMM vs. CPM.
The High Cost of Care at the End of Life

Over $80 billion per year is spent on end-of-life care in the United States, and almost 50% of that sum is spent on cancer patients [9]. “End-of-life care” extends beyond cancer patients. The 2012 *Journal of Oncologic Practice* study “Health Care Costs for Patients With Cancer at the End of Life” estimates that the majority of all end-of-life expenses for cancer patients are derived from life-sustaining measures, with 55% of the total cost being spent on acute care in the last six months before death [12]. Importantly, nearly half of the acute care spending occurs only one month before death. Acute care would encompass all forms of treatment outlined under AAMM. This statistic illustrates again the persistence of the aggressive attitude engrained in the oncologic community since the 1950s. The same study goes on to calculate the mean cost for a cancer patient’s last six months of life: $74,212, $22,797 (31%) of which accrue in the last month alone.

AAMM takes on a variety of forms. One is in the intensive care unit (ICU). In the United States, nearly one fifth of deaths occur during or not long after a stay in an ICU [10]. ICUs provide some of the most costly care in modern medicine, accounting for 20-30% of all hospital costs—one day’s stay in an ICU can cost anywhere from $2,000-$4,500 [11]. Other forms of AAMM are CPR/resuscitation, insertion of feeding tubes, blood transfusions, and chemotherapy—to name only some [8].

A key to understanding AAMM, and many of the aggressive and invasive procedures it embodies, is that it is often performed by default. In the absence of proper documentation from the patient, doctors are required to do everything they can to keep their patients alive, regardless of their quality-of-life, and often against the patients’ wishes [3]. Often, artificial feeding and ventilation are implemented. Procedures such as
these are some of the most costly forms of AAMM and cause a good deal of financial strain on both the patient’s family and the medical community.

Using all of this knowledge—from the dichotomy of methods to the high cost of care at the end of life—the thesis will now review literature outlining the effect some factors can have on end-of-life care’s implementation. Then, the thesis will synthesize it into a game theoretic model for analysis.
2. Variables to be Considered in Implementation

The Influence of Advanced Directives and End-of-Life Conversations

Advanced directives allow patients to clearly outline and document their treatment preferences in the event they are unable to convey them themselves. One of the simplest forms of an advanced directive is a Do Not Resuscitate order (DNR). DNRs provide doctors and nurses with the information that their patient does not want to be revived should some form of sudden fatality occur, e.g. a fatal heart attack. Beyond this, patients can create their own advanced directives in such a way so as to inform their doctors of any number of health care choices. Patients state their preferences regarding artificial ventilation, the insertion of a feeding tube, the possibility of surgery, or a stay in the ICU, among others. Preferences can also be conditional. For instance, a patient elects to undergo surgery only if there is a good prognosis, or another patient chooses to forego artificial ventilation when faced with incapacitation.

Many researchers have believed that since advanced directives allow patients to convey their preferences to their physicians, advanced directives will be instrumental in reducing overall end-of-life costs [3]. This belief stems from the knowledge that many aggressive and acute life-prolonging procedures are often performed by default, and in fact 70% of all patients would choose to forego those types of procedures in circumstances with a bleak outlook, which are often the circumstances encountered [3].
**Literature Review**

This section reviews five recent studies on the topic of advanced directives and end-of-life counseling. The first article finds no correlation between the possession of an advanced directive and a reduction in healthcare costs. To contrast, the second study does in fact find said correlation. The section then concludes with an examination of three papers that deal with the effect that an end-of-life conversation can have on end-of-life healthcare spending. All of these five studies analyze the situation from a monetary perspective. Finances are quantifiable, easy-to-measure, and can give a clear picture of something’s impact. However, it is important to keep in mind that patient quality-of-life (QOL) is affected by more than just the bottom-line. In later sections, the paper will address this further.

The 2011 *Oncology* paper “End-of-Life Hospital Costs in Cancer Patients: Do Advance Directives or Routes of Hospital Admission Make a Difference?” uses a retrospective study of patients who died in an in-patient oncology service from 2008 to 2009 [9]. With a sample size of 120 patients, the authors found that 46 (38%) had advanced directives upon admission. After looking at total expenses, they also found no statistical difference between the cost of patients with advanced directives and those without [9]. A possible explanation of this finding is the ambiguity within the advanced directive. Of the 46 patients with advanced directives on record, 32 of them stated that they would not want heroic end-of-life interventions employed. However, their advanced directives also clearly stated that the omission of these heroic interventions was contingent on there being “no prospect of meaningful recovery” [9]. “Meaningful recovery” can have a great many definitions, depending on who one consults.
Additionally, “no prospect” is ambiguous. Doe it literally mean a 0% chance? If there is a 1% chance of “meaningful recovery”, should the doctor perform the intervention? Whenever in doubt, the doctor is required to take every measure to keep his or her patient alive, and the way these directives were phrased certainly leaves a significant amount of ambiguity. The authors also noted that all but one of the 46 advanced directives appeared to be derived from templates filled with similarly vague questions:

“For example, one included the following statement: ‘If I had a reasonable chance of recovery, and were temporarily unable to decide or speak for myself, I would want [fill in the blank].’ Another asked patients to place their initials next to one of the following choices: ‘no life sustaining treatment, treatment for restoration, treatment unless permanently unconscious, or maximum treatment.’ Each category also provided further explanation beyond these choices, but there was no guidance or specific discussion of circumstances that outlined why a patient might choose one over another” [9].

A reasonable interpretation is that the advanced directives in The Oncology study did not create a reduction in cost because they were inadequate as advanced directives. The documents were too vague for the doctors or even the patients to fully understand. Subsequent research points to the benefits of advanced directives, given they are of a proper quality and often in conjunction with some form of consultation.

One such study, published in the American Journal of Managed Care, employed a predictive model designed to target patients twelve months before death. Using patterns of treatment as indicators, the model was able to accomplish this with 90% accuracy [3]. The primary goal of the model was to flag patients a reasonable amount of time before
their death so that they might be able to receive adequate end-of-life counseling. The authors created a pool of participants with 3,112 in the intervention group and 1,630 in the control group [3]. Upon being flagged, members of the intervention group would be contacted via telephone by a nurse trained in end-of-life counseling. Their conversations would be quite thorough and often cover a number of topics: education and counseling regarding the creation of advanced directives, the dichotomy of aggressive vs. palliative care, potential hospice enrollment, and also support for caregivers [3]. At the study’s conclusion, members of the intervention group who had received telephonic counseling and end-of-life education had total hospital costs that were on average $1,913 lower than their control group counterparts. Across the study there was an aggregate savings of $5.95 million from the intervention group [3]. This study is not alone in finding significant savings associated with advanced directives and end-of-life conversations.

Without regard to advanced directives specifically, one study was developed to determine if there was any association with patient/physician end-of-life conversations and costs in the final week of care [13]. One hundred and eighty-eight out of six hundred and three patients in the study reported having had end-of-life conversations with their physicians at the baseline—usually about six months before death. The authors found that final week’s cost was on average $1,876 for those who reported conversations and $2,917 for those who did not. The result was a savings of $1,041 (35.7% lower) for patients who had taken the time to discuss their potential end-of-life care choices with their doctors [13]. Similarly, another study sought to discover if there was a correlation between patient/physician end-of-life discussions and the specific forms of care received near death. The authors were able to see a clear correlation between end-of-life conversations
that occurred more than 30 days before death and a reduction in the utilization of several forms of AAMM, such as acute care services and chemotherapy [15]. Those patients also utilized hospice at a higher rate [15]. In 2015, *Health Services Research* published a paper that uses a comparable marker—this time a consultation with a palliative care team (PCT) instead of only the patient’s attending physician—and also finds a reduction in cost and utilization of resources [14]. The patients examined in that study had hospital stays of 7-30 days, and then they were then divided into two groups: those who died after discharge and those who died while in the hospital. Cancer patients exhibited the highest sensitivity to PCT consultations with a mean savings of $3,647 for those who died after discharge and $7,126 for those who died while in the hospital [14]. The authors also found that the earlier a PCT consultation occurred, the larger the impact it would have on patient care spending [14]. This result make sense because the sooner a patient is made aware of his or her palliative care options (CPM), the sooner he or she may cut back on aggressive procedures (AAMM).

**Discussion**

There are numerous additional studies with similar findings. So, while there is some variation in magnitude, the literature has definitively demonstrated a correlation between the employment of thorough end-of-life education (whether it be through a long conversation or a detailed and thought-out advanced directive document) and a significant reduction in end-of-life healthcare costs. The reduction in costs arises jointly from a decrease in consumption of AAMM procedures and thereby an increase in consumption of CPM practices. Through their conversations, patients are able to more
fully process their desires towards end-of-life care, while also gaining insight as to what is to be reasonably expected from different paths of treatment. The literature suggests that because of these conversations patients will oftentimes elect to proceed in a much less aggressive manner than they would if they had foregone counseling.

While it is true that this reduction in spending and shift consumption at the end-of-life is good for the healthcare sector as a whole, it is important to note that none of the patients in theses studies were coerced into pursuing CPM procedures. Rather, each patient was free to make his or her own decision regarding end-of-life care. It is entirely possible that at the end of a consultation, a patient could come to the conclusion that they want every measure taken to keep them alive—even if only for a few more days—and opt for AAMM procedures. However, this is not what is generally seen in the literature [3, 13, 14, 15]. It is dangerous when discussing healthcare, and especially end-of-life care, to begin thinking about things in a strictly monetary manner—that conversation often devolves quickly to one characterized by euthanasia and “death panels”. One must continually keep the patient’s interests at the forefront. One manifestation on these interests can be found in the patient’s quality-of-life.

The Quantification of Quality-of-Life

One study suggests that a group’s quality-of-life is “the relationship between their present experience of reality and their hopes and expectations” [16]. While this is a fairly abstract concept, there have been several successful efforts to quantify this relationship [16, 17]. This quantification is largely done through the periodic administration of tests.
The content and length of these tests vary, but they will generally hit many of the same points [16]. The McGill Quality-of-Life Questionnaire (MQOL) is one of the most commonly used. The test itself takes between ten to thirty minutes for patients to complete and consists of sixteen questions. These sixteen questions are then divided into five sections: Physical Symptoms (1-3), Physical Well-Being (4), Psychological Well-Being (5-8), Existential Well-Being (9-14), and Support Issues (15-16) [17]. All questions are answered on a 1-10 scale, excluding a final yes/no question that asks whether or not the patient had any help in filling out the questionnaire [17]. Tests like the MQOL allow researchers to compare patients across circumstances, and a number of studies have utilized them in analyzing end-of-life care. One such study found an inverse relationship between a person’s end-of-life expenditures and his or her quality-of-life [3].

The primary purpose of this thesis is to create a game theoretic model of the doctor/patient relationship at the end of life. The patient’s QOL is synthesized with several psychosocial factors so that the model can predict what decisions both the doctor and the patient will make under different scenarios. In the next section, a general background of game theory is provided, followed by the presentation of the game developed in this thesis.
3. The Game Theoretic Model

Background of Game Theory

In 1944, John von Neumann and Oskar Morgenstern published their book *Game Theory and Economic Behavior*, giving birth to a new branch of economics [18]. Dr. V.M. Malhotra defines the concept of game theory:

“Game Theory is a branch of applied mathematics that provides tools for analyzing situations in which parties make decisions that are interdependent. This interdependence causes each player to consider the other player’s possible decisions, in formulating his own. A game describes the optimal decisions of the players, who may have similar, opposed, or mixed interests, and the outcomes that may result from these decisions. Game theory has also been defined as a study of mathematical models of conflict and cooperation between intelligent and rational decision makers.” [21]

The applications of game theory are quite broad, with examples ranging from choosing which side of the sidewalk to take to predicting the next move of enemy nations during wartime. Entering into economics in the 1950s, Nobel Prize winning mathematician John Nash revolutionized the applications of modern game theory. Taking into account two or more players, common interests and conflict of interests, Nash was able to create his “Nash Equilibrium” concept [18]. His ideas have been widely applied in
the field of economics and have spread to many other fields. Here, the methods are used to analyze healthcare choices.

In game theory, strategic interaction is a “game”. A game identifies payoffs and strategies in situations where players can interact and jointly determine outcomes. A famous example is the Prisoner’s Dilemma. This game has numerous applications; however, it is most commonly described using a hypothetical situation involving the interaction of prisoners, which is the basis of the game’s name. In the scenario two people are involved in a crime and separated during their interrogation. Without the cooperation of the accused, the police only have enough evidence to put them away for very long. Thus, if neither party confesses, then each will only be incarcerated for a minimal amount of time, e.g. two years. However, if the police can convince one prisoner to implicate his partner, then that prisoner will receive no jail time whereas his now condemned partner will receive 10 years of incarceration. If both confess, they will both receive four years. For both parties, the best-combined outcome is if neither confesses, but that is not what occurs. However, each is motivated by both the fact that if a confession yields the possibility of avoiding jail all together. Given this incentive, each party confesses. Each party simultaneously playing what is known as a “best response” comprises what is called the Nash Equilibrium. Fisher defines this as follows: “if each party has chosen a strategy, and no party can benefit by changing his or her strategy while the other parties keep theirs unchanged, then that set of strategy choices and their corresponding payoffs constitute a Nash Equilibrium,” [19]. This equilibrium concept is the key to understanding games. It is important to note that some Nash Equilibria include positive outcomes for all players.
This paper will examine use game theory to examine the doctor/patient relationship in the specific context of end-of-life care.

**Game Theoretic Model**

This thesis develops a game theoretic model of the doctor/patient relationship at the end of the patient’s life. The game involves asymmetric information on the side of the doctor in what is known as a signaling game. In the game, there are two states of the world: one in which the doctor is “good” and one in which the doctor is “okay”—while the terms “good” and “okay” are somewhat arbitrary, they serve to indicate a key difference in the doctor’s ability to correctly diagnose the patient’s condition. The difference has implications for the payoff scheme that will be outlined later. Only the doctor knows the state of the world in which the game is played. That is, only the doctor knows whether she is “good” or “okay”. The patient only knows the likelihood that the doctor is “good” or “okay”. The doctor then recommends to the patient palliative or aggressive care, and the patient can accept or reject the physician’s advice. In the presentation below, the general game is outlined first, and then it is analyzed in seven scenarios. For simplicity, the doctor has been referred to with a female pronoun, and the patient with a male pronoun.

**Model**

The game has three stages before the final payoffs are awarded to each player. In the first stage, nature determines whether the doctor is “good” or “okay”. Here, the doctor is “good” if she has had significant experience with critically ill cancer patients, giving
her a higher rate of recovery-to-discharge when utilizing AAMM procedures than the “okay” doctor. The doctor is “okay” if she has had less experience with critically ill cancer patients, with the consequence of lower rates of recovery-to-discharge when utilizing AAMM procedures. The probability that the doctor will be “good” is denoted by $\alpha$, and the probability that the doctor will be “okay” is denoted by $(1-\alpha)$. The doctor is aware of the true state of the world throughout the game, while the only learns the true state once the final payoffs are revealed. In the second stage, the doctor recommends an aggressive treatment plan or a palliative care plan. The doctor’s decision to recommend aggressive treatment is denoted by $A$ if she is “good” and $A'$ if she is “okay”, and the doctor’s decision to recommend palliative care is denoted by $P$ if she is “good” and $P'$ if she is “okay”. In the third stage, the patient chooses to undergo an aggressive treatment plan or a palliative treatment plan. The patient’s decision to undergo aggressive treatment is denoted by $a$ if he is recommended aggressive treatment and $a'$ if he is recommended palliative care, and the patient’s decision to undergo palliative care is denoted by $p$ if he is recommended aggressive treatment and $p'$ if he is recommended palliative care. It is important to note that the prime in the doctor’s decision notation differentiates between whether the doctor’s type is “good” or “okay”, whereas the prime in the patient’s decision notation indicates that the doctor has recommended palliative care. Figure 1 illustrates the model in the form of a game tree.
**Payoffs**

Each course of action within the game is associated with payoffs for each player in units of utility. These payoffs are combinations of parameters constructed to illustrate how the doctor or patient will feel in the event of a given outcome. The payoffs do not incorporate monetary issues directly, although they do take into account the manner in which finances can impact one’s utility. For instance, one study found an inverse relationship between the amounts of money spent on end-of-life care and a patient’s QOL [3]. While the payoffs in each scenario are highly qualitative, they are intended to be a reasonably accurate portrayal of both the doctor’s and the patient’s relative well-being in the given outcome. The utility values were based primarily on research on patient QOL at the end of life as well as some research on the psyche of doctors. Other considerations were also taken into account, and these are noted as they arise.

The doctor’s payoffs are based on the existing literature and also by positing some reasonable assumptions. There is need for more study on the decision making process of physicians and how they are affected by different routes of treatment. The parameter $a_{gd}$ denotes the payoff to a “good” doctor when the patient chooses aggressive care, and $a_{od}$ denotes the payoff to an “okay” doctor when the patient chooses aggressive care. The parameter $p_{gd}$ denotes the payoff to a “good” doctor when the patient chooses palliative care, and $p_{od}$ denotes the payoff to an “okay” doctor when the patient chooses palliative care. It is important to note that these payoffs are independent of what the doctor actually recommends, i.e. they are determined by the patient’s care choice and the doctor’s type.
The Doctor

X The Patient

Aggressive Recommendation by the “Good” Doctor

Aggressive Recommendation by the “Okay” Doctor

P Palliative Recommendation by the “Good” Doctor

P′ Palliative Recommendation by the “Okay” Doctor

a Aggressive Selection by the Patient when Recommended A or A′

a′ Aggressive Selection by the Patient when Recommended P or P′

p Palliative Selection by the Patient when Recommended A or A′

p′ Palliative Selection by the Patient when Recommended P or P′

α Probability that the Doctor will be “Good”

Patient is unable to perceive at which node they are located

<table>
<thead>
<tr>
<th>D</th>
<th>X</th>
<th>( a_d )</th>
<th>( a_d' )</th>
<th>( p_d )</th>
<th>( p_d' )</th>
<th>( r_d )</th>
<th>( r_d' )</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Doctor</td>
<td>The Patient</td>
<td>“Good” Doctor Payoff for Patient Undergoing Aggressive Care</td>
<td>“Okay” Doctor Payoff for Patient Undergoing Aggressive Care</td>
<td>“Good” Doctor Payoff for Patient Undergoing Palliative Care</td>
<td>“Okay” Doctor Payoff for Patient Undergoing Palliative Care</td>
<td>Patient Payoff for Undergoing Aggressive Care with “Good” Doctor</td>
<td>Patient Payoff for Undergoing Aggressive Care with “Okay” Doctor</td>
</tr>
<tr>
<td>A</td>
<td>Aggressive Recommendation by the “Good” Doctor</td>
<td>( a_d )</td>
<td>( a_d' )</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A′</td>
<td>Aggressive Recommendation by the “Okay” Doctor</td>
<td>( p_d )</td>
<td>( p_d' )</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P</td>
<td>Palliative Recommendation by the “Good” Doctor</td>
<td>( a_d )</td>
<td>( a_d' )</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P′</td>
<td>Palliative Recommendation by the “Okay” Doctor</td>
<td>( p_d )</td>
<td>( p_d' )</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a</td>
<td>Aggressive Selection by the Patient when Recommended A or A′</td>
<td>( p_d )</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a′</td>
<td>Aggressive Selection by the Patient when Recommended P or P′</td>
<td>( r_d )</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>p</td>
<td>Palliative Selection by the Patient when Recommended A or A′</td>
<td>( r_d )</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>p′</td>
<td>Palliative Selection by the Patient when Recommended P or P′</td>
<td>( r_d )</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>α</td>
<td>Probability that the Doctor will be “Good”</td>
<td>( r_d )</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 1: Game Tree for the Generalized Model
The parameter $r_d$ indicates the amount of utility a doctor derives from being respected—that is to say, how important it is to her that the patient selects the same treatment as the one she recommends. Here, both doctor types are assumed to receive the same utility from respect. The value of this parameter varies with each scenario, and the rationales are explained as the different scenarios are presented.

The patient’s payoffs are the sum of two components: QOL and emotion. The QOL component is determined by the patient’s care choice and the doctor’s type, and values were based on the literature. In contrast with the literature on a doctor’s emotions, there is a wealth of literature that addresses patient emotion and QOL, especially at the end of life. The parameter $a^g_x$ denotes the patient’s payoff when he undergoes aggressive care and the doctor’s type is “good”, and $a^o_x$ denotes the payoff to the patient with the same choice when the doctor’s type is “okay”. By assumption $a^g_x > a^o_x$ in all scenarios. This follows from the notion that since a “good” doctor with more experience subsequently has higher rates of recovery-to-discharge than an “okay” doctor, as the patient derives a higher utility from recovery than from non-recovery (death). Herein lies the primary outcome distinction between the “good” and “okay” doctors for the patient.

The parameter $p_x$ denotes the patient’s payoff in the event that he chooses palliative care. It is important to note that $p_x$ is independent of the doctor’s type. This is because palliative care is administered by a specialist whose care is not impacted by the recommending doctor’s ability to achieve a high recovery-to-discharge rate under aggressive care. The second component is emotion. The parameter $r_x$ denotes the value the patient places on respecting the doctor—that is to say, how much solace the patient takes in deferring to the physician’s superior medical acumen.
Methods

In order to analyze the unique values for each parameter in the given scenarios, the expected utilities are calculated for each player. The expected utility indicates the player’s perceived outcome in uncertain situations, such as the one presented here. The expected utilities of the doctor are presented first. The expected utilities for the doctor (\( E[U_d] \)) were calculated as follows:

\[
E[U_d] = \alpha U_d^g + (1 - \alpha)U_d^o
\]

Both \( U_d^g \) and \( U_d^o \) represent the sum of parameters in a given outcome. For instance, in the situation where both a “good” and an “okay” doctor recommend aggressive care (AA’), and also the patient chooses to undergo aggressive care when he is recommended it by a doctor, the doctor’s expected utility is:

\[
E[U_d|(AA’, aa’)] = \alpha (a_d^g + r_d) + (1 - \alpha)(a_d^o + r_d)
\]

The patient’s payoffs were constructed in an analogous manner:

\[
E[U_d] = \alpha U_d^g + (1 - \alpha)U_d^o
\]

As with the doctor, both \( U_d^g \) and \( U_d^o \) represent the sum of the parameters in a given outcome for the patient. An example here could be the situation in which the “good” doctor recommends aggressive care and the “okay” doctor recommends palliative care,
with the patient selecting palliative care without regard to the doctor’s recommendation.

Then, his payoff would be calculated thus:

\[
E[U^\text{Combined}_X|(AP, pp')] = \alpha p_X + (1 - \alpha)(p_X + r_X)
\]  

(4)

All of the expected utilities were calculated and arranged in the normal form using Microsoft Excel.

In the creation of this model, thirty distinct combinations of parameter values were analyzed. Of these thirty, seven were chosen for exposition in this paper. They were selected for the manner in which they were representative of either real situations found in the literature or hypothetical situations influenced by the literature. Each scenario has its own set of parameter values that were used to calculate the expected utilities for each player. The baseline scenario is presented first.
4. The Scenarios

Baseline Scenario, No Respect

The baseline scenario contains respect parameters equal to zero, i.e., $r_d = 0$ and $r_x = 0$. For simplicity, this scenario will be referred to as the BN scenario. The BN scenario game tree is presented in Figure 2. In the BN scenario, $\alpha$ is set at 0.4. The choice is based on the assumption that there are less “good”, experienced, doctors in the world than there are “okay”, inexperienced, doctors, and therefore it is less likely for the patient to encounter a “good” doctor. As a baseline, this scenario was designed to be fairly generic. In it, the “good” doctor is better off when the patient chooses aggressive care ($a^g_D > p^g_D$), and the “okay” doctor is indifferent towards the patient’s choice ($a^o_D = p^o_D$). The patient prefers aggressive care by a “good” doctor to palliative care by any type of doctor, and he prefers both of those to aggressive care by an “okay” doctor. As stated above, neither player considers respect in this version of the baseline scenario. This is an unrealistic assumption, one made only so that scenarios with and without respect can be contrasted so as to illuminate the dynamic relationship between the patient and the doctor.
Figure 2: Game Tree, The BN Scenario

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>D</td>
<td>The Doctor</td>
</tr>
<tr>
<td>X</td>
<td>The Patient</td>
</tr>
<tr>
<td>A</td>
<td>Aggressive Recommendation by the “Good” Doctor</td>
</tr>
<tr>
<td>A'</td>
<td>Aggressive Recommendation by the “Okay” Doctor</td>
</tr>
<tr>
<td>P</td>
<td>Palliative Recommendation by the “Good” Doctor</td>
</tr>
<tr>
<td>P'</td>
<td>Palliative Recommendation by the “Okay” Doctor</td>
</tr>
<tr>
<td>a</td>
<td>Aggressive Selection by the Patient when Recommended A or A'</td>
</tr>
<tr>
<td>a'</td>
<td>Aggressive Selection by the Patient when Recommended P or P'</td>
</tr>
<tr>
<td>p</td>
<td>Palliative Selection by the Patient when Recommended A or A'</td>
</tr>
<tr>
<td>p'</td>
<td>Palliative Selection by the Patient when Recommended P or P'</td>
</tr>
<tr>
<td>α</td>
<td>Probability that the Doctor will be “Good”</td>
</tr>
<tr>
<td>Patient is unable to perceive at which node they are located</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Payoff</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>$a^d = 6$</td>
</tr>
<tr>
<td>a'</td>
<td>$a'^d = 4$</td>
</tr>
<tr>
<td>p</td>
<td>$p^d = 3$</td>
</tr>
<tr>
<td>p'</td>
<td>$p'^d = 4$</td>
</tr>
<tr>
<td>A</td>
<td>$d^a = 3$</td>
</tr>
<tr>
<td>A'</td>
<td>$d'^a = 4$</td>
</tr>
<tr>
<td>P</td>
<td>$d^p = 4$</td>
</tr>
<tr>
<td>P'</td>
<td>$d'^p = -2$</td>
</tr>
<tr>
<td>a</td>
<td>$r_a = 0$</td>
</tr>
<tr>
<td>a'</td>
<td>$r_a' = 0$</td>
</tr>
<tr>
<td>p</td>
<td>$r_p = 0$</td>
</tr>
<tr>
<td>p'</td>
<td>$r_p' = 0$</td>
</tr>
<tr>
<td>α</td>
<td>$&lt;0.4&gt;$</td>
</tr>
<tr>
<td>Patient is unable to perceive at which node they are located</td>
<td></td>
</tr>
</tbody>
</table>
Parameter Value Rationale, BN Scenario

As mentioned earlier, there is limited research on the decision making process of doctors and the effect of emotions in their profession. Here, payoffs were created via some reasonable assumptions, along inferences based on the limited literature. Specifically, values for a “good” doctor were $a^g_d = 6$, and $p^g_d = 3$. These values represent the “good” doctor’s preference for aggressive treatment being chosen by the patient, while still getting positive utility when the patient chooses palliative care. These payoffs stem from a study in the Journal of the American Medical Association “The Inner Life of Physicians and the Care of the Seriously Ill.” In it, the authors articulate the struggle many physicians have with not wanting to abandon the hope of recovery. Therefore, doctors will often prefer more aggressive treatments instead of their palliative, non-curative counterparts, although physicians can still see benefits to both [23]. It is also possible that a physician is unfamiliar with palliative care and wants to focus on his or her Hippocratic responsibility to heal the patient [25]. The payoffs for an “okay” doctor were set at $a^o_d = 4$ and $p^o_d = 4$. The rationale here is that while an “okay” doctor might prefer that the patient chooses aggressive care over palliative care, her lack of experience causes her to have a certain amount of disutility from the extra effort expended in administering the aggressive care, causing the payoffs for aggressive care and palliative care to be equal for an “okay” doctor. As mentioned previously, for both doctor types $r_d = 0$.

The patient’s payoffs were determined in a similar manner to the doctor’s, albeit with relatively more literature. The value of $a^g_s = 4$, and the value of $a^o_s = -2$. These payoffs represent the combination of several factors. For one, the game is simplified so
that whether the patient actually recovers after he undergoes aggressive treatment is not directly considered. To account for this, the patient’s payoffs are considered to be an aggregate of both outcomes: recovery and the lack thereof. Presumably, the patient receives high payoffs when he is able to recover, and low payoffs when he is unable to do so. The literature documents the enormous physical and emotional strains aggressive treatment at the end of life can have on both a patient and his or her family [3, 8, 15, 24, 26]. A higher likelihood of recovery offsets some of these disutilities. As the probability of recovery is higher with “good” doctors, it follows that $a^g_x > a^o_x$. This relative ordering will be used throughout all seven scenarios, although if the magnitude of the differences change. The value of $p_x = 3$, so that $a^g_x > p_x > a^o_x$. These relative values indicate that the patient prefers aggressive care by a “good” doctor to palliative care by any type of doctor to aggressive care by an “okay” doctor—The parameter $r_i = 0$. All four of these payoffs are independent of which treatment route the doctor recommends.

**Analysis**

The final parameter values for the BN scenario are arranged Table 1, and the normal form with the calculated expected utilities for the scenario are displayed in Table 2.

**Table 1: Parameter Values, Baseline Scenario with No Respect**

| $a^g_d$ | 6 | $p^g_d$ | 4 | $p_x$ | 3 |
| $a^o_d$ | 4 | $a^o_x$ | 4 | $r_i$ | 0 |
| $p^o_d$ | 3 | $a^o_x$ | -2 | $r_i$ | 0 |
Three Nash Equilibria were discovered: (AP', ap'), (PA', pa'), and (PP', pp'). The first Nash Equilibrium of (AP', ap') represents a fairly intuitive outcome. It represents a scenario in which the “good” doctor recommends aggressive care and the “okay” doctor recommends palliative, and then the patient respects the doctor’s opinion in both cases. This is what is known as a separating equilibrium because it separates the “good” and the “okay” doctors down two distinct outcome pathways. The “good” doctor sees aggressive care realized—the mode she prefers—and the “okay” doctor sees palliative care realized. The patient reaches his ideal outcome in both states of the world.

The second Nash Equilibrium, (PA’, pa’), is also a separating equilibrium. This time, however, the patient exhibits a complete disregard for the doctor’s recommendation. Here, the “good” doctor recommends palliative care, and the “okay” doctor recommends aggressive care. Now, the patient chooses to undergo palliative care when he is recommended aggressive care, and he chooses to undergo aggressive care when he is recommended palliative care. Here again, the patient reaches his ideal outcome in both states of the world, but this time he reaches it in defiance to the doctor.

The third Nash Equilibrium of (PP’, pp’) is less intuitive. Under (PP’, pp’), both the “good” and “okay” doctors recommend palliative care, and the patient chooses to undergo that palliative care when it is recommended to him. The equilibrium also
indicates that the patient will select palliative care if he is recommended aggressive care. What would motivate the patient to do this?

Since the Nash Equilibrium is (PP’, pp’), the patient expects the doctor to always recommend palliative care. So, if the doctor recommends aggressive care, the patient is not sure what to believe. To incorporate this, the paper adds another variable $\mu_N$ to denote the patient’s perception of the probability of a doctor being “good” when he is recommended aggressive care within the scenario. So, the Nash Equilibrium really becomes (PP’, pp’, $\mu_N$), but for what values of $\mu_N$? In order to understand the patient’s reasoning we must look at his expected utility with respect to $\mu_N$ when he is recommended aggressive care.

\[
E[U_x(a)|A or A'] = 4\mu_N - 2(1 - \mu_N) = 6\mu_N - 2 \tag{5}
\]

\[
E[U_x(p)|A or A'] = 3\mu_N + 3(1 - \mu_N) = 3 \tag{6}
\]

Then, these two equations must be put into an inequality to discover the value for which $\mu_x$ must be less than in order for the patient to choose $p$ when recommended $A$ or $A'$.

\[
E[U_x(a)|A or A'] < E[U_x(p)|A or A'] \tag{7}
\]

Using $E[U_x(a)|A or A'] = 6\mu_N - 2$ from equation (5) on the right-hand side of equation (7) and $E[U_x(a)|A or A'] = 3$ from equation (6) on the left-hand side of equation (7) yields the condition $6\mu_N - 2 < 3$ or $\mu_N < 0.833$. 

28
So, in order for \((PP', pp')\) to hold, \(\mu_N\) must be less than 0.833—that is to say, the patient must believe the probability of the doctor being “good” to be less than 83.3\%.

With this added knowledge, the Nash Equilibrium is modified to be \((PP', pp', \mu_N < 0.833)\). In the BN scenario, the likelihood of the doctor being good is only 0.4. Given that the patient is rational, he should be aware of this fact and elect to undergo palliative care if the doctor surprises him with an aggressive care recommendation. Therefore, the equilibrium is upheld.

**Baseline Scenario, Respect**

This baseline scenario now considers the respect parameters and will be referred to as the BR scenario. Except for the modification of the respect parameters, all the parameters and conditions set in the BN scenario remain the same in the BR scenario.

The new cumulative payoffs for the patient are now exemplified in the game tree shown in Figure 3.

**Parameter Value Rationale, BR Scenario**

To avoid redundancy, the value rationalization for all parameters excluding \(r_d\) and \(r_x\) can be found under the previous section’s *Parameter Value Rationale* sub-heading.

There is significant reason to believe that respect is an important factor in the doctor/patient relationship, both logically and within the literature. For both the “good” and “okay” doctors, the value of \(r_d = 2\). The reasoning for this payoff follows from the fact that doctors require the trust of their patients. Physicians cannot adequately perform their duties if their patients do not comply with their recommendations. Therefore, they
receive a benefit if they are heeded and nothing if they are disregarded [20]. The parameter $r_x = 2$. Here, the paper assumes that the patient would acknowledge the doctor’s superior medical acumen and therefore take some solace from doing what he or she says.

*Analysis*

The parameter values for the BR scenario are shown in Table 3, and the normal form with the expected utilities for the baseline scenario is shown in Table 4. The discovered Nash Equilibria are shaded:

**Table 3: Parameter Values, Baseline Scenario with Respect**

<table>
<thead>
<tr>
<th>$a^{d_a}$</th>
<th>6</th>
<th>$p^{d_a}$</th>
<th>4</th>
<th>$p_x$</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>$a^{p_a}$</td>
<td>4</td>
<td>$a_x$</td>
<td>4</td>
<td>$r_d$</td>
<td>2</td>
</tr>
<tr>
<td>$p^{p_a}$</td>
<td>3</td>
<td>$a_x$</td>
<td>-2</td>
<td>$r_x$</td>
<td>2</td>
</tr>
</tbody>
</table>

**Table 4: Normal Form, Baseline Scenario with Respect, $\alpha = 0.4$**

<table>
<thead>
<tr>
<th>D</th>
<th>X</th>
<th>aa'</th>
<th>ap'</th>
<th>pa'</th>
<th>pp'</th>
</tr>
</thead>
<tbody>
<tr>
<td>AA'</td>
<td>6.8</td>
<td>2.4</td>
<td>6.8</td>
<td>2.4</td>
<td>3.6</td>
</tr>
<tr>
<td>AP'</td>
<td>6.8</td>
<td>1.2</td>
<td>3.6</td>
<td>0</td>
<td>4.8</td>
</tr>
<tr>
<td>PA'</td>
<td>6</td>
<td>1.6</td>
<td>5.6</td>
<td>2</td>
<td>4.8</td>
</tr>
<tr>
<td>PP'</td>
<td>4.8</td>
<td>0.4</td>
<td>5.6</td>
<td>5</td>
<td>4.8</td>
</tr>
</tbody>
</table>
Figure 3: Game Tree, The BR Scenario
So, in the BR scenario only two Nash Equilibria are encountered: \((AP', ap')\) and \((PP', pp')\), both of which were seen in the previously in the BN scenario. The first equilibrium of \((AP', ap')\) still represents a scenario in which the “good” doctor recommends aggressive care and the “okay” doctor recommends palliative care, and then the patient respects the doctor’s opinion in both cases. The difference in implications here for the BR scenario lies in the fact that now the patient is actually listening to what the doctor has to say, whereas before it was essentially “cheap talk”. In this scenario, the doctor is able to signal her type—“good” or “okay”—to the patient via her choice of recommendation. Therefore, if the doctor recommends aggressive care \(A\), then the patient will willingly respect that opinion and opt for that aggressive care \(a\) because he believes the doctor to be “good”. Additionally, if the doctor recommends palliative care \(P\), then the patient will again respect that opinion and opt for palliative care \(p'\) because he believes the doctor to be “okay”. Here the doctor wants to be honest with the patient and signal her type because the patient’s interests align with her own.

The second equilibrium of \((PP', pp')\) also is persistent in coming into the BR scenario from the BN scenario, and its implications are similar as well. Under \((PP', pp')\), both the “good” and “okay” doctors recommend palliative care, and the patient respects that opinion, choosing to undergo palliative care when it is recommended to him. The equilibrium also indicates that the patient will select palliative care if he is recommended aggressive care. Why would the patient do this in this scenario, one where the recommendation of aggressive care should signal that the doctor is “good”?

The rationalization follows the same logic seen in \((PP', pp')\)’s analysis from the BN scenario. Since the Nash Equilibrium is \((PP', pp')\), the patient expects the doctor to
always recommend palliative care. So, if the doctor recommends aggressive care, the patient is not sure what to believe. To incorporate this, the paper must again add another variable, now termed $\mu_R$, to denote the patient’s perception of the probability of a doctor being “good” when he is recommended aggressive care within the scenario. In order to understand the patient’s reasoning we must look at his expected utility with respect to $\mu_R$ when he is recommended aggressive care.

\[
E[U_x(a)|A or A'] = 6\mu_R + 0(1 - \mu_R) = 6\mu_R
\]  

(8)

\[
E[U_x(p)|A or A'] = 3\mu_R + 3(1 - \mu_R) = 3
\]  

(9)

Then, these two equations must be put into an inequality in order to discover the value for which $\mu_R$ must be less than for the patient to choose $p$ when recommended $A$.

\[
E[U_x(a)|A or A'] < E[U_x(p)|A or A']
\]  

(10)

Using $E[U_x(a)|A or A'] = 6\mu_R$ from equation (8) on the right-hand side of equation (10) and $E[U_x(a)|A or A'] = 3$ from equation (9) on the left-hand side of equation (10) yields the condition $6\mu_R < 3$ or $\mu_R < 0.5$.

So, in order for $(PP', pp')$ to hold, $\mu_R$ must be less than 0.5—that is to say, the patient must believe the probability of the doctor being “good” to be less than fifty percent. With this added knowledge, the Nash Equilibrium is modified to be $(PP', pp', \mu_R < 0.5)$. 

33
Although (PP’, pp’, \( \mu_R < 0.5 \)) technically holds within the baseline scenario, it should be noted that it is an unrealistic equilibrium. This notion is because only the “good” doctor prefers aggressive care within this scenario. The rational patient should be aware of that fact and therefore respect aggressive recommendations. In addition, this equilibrium is Pareto inferior to the first Nash Equilibrium of (AP’, ap’)—that is to say, both players have higher payoffs in the first equilibrium, (AP’, ap’), than in this equilibrium.

While this is a highly simplified scenario, it is indicative of a situation many patients face in not knowing the preferences or biases of their doctors. The parameters are general, and the outcome of the patient always respecting his doctor’s opinion is largely what is seen in the healthcare sector today. From here, the paper will examine five more scenarios. These scenarios are more specific and are not intended to be representations of the general marketplace. Rather, through their specificity, these scenarios reveal very interesting nuances in the doctor/patient interaction at the end of life.

**Deceit-is-Likely Scenario, No Respect**

As in the baseline scenarios, \( \alpha \) is set to 0.4. The only difference between this scenario and the baseline scenario is the fact that the “okay” doctor now prefers aggressive care to palliative care even more strongly than the “good” doctor, thereby making her want to deceive the patient into believing she is in fact a “good” doctor. Since the probability that the doctor is “okay” is 0.6 in this scenario, the prospect of deceit for the patient is likely. The outcome parameters for the doctor are now ordered in the following manner: \( d^o_d > d^g_d > p^g_d > p^o_d \). Also as in the baseline scenarios, the Deceit-is-
Likely scenario will be examined with and without consideration for the respect parameters: the DLR scenario and the DLN scenario, respectively. First, the paper will discuss the DLN scenario. Figure 4 displays the new game tree along with the cumulative payoffs for each player.

Parameter Value Rationale, DLN Scenario

To create the desired parameter order, \( a^{o_d} = 8 \) and \( p^{o_d} = 2 \). There could be multiple reasons why an “okay” doctor might prefer aggressive care to palliative care more so than a “good” doctor. For one, the “okay” doctor may be naïve to the world of palliative care due to her lack of experience. If this were the case, she would see relatively little benefit to palliative care, not knowing the benefits it can provide to the patient. Even though the “okay” doctor receives a certain amount of disutility in the administration of aggressive care, due to the extra effort she needs to expend because of her lack of experience, she might value the effect of aggressive care very highly. This would harken back to the mentality of David Karnofsky and his nearly anti-palliative medicine approach [4, 5]. While the “good” doctor still prefers aggressive care, her payoffs are considerably more moderate in their relative difference.

Analysis

The parameter values for the DLN scenario are shown in Table 5, and the normal form with the expected utilities for the scenario is displayed in Table 6. The singular Nash Equilibrium is shaded.
The Nash Equilibrium discovered here of (PP’, pp’) is an interesting result, and also one that was seen in the baseline scenario. Under it, both the “good” and “okay” doctors recommend palliative medicine. Furthermore, when the patient is recommended palliative medicine, he will choose to respect the doctor and follow her recommendation. This conclusion makes sense because since the patient is rational, and he knows the doctor is rational, he knows that the “okay” doctor strongly prefers aggressive care. Therefore, even though he receives a higher payoff for undergoing aggressive treatment with the “good” doctor than he does for undergoing palliative medicine, he will select to undergo palliative treatment regardless of what the doctor recommends. He does not want to risk the potential of undergoing aggressive treatment with an “okay” doctor and consequently selects the constancy of his payoffs for palliative care. On the other hand, upon consulting the far right column in Table 6, one can see that the doctor is unable to affect her potential payoffs by changing her recommendation strategy when the patient selects (pp’). In fact, the doctor’s payoffs do not get lower than they are when the patient decides to choose palliative care without regard to the doctor’s recommendation. So,
Figure 4: Game Tree, The DLN and DUN Scenarios

<table>
<thead>
<tr>
<th>Event</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>D</strong></td>
<td>The Doctor</td>
</tr>
<tr>
<td><strong>X</strong></td>
<td>The Patient</td>
</tr>
<tr>
<td><strong>A</strong></td>
<td>Aggressive Recommendation by the “Good” Doctor</td>
</tr>
<tr>
<td><strong>A’</strong></td>
<td>Aggressive Recommendation by the “Okay” Doctor</td>
</tr>
<tr>
<td><strong>P</strong></td>
<td>Palliative Recommendation by the “Good” Doctor</td>
</tr>
<tr>
<td><strong>P’</strong></td>
<td>Palliative Recommendation by the “Okay” Doctor</td>
</tr>
<tr>
<td><strong>a</strong></td>
<td>Aggressive Selection by the Patient when Recommended A or A’</td>
</tr>
<tr>
<td><strong>a’</strong></td>
<td>Aggressive Selection by the Patient when Recommended P or P’</td>
</tr>
<tr>
<td><strong>p</strong></td>
<td>Palliative Selection by the Patient when Recommended A or A’</td>
</tr>
<tr>
<td><strong>p’</strong></td>
<td>Palliative Selection by the Patient when Recommended P or P’</td>
</tr>
<tr>
<td><strong>α</strong></td>
<td>Probability that the Doctor will be “Good”</td>
</tr>
<tr>
<td><strong>x</strong></td>
<td>Patient is unable to perceive at which node they are located</td>
</tr>
</tbody>
</table>

**The Payoffs:**
- $d^g = 6$ “Good” Doctor Payoff for Patient Undergoing Aggressive Care
- $d^o = 8$ “Okay” Doctor Payoff for Patient Undergoing Aggressive Care
- $p^g = 3$ “Good” Doctor Payoff for Patient Undergoing Palliative Care
- $p^o = 2$ “Okay” Doctor Payoff for Patient Undergoing Palliative Care
- $a_x = 4$ Patient Payoff for Undergoing Aggressive Care with "Good" Doctor
- $d_x = 2$ Patient Payoff for Undergoing Aggressive Care with "Okay" Doctor
- $p_x = 3$ Patient Payoff for Undergoing Palliative Care with Any Doctor
- $r_d = 0$ Doctor Payoff for Patient Respecting Her Recommendation
- $r_x = 0$ Patient Payoff for Respecting the Doctor's Recommendation
while the game does yield a Nash Equilibrium of \((PP', pp')\), the doctor is in reality indifferent to what recommendations she makes.

As in both baseline scenarios, this equilibrium creates a situation where the patient expects the doctor to always recommend palliative care. So, if the doctor recommends aggressive care, the patient is not sure what to believe. Since the parameter values are the same for the patient here in the DLN scenario as they are in the BN scenario, the game yields the same result of \(\mu_N < 0.833\) upon the examination of \(\mu_N\)'s relationship to the patient’s expected utility. So the patient will select palliative care upon the receipt of an aggressive care recommendation if they perceive the likelihood of the doctor being good to be less than 83.3%. The resulting modified Nash Equilibrium of \((PP', pp', \mu_N < 0.833)\) is realistic in this case because this is a situation in which an aggressive care recommendation is a bad signal, and it would not be in the best interests of the patient to comply with such a recommendation unless he was relatively sure that the doctor would be “good”.

In the following section the paper will explore that very situation by increasing the value of \(\alpha\).

**Deceit-is-Unlikely Scenario, No Respect**

This Deceit-is-Unlikely (DU) scenario is identical to the previous Deceit-is-Likely (DL) scenario, except for the fact that \(\alpha\) was set to be 0.9. Given the fact that the probability the doctor will be “okay” in this scenario is now 0.1, it is safe for the patient to consider the potential of deceit unlikely. Figure 4 may still be used as the game tree of this scenario. Additionally, the reasoning behind the parameters is the same and can be
referenced under the previous section’s *Parameter Value Rationale* subheading. Note that the respect parameters are also similarly ignored, but later on in the paper, the effect of respect on this scenario will be studied. For this reason, it is necessary to differentiate between the two. The following scenario will be termed the DUN scenario, and its respect-incorporating counterpart will be termed the DUR scenario.

*Analysis, BR Scenario*

Table 5 still outlines the scenario’s parameter values, and Table 4 shows the new normal form, with the new Nash equilibria shaded.

<table>
<thead>
<tr>
<th>αₐ', αₚ₀</th>
<th>2</th>
<th>p₀, r₀</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>2</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

Table 7: Parameter Values, Deceit-is-Unlikely Scenario with No Respect

Table 8: Normal Form, Deceit-is-Unlikely Scenario with No Respect, α = 0.9

<table>
<thead>
<tr>
<th>D</th>
<th>X</th>
<th>aa'</th>
<th>ap'</th>
<th>pa'</th>
<th>pp'</th>
</tr>
</thead>
<tbody>
<tr>
<td>AA'</td>
<td>6.2</td>
<td>3.4</td>
<td>3.4</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>AP'</td>
<td>6.2</td>
<td>3.4</td>
<td>3.4</td>
<td>3.5</td>
<td>2.5</td>
</tr>
<tr>
<td>PA'</td>
<td>6.2</td>
<td>3.4</td>
<td>2.5</td>
<td>3.9</td>
<td>2.9</td>
</tr>
<tr>
<td>PP'</td>
<td>6.2</td>
<td>3.4</td>
<td>3</td>
<td>2.9</td>
<td>2.9</td>
</tr>
</tbody>
</table>

The two Nash Equilibria, (AA’, aa’) and (AA’, ap’), yield similar situations to each other. They are alike in that under them, both the “good” and “okay” doctors recommend aggressive care, and the patient then respects the doctor’s opinion and opts for aggressive care when it is recommended to him. Where they differ is in the patient’s actions when he is recommended palliative care. In (AA’, aa’), the patient selects...
aggressive care when he is recommended palliative care. By contrast in (AA’, ap’), the patient is respectful and selects palliative care when he is recommended palliative care. How does one know which is the correct equilibrium?

This situation is comparable to that seen in the analysis of (PP’, pp’) in both the baseline scenarios and their consequent incorporation of \( \mu \) into the model. Under these equilibria, the doctor always recommends aggressive care. So, if the doctor recommends palliative care, the patient is not sure what to believe. To incorporate this, the paper must again add another variable—now, \( \gamma_N \)—to denote the patient’s perception of the probability of a doctor being “good” when he is recommended palliative care within the scenario. So, the Nash Equilibria really become (AA’, aa’, \( \gamma_N \)) and (AA’, ap’, \( \gamma_N \)), but for what values of \( \gamma_N \)? Similarly to before, one must look at his expected utility with respect to \( \gamma_N \) when he is recommended palliative care in order to better understand his reasoning.

\[
E[U_x(a')|P \text{ or } P'] = 4\gamma_N - 2(1 - \gamma_N) = 6\gamma_N - 2
\]  
(11)

\[
E[U_x(p')|P \text{ or } P'] = 3\gamma_N + 3(1 - \gamma_N) = 3
\]  
(12)

Then, these two equations must be put into an inequality to discover the value for which \( \gamma_N \) must be less than in order for the patient to choose \( p' \) when recommended \( P \) or \( P' \).

\[
E[U_x(a')|P \text{ or } P'] < E[U_x(p')|P \text{ or } P']
\]  
(13)
Using \( E[U_x(a')|P \text{ or } P'] = 6\gamma_N - 2 \) from equation (11) on the left-hand side of equation (13) and \( E[U_x(p')|P \text{ or } P'] = 3 \) from equation (12) on the right-hand side of equation (13) yields the condition \( 6\gamma_N - 2 < 3 \) or \( \gamma_N < 0.833 \).

This result means that the patient will choose to undergo palliative care when recommended aggressive care in this scenario only if they perceive the likelihood of the doctor being good to be less than 83.3%. The value of \( \alpha \) is 0.9 in this scenario, meaning that the likelihood of the doctor being “good” under these conditions is 90%. Given that the patient is aware of this and rational, it is fair to infer that the patient will consequently not choose to undergo palliative care in response to a palliative care recommendation. Rather, they will choose to undergo aggressive care. Consequently, the equilibrium of \((AA', ap')\) is deemed unrealistic under these conditions, leaving the scenario only with \((AA', aa')\).

So, the paper was able to completely change the outcome of the DLN scenario to its polar opposite in the DUN scenario, just by modifying the value of \( \alpha \). This outcome represents the importance of the exogenous beliefs that the patient has about the doctor, which is especially important in this deceit-characterized situation.

The next two sections will examine both the DL and DU scenarios with the incorporation of respect. In this context, they are termed DLR and DUR.

### Deceit-is-Likely Scenario, with Respect

The DLR scenario is identical to its counterpart DLN except for the fact that, in this case, both the doctor and the patient consider respect in their decision-making. Figure 5 illustrates the resulting cumulative payoffs and game tree for the DLR scenario.
Parameter Value Rationale, DLR Scenario

As stated above, the parameter values are identical to those seen in the DLN scenario, excluding the values for \( r_d \) and \( r_x \). As it turns out, the values and corresponding rationale for \( r_d \) and \( r_x \) in this scenario are gleaned from the BR scenario.

Analysis, DLR Scenario

The parameter values for the DLR scenario are displayed in Table 8. Additionally, the normal form for the DLR scenario is displayed here in Table 9 and the resulting Nash Equilibrium is shaded.

Table 9: Parameter Values, Deceit-is-Likely Scenario with Respect

<table>
<thead>
<tr>
<th>( a' _d )</th>
<th>6</th>
<th>( p' _d )</th>
<th>2</th>
<th>( p_a )</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>( a' _d )</td>
<td>8</td>
<td>( a' _x )</td>
<td>4</td>
<td>( r_d )</td>
<td>2</td>
</tr>
<tr>
<td>( p' _d )</td>
<td>3</td>
<td>( p' _x )</td>
<td>-2</td>
<td>( r_x )</td>
<td>2</td>
</tr>
</tbody>
</table>

Table 10: Normal Form, Deceit-is-Likely Scenario with Respect, \( \alpha = 0.4 \)

<table>
<thead>
<tr>
<th>( D )</th>
<th>( X )</th>
<th>( aa' )</th>
<th>( ap' )</th>
<th>( pa' )</th>
<th>( pp' )</th>
</tr>
</thead>
<tbody>
<tr>
<td>AA'</td>
<td>9.2</td>
<td>2.4</td>
<td>9.2</td>
<td>2.4</td>
<td>2.4</td>
</tr>
<tr>
<td>AP'</td>
<td>8</td>
<td>1.2</td>
<td>5.6</td>
<td>5.4</td>
<td>6</td>
</tr>
<tr>
<td>PA'</td>
<td>8.4</td>
<td>1.6</td>
<td>8</td>
<td>2</td>
<td>3.6</td>
</tr>
<tr>
<td>PP'</td>
<td>7.2</td>
<td>0.4</td>
<td>4.4</td>
<td>5</td>
<td>7.2</td>
</tr>
</tbody>
</table>

The appearance of the sole equilibrium of \((PP', pp')\) is exactly what was seen previously in the analysis of DLN. It carries with it the same implications in this scenario. Under it, both the “good” and “okay” doctors recommend palliative medicine. Furthermore, when the patient is recommended palliative medicine, he will choose to respect the doctor and follow her recommendation. This conclusion makes sense because since the patient is
rational, and he knows the doctor is rational, he knows that the “okay” doctor strongly prefers aggressive care. Therefore, even though he receives a higher payoff for undergoing aggressive treatment with the “good” doctor than he does for undergoing palliative medicine, he will select to undergo palliative treatment regardless of what the doctor recommends. He does not want to risk the potential of undergoing aggressive treatment with an “okay” doctor and consequently selects the constancy of his payoffs for palliative care. The doctor knows that the patient knows that the doctor is rational, so therefore the doctor knows the patient is going to select palliative medicine no matter what she recommends. So since she values the respect of the patient, she chooses to recommend the palliative care she knows with which the patient will comply.

As in the baseline scenarios, this equilibrium creates a situation where the patient expects the doctor to always recommend palliative care. So, if the doctor recommends aggressive care, the patient is not sure what to believe. Since the parameter values are the same for the patient in this scenario as they are in the BR scenario, the game yields the same result of $\mu_R < 0.5$ upon the examination of $\mu_R$’s relationship to the patient’s expected utility. However, unlike the baseline scenario, the consequent equilibrium of $(PP', pp', \mu_R < 0.5)$ is much more realistic. This is a Nash Equilibrium where everyone recommends palliative care since recommending aggressive care is now a bad signal.

**Deceit-is-Unlikely Scenario, with Respect**

This scenario is identical to the previous one, except for the fact that $\alpha$ was set to 0.9, as was seen in its other counterpart, the DUN scenario. Figure 5 may be used as the game tree of this scenario. Additionally, the parameter values and corresponding
Figure 5: Game Tree, The DLR and DUR Scenarios
7 rationale are the same as that seen in the DLR scenario, being borrowed in the same fashion from previous scenarios.

Analysis, DUR Scenario

Table 11 shows the parameter values for the DUR scenario, which are persistent from the DLR scenario; and Table 11 shows the new normal form with the new Nash Equilibria shaded.

<table>
<thead>
<tr>
<th>$a_d^p$</th>
<th>6</th>
<th>$p_d^p$</th>
<th>2</th>
<th>$p_e$</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>$a_d^a$</td>
<td>8</td>
<td>$a_e^p$</td>
<td>4</td>
<td>$r_f$</td>
<td>2</td>
</tr>
<tr>
<td>$p_d^a$</td>
<td>3</td>
<td>$a_e^a$</td>
<td>-2</td>
<td>$r_f$</td>
<td>2</td>
</tr>
</tbody>
</table>

Table 11: Parameter Values, Deceit-is-Unlikely Scenario with Respect

<table>
<thead>
<tr>
<th>D</th>
<th>X</th>
<th>aa'</th>
<th>ap'</th>
<th>pa'</th>
<th>pp'</th>
</tr>
</thead>
<tbody>
<tr>
<td>AA'</td>
<td>8.2</td>
<td>5.4</td>
<td>8.2</td>
<td>5.4</td>
<td>2.9</td>
</tr>
<tr>
<td>AP'</td>
<td>8</td>
<td>5.2</td>
<td>7.6</td>
<td>5.9</td>
<td>3.5</td>
</tr>
<tr>
<td>PA'</td>
<td>6.4</td>
<td>3.6</td>
<td>5.5</td>
<td>4.5</td>
<td>5.6</td>
</tr>
<tr>
<td>PP'</td>
<td>6.2</td>
<td>3.4</td>
<td>4.9</td>
<td>5</td>
<td>6.2</td>
</tr>
</tbody>
</table>

Table 12: Normal Form, Deceit-is-Unlikely Scenario with Respect

There were three Nash Equilibria discovered: (AA’, aa’), (AA’, ap’), and (PP’, pp’).

The third, (PP’, pp’), is the same as that in the previous scenario, and therefore its explanation remains the same. It should also be noted that the stipulations surrounding $\mu_R$ remain the same as well since the same parameter values were used. Therefore, it is still the case that for (PP’, pp’) to be a Nash Equilibrium, $\mu_R$ must still be less than 0.5 (i.e. the patient must still perceive the probability of the doctor being “good” to be less than fifty
percent). Since the probability that the doctor is “good” is greater than 0.5 in this scenario, the Nash Equilibrium of (PP’, pp’) can be deemed unrealistic.

The first two Nash Equilibria, (AA’, aa’) and (AA’, ap’), are the same as the Nash Equilibria seen in the DUN scenario and still yield similar outcomes to each other. Under them, both the “good” and “okay” doctors recommend aggressive care, and the patient then respects the doctor’s opinion and opts for aggressive care when it is recommended to him. As in the DUN scenario, it is necessary to incorporate γ in order to discover how the patient’s perception of the probability that the doctor is “good” affects his decision-making. To differentiate between the DUR and the DUN scenarios, the defining variable will be γR. So, the Nash Equilibria really become (AA’, aa’, γR) and (AA’, ap’, γR), but for what values of γR? Similarly to before, one must look at his expected utility with respect to γR when he is recommended palliative care in order to better understand his reasoning.

\[
E[U_x(a')|P or P'] = 4\gamma_R - 2(1 - \gamma_R) = 6\gamma_R - 2
\]  
\[
E[U_x(p')|P or P'] = 5\gamma_R + 5(1 - \gamma_R) = 5
\]  

Then, these two equations must be put into an inequality to discover the value for which γR must be less than in order for the patient to choose p’ when recommended P or P’.

\[
E[U_x(a')|P or P'] < E[U_x(p')|P or P']
\]  

(16)
Using $E[U_x(a')|P \text{ or } P'] = 6\gamma_R - 2$ from equation (14) on the left-hand side of equation (16) and $E[U_x(p')|P \text{ or } P'] = 5$ from equation (15) on the right-hand side of equation (16) yields the condition $6\gamma_R - 2 < 5$ or $\gamma_R < 1.167$.

This inequality does not provide the scenario with a logical result. It is impossible that there be a 116.7% chance that the doctor is “good” in any scenario. However, it does imply there will never be a situation in which the patient will not select palliative care when recommended it in this scenario. To confirm this implication, one must examine the game tree and the cumulative payoffs it displays in Figure 5. Looking at the patient’s payoffs on the left side of the tree—the side where the doctor recommends palliative care to her patient—it is apparent that there is no state of the world where the patient will select aggressive care with that palliative recommendation from the doctor. In the state of the world where the doctor is “good”, the patient will select palliative care upon a palliative recommendation because $5 > 4$. Similarly, in the state of the world where the doctor is “okay”, the patient will select palliative care upon a palliative recommendation because $5 > -2$.

With this knowledge, one can rule out $(AA', aa')$ as a realistic equilibrium in this scenario, and since $(PP', pp')$ was deemed unrealistic in a similar manner, the game is left with $(AA', ap')$ as its primary Nash Equilibrium.

So, just by changing the $\alpha$ value of the previous scenario, the paper was again able to create a new set of equilibria, with an entirely new primary equilibrium, $(AA', ap')$. This equilibrium is in contrast to the DUN scenario’s final equilibrium of $(AA', aa')$. The consideration of respect parameters being the only difference between the two scenarios, it must have caused this change. In the DUN scenario, there was a point where the patient
would begin to consider undergoing aggressive care when he was recommended palliative care, and in the DUR scenario there is no such point. Here, one can see the patient’s respect parameter preventing him from making certain decisions.

The Counseling Scenario

While the games leading up to this point paint interesting pictures of what the doctor/patient relationship can be at the end-of life, the primary goal of this paper has been to illustrate the influence end-of-life counseling and effective advanced directives can have on that relationship. Within the following scenario, end-of-life counseling and effective advanced directives are now factors.

This scenario uses the baseline scenario as a point of reference for new parameter values. In it, the paper examines a scenario where the patient has now undergone end-of-life counseling and created an effective advanced directive before the start of the game. How this affects both the patient and doctor payoffs will be explained in the next section. For this scenario, \( \alpha \) has again been set to 0.4, and the game tree is shown in Figure 6.

Parameter Value Rationale, Counseling Scenario

For the most part, the doctor’s parameters remained at the same values indicated in the baseline scenario: \( r_d \) was set at +2, \( \alpha^g_d \) was set at +6, and \( \alpha^o_d \) was set at +4. The key difference lies in the fact that the parameters representing the realization of palliative care for both doctors are increased: \( p^g_d \) was set at +4, and \( p^o_d \) was set at +5. For the “good” doctor, this leaves her still preferring to recommend aggressive care, but now it is not quite as extreme as before. For the “okay” doctor, this leaves her now actually preferring
Figure 6: Game Tree, The Counseling Scenario
to recommend palliative care, whereas she was indifferent before. Both parameters were increased by a magnitude of 1 unit of utility. The reasoning behind these increases stems from the fact that her patient has now undergone end-of-life counseling and created an effective advanced directive. It has been shown in the literature that patients often show an increased preference for palliative care once they have done one or both of these things [3, 13, 14, 15, 27]. Therefore, the game refers to the literature that suggests doctors feel much better about taking these kind of routes and recommending them to their patients if they feel they know it is what the patient truly desires [3, 15, 23, 27].

In contrast to the doctor, all of the patient’s parameter values change once he has undergone end-of-life counseling and created an effective advanced directive. Both $a_\phi^x$ and $a_\phi^o$ were reduced: $a_\phi^x$ was set at $+3$, and $a_\phi^o$ was set at $-3$. Conversely, $p_\phi$ was increased to $+4.5$. This reduction in affinity for aggressive care and increase in affinity for palliative care reflect the literature that shows patients increasing utilization of palliative care—thereby reducing utilization of aggressive care—when they create effective advanced directives and/or undergo end-of-life counseling [3, 13, 14, 15, 27]. In addition to this, the value of $r_\phi$ was reduced to $+1$. This reduction in respect for the doctor’s opinion on the part of the patient is indicative of the patient’s increase in self-assurance. By undergoing end-of-life counseling and creating an effective advanced directive, he is educating himself further not only about what his options may be, but also about his situation in general and different outcome possibilities. Therefore, it is the assumption of this paper that while the patient would still certainly respect the doctor’s opinion, it would be to a slightly lesser degree once he has done these things. He will feel more comfortable making his own decision if he is so moved.
Analysis, Counseling Scenario

The parameter values for the counseling scenario are outlined in Table 12, and the normal form for this scenario is displayed in Table 13, with the resulting Nash Equilibrium shaded.

Table 13: Parameter Values, Counseling Scenario

<table>
<thead>
<tr>
<th>x0</th>
<th>x0'</th>
<th>x'0</th>
<th>y''</th>
<th>y'''</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>5</td>
<td>4.5</td>
<td>3</td>
<td>2</td>
</tr>
</tbody>
</table>

Table 14: Normal Form, Counseling Scenario

<table>
<thead>
<tr>
<th>D</th>
<th>X</th>
<th>a''</th>
<th>a'</th>
<th>p''</th>
<th>p'</th>
</tr>
</thead>
<tbody>
<tr>
<td>AA'</td>
<td>7.6</td>
<td>2.8</td>
<td>7.6</td>
<td>2.8</td>
<td>4.2</td>
</tr>
<tr>
<td>AP'</td>
<td>7.2</td>
<td>2.6</td>
<td>7.8</td>
<td>4.3</td>
<td>4</td>
</tr>
<tr>
<td>PA'</td>
<td>6</td>
<td>2</td>
<td>6</td>
<td>4</td>
<td>5.8</td>
</tr>
<tr>
<td>PP'</td>
<td>5.6</td>
<td>1.8</td>
<td>6.2</td>
<td>5.5</td>
<td>5.6</td>
</tr>
</tbody>
</table>

The sole Nash Equilibrium of (PP', pp') is the same result as that seen in the aggressive “okay” scenario. In it, both the “good” doctor and “okay” doctor always recommend palliative treatment. Then, the patient chooses to undergo palliative care when his doctor recommends palliative care and also in the event that his doctor recommends aggressive care.

As in the previous scenarios, the doctor always recommends palliative care in the (PP’, pp’) equilibrium. So, again, the patient is surprised if he is recommended aggressive care, and then he doesn’t know what to believe. However, upon attempting to incorporate a \( \mu \) value, one gets a similar result as to that seen with \( \gamma \) in the Deceit-is-Unlikely scenarios. After completing the analogous calculations with the patient’s expected
utilities in terms of $\mu$ and then the subsequent inequality analysis, the paper determined that the patient will choose to undergo palliative care when he is recommended palliative care for $\mu < 1.083$. As in the DUR, this condition is illogical. It is impossible for the doctor to be “good” with a probability of 108.3%. However, this condition also carries the same implication as in the $\alpha$ scenario: that there is no state of the world in which the patient will not choose to undergo palliative care when he is recommended it under these parameters. One can see this easily in a consultation of the cumulative payoff values in Figure 6. In the case of the “good” doctor, the patient prefers palliative care to aggressive care when the doctor recommends aggressive care because $4.5 > 4$. Similarly, in the case of the “okay” doctor, the patient prefers palliative care to aggressive care when the doctor recommends aggressive care because $4.5 > -2$. Therefore $(PP', pp')$ holds as a Nash Equilibrium no matter what the patient’s perceptions about the doctor may be.

It is also of note that in this scenario, the Nash Equilibrium present is independent of changes in $\alpha$’s value. Here, as in there, this fact is indicative of the doctor and patient’s mutual interests and trust. While the “good” doctor still prefers the realization of aggressive care, she is willing to put it aside because of the value she places on the patient’s respect.

**Discussion of the Model**

In the development of these scenarios, the author synthesized knowledge learned from the literature about how factors like preferences, bias, emotion, and quality-of-life play into both the doctor and patient’s decision-making processes at the end-of-life. The
model itself provides a platform for all of these variables to come together. While not all of the results were what one might have initially posited about a given scenario, and some of the results were essentially illogical, each examined scenario contained at least one feasible equilibrium. And those equilibria provide the commentary for just how all of the aforementioned factors affect the doctor/patient interaction at the end of life.

One Nash Equilibrium in particular threaded its way through almost all of the seven scenarios, although it was not always considered logical: \((PP’, pp’)\). Its stipulation is simple: both the “good” and “okay” doctors will recommend palliative care, and the patient will choose to undergo that palliative care when it is recommended to him, with the added condition that the patient will also choose to undergo palliative care in the surprise event that the doctor recommends aggressive care.

In the baseline scenarios, the condition for \(\mu\) was calculated to determine what the patient’s perceived probability of a “good” doctor needed to be for him to select \(p\) when recommended \(A\) or \(A’\). In the BN scenario, \(\mu_N\) needed to be less than 0.83 for the equilibrium of \((PP’, pp’)\) to be upheld. This result made sense because since the patient did not respect what the doctor had to say, he was basically making his care decision based solely on his own beliefs. Therefore, he would need to believe that the doctor was “good” with a fairly high probability in order for him to be willing to take the risk of undergoing aggressive care. In the BR scenario, \(\mu_R\) needed only to be less than 0.5 for the equilibrium of \((PP’, pp’)\) to be upheld. However, in light of the fact that within the game it did not make logical sense for the patient to ever ignore an aggressive care recommendation (since only “good” doctors would reasonably make them) and also that
this equilibrium was Pareto inferior to the other equilibrium in the scenario, this equilibrium was deemed unrealistic.

In both the DLN and DLR scenarios, one again encounters the \((PP', pp')\) equilibrium again, now for different reasons. In the DLN scenario, the patient is hedging his bets since he does not respect the doctor’s opinion and therefore has to make his healthcare decisions based on his own beliefs, so he selects palliative care every time out of fear. In this case the doctor is indifferent to the patient’s actions because she cannot influence her own outcomes once the patient chooses to always select palliative care. A similar result is seen in the DLR scenario, although now the doctor and patient are listening to each other. Here, the patient was motivated to always choose to undergo palliative care due to his fear of being tricked into undergoing aggressive care by an “okay” who doctor was masquerading as a “good” doctor. Both the “good” and “okay” doctors were then driven to recommend palliative care out of a desire to recommend treatment that the patient will actually select. While it is a dysfunctional outcome, it is reasonable given the situation and circumstances.

The equilibrium \((PP', pp')\) is not present in the DUN scenario, and although it is exhibited in its sister DUR scenario, it is considered unrealistic. In both of these cases, the probability of the doctor being “good” is high. Therefore, even though the patient is afraid of undergoing aggressive care with an “okay” doctor, he is willing to risk it to receive the benefit of undergoing aggressive care with a “good” doctor since the odds are on the side of the patient. There is little reason for the patient to hedge his bets by selecting palliative care in every situation.
In the counseling scenario, \((PP', pp')\) is the only Nash Equilibrium present. Here, one sees again the extreme case of only palliative care selection on the part of the patient, although now it is for different reasons. Whereas before, the patient was choosing palliative care out of the fear that he would be deceived by an “okay” doctor into undergoing aggressive care, now he is choosing palliative care out of an increased affinity for palliative medicine. So it is similarly with the doctor: whereas before both the “good” and “okay” doctors were recommending palliative medicine out of concern that it was the only advice the patient would respect, now that is only the case with the “good” doctor. The “okay” doctor is now recommending palliative medicine because it is in line with her preferences. Further illustrating the positive effect that effective advanced directives and end-of-life counseling can have on a patient is the fact that the patient’s payoff is highest within the \((PP', pp')\) of the counseling scenario than in any of the other equilibria in any of the other scenarios.

Throughout all of these scenarios, one is able to see the influence that both the patient and doctor’s value of respect can have on outcomes. An example that further emphasizes this influence can be found in the DLR scenario. As it was initially examined, the DLR scenario yielded the sole Nash Equilibrium of \((PP', pp')\). However, if one raises the patient’s respect parameter, \(r_s\), by +1, two more equilibria appear: \((AA', aa')\) and \((AA', ap')\). Here we see the patient potentially forfeiting his more ideal outcome for the sake of respect. So, one can see that while the notion of respect in the doctor patient relationship can be helpful in communication, putting too much emphasis on it can be detrimental to the patient’s well-being. It is important that the patient be informed for himself.
Limitations

By necessity, game theory hyper-simplifies situations, breaking them down to their component parts and keeping only what is most important. So, one will generally receive simple results from a game because the game itself is simple. For a relationship as complex as the one between doctors and patients at the end of life, it is impossible to incorporate all the associated factors into a game theoretic model. Furthermore, despite developments regarding the quantification of quality-of-life, there was significant difficulty in the creation of parameter values for the patient and especially for the doctor. Although the author believes the payoffs to be accurate in their representation of both patient and doctor feelings, there is need for more research on how all these factors can be incorporated into a model and then compared to one another.

Another consideration needs to be made for the sensitivity of the model to changes in the values of its variables. An example of this can be found in the baseline scenarios and their relationship to $\alpha$. In both the BN and BR scenarios, $\alpha$ was set to 0.4. It was later discovered that raising $\alpha$‘s value caused a significant change in the Nash Equilibria that were expressed. Raising $\alpha$ to 0.84 in the BN scenario caused the equilibrium of (PP’, pp’) to give way to the equilibrium of (AA’, aa’), the situation where both the patient and doctor opt for aggressive care in all cases. By contrast, $\alpha$ only needed to be raised to 0.5 in the BR scenario to see the (AA’, aa’) equilibrium, and in this situation the (PP’, pp’) equilibrium persists.

It should also be noted that the author is aware that the outcomes of these scenarios would not necessarily hold true for every person placed in the game. While they are representative of what the paper proposes the general population to be like, it is
impossible to create absolutes when dealing with emotions and especially life-or-death situations. For instance, there will be some patients who receive end-of-life counseling and then come to the conclusion that they want nothing but aggressive care and to be kept on a ventilator for an infinite amount of time, regardless of prognosis. In that event, the model created in this paper would not fit for them.
5. Implications and Conclusion

This paper began by examining the history of oncologic end-of-life care. Its deep-seated attitude against the incorporation of palliative care at the end-of-life would evolve to become more accepting of that care, but many of the sentiments felt then by doctors are still exhibited today. This tension provides for the paper a platform on which the doctor and patient interact at the end of life.

Aggressive treatment and palliative care are fundamentally different. Dr. Vincent Maida used more detailed terms to capture them: Active and Aggressive Medical Management in contrast to Conservative Palliative Management. The former was defined to be any active procedure or treatment focused on physiologic ailments, always with the primary intention of prolonging life. The latter was defined to be any form of care focused on things like symptom management, pain control, and emotional well being, usually without the intentional prolonging of life.

With this background knowledge, the paper then examined the current, high costs associated with end-of-life care in the United States today. It was shown that the majority of these costs are accrued by aggressive treatments and procedures—things like chemotherapy treatments and ventilator usage. It was also noted that often times, these types of treatments are performed by default, and sometimes contrary to what the patient may have actually wanted, but in the absence of proper documentation the doctor must do everything he or she can in order to sustain the patient’s life. The paper then sought to
explore what kind of impact that proper documentation along with the utilization of end-of-life counseling might have on the current end-of-life care landscape, turning to the existing literature.

The first study outlined in the literature review did not find any correlation between the possession of an advanced directive and a reduction in end-of-life expenditures. Although the authors of that paper did make the acknowledgment that nearly all of the advanced directives within that study were extremely vague in nature and therefore unable to communicate anything with much certainty to the doctor. This lack of communication is at the foundation of what went wrong with the advanced directives in the first study. On the other hand, the subsequent studies examined were unanimous in their correlation between a patient either possessing an advanced directive or having undergone end-of-life counseling and a great reduction in expenditures at the end of life and a great improvement in quality-of-life at the end of life. The key here was that these two tools had to be very thorough and effective in their implementation.

While these studies address patient quality-of-life and other intangible factors to a degree, their primary measure of success is monetary. This convention makes sense in that money is quantifiable and it is comparable across scenarios. However, when dealing with healthcare and especially end-of-life care, thinking about things in a strictly fiduciary sense can be dangerous. At its extreme, it leads to talk of death panels; and at its minimum, it is insensitive to the patient. Things like the McGill Quality of Life Questionnaire are useful in allowing researchers to measure outcomes in quantifiable values besides just what the bottom line may be in a given scenario.
The primary purpose of this paper was to create a game theoretic model of the doctor/patient relationship at the end of life. In doing this, it synthesized the patient’s QOL with a number of other psychosocial factors and predicted what decisions both the doctor and the patient will make in different scenarios.

The game involved asymmetric information on the side of the doctor within what is known as a signaling game. In the game, there were two states of the world: one in which the doctor was “good” and one in which the doctor was “okay”. Only the doctor knew the state of the world in which the game was played. The doctor then recommended to the patient palliative or aggressive care, and the patient could accept or reject the physician’s advice. While the patient garnered utility from undergoing aggressive care with the “good” doctor and also from undergoing palliative care with either party, the patient always derived disutility—that is, negative utility—from undergoing aggressive care with the “okay” doctor. In the respect scenarios, all parties gained utility from the patient choosing the same treatment route as the one recommended by the physician; and in the scenarios without respect, they remained indifferent.

The BN scenario showed the patient not respecting the doctor’s recommendations, and therefore the outcomes were spread across the board. Two of the equilibrium yielded the same result, but they had different ways of getting there. In one, the “good” doctor recommended aggressive care, and the “okay” doctor recommended palliative care, with the patient following each doctor’s recommendation. In the other, the “good” doctor recommended palliative care, and the “okay” doctor recommended aggressive care, now with the patient opting for the opposite of each doctor’s advice.
There was also a situation where the patient always selected palliative care, and the doctor’s always recommended it.

The BR scenario was simpler. It presented a situation where the doctor and patient would end up cooperating. The “good” doctor would recommend aggressive care and the “okay” doctor would recommend palliative care, with the patient respecting each of the doctor’s recommendations—this was the ideal situation for all parties involved within this scenario.

The following four scenarios introduced the concept of deceit, where the doctor now did not want the patient to know her type. This was because the “okay” doctor now preferred aggressive care even more strongly than the “good” doctor, and the patient was averse to that outcome. In the DLN scenario, the probability of the doctor being “good” was low. Since the patient did not respect the doctor’s opinion, he instead used his exogenous beliefs to help make his decision regarding care. He selected to always undergo palliative care as a way to protect himself in the face of an uncertain type of doctor. In the DUN scenario, the probability of the doctor being “good” was made significantly higher. Here, the patient’s perception of this probability caused him to be willing to take the risk of perhaps dealing with an “okay” doctor and select aggressive care in every situation. He did this in order to reap the benefits of undergoing aggressive care with a “good” doctor, which was highly probable given the value of $\alpha$.

The DLR scenario was very similar to the DLN scenario except now the patient was listening to his doctor. It yielded the same result in that both the patient and doctor opt for palliative care in every situation, but now there was more reasoning behind it. Here, both the “good” and “okay” doctors ended up recommending palliative care.
because they knew that it was the only recommendation the patient would comply with in light of his fear that the “okay” doctor would trick him into undergoing aggressive care. In the DUR scenario, a comparable outcome was seen to that of the DUN scenario. Here, in what was determined to be the logical equilibrium, both the “good” and “okay” doctors would recommend aggressive care, and the patient would select aggressive care upon that recommendation, and even if he was surprised by a palliative care recommendation.

The counseling game incorporated many of the factors seen in the literature examined in the first sections of the paper and had a very pleasant outcome. Both the “good” and “okay” doctors would recommend to the patient palliative care, and the patient would choose to undergo palliative care when it was recommended to them. Unlike in the aggressive “okay” scenario’s similar outcome, here the patient is choosing to undergo palliative care as a result of his own sheer preference and not out of fear that he will be deceived into doing something he does not desire. It is also of note that the patient derives his highest utility in the model from the outcome of the counseling scenario—in the situation where he undergoes palliative care in every state of the world as a result of his own, unforced choices.

It should be noted that it is not the argument of this paper that everyone should undergo palliative care in every situation—that is a decision that should remain in the hands of the patient after consulting with his or her doctor. However, this paper has effectively demonstrated—through both its model and a review of the literature—that effective advanced directives and counseling are key to increasing the patient’s quality-of-life at the end of life. By educating patients, end-of-life counseling allows them to make more informed decisions, no matter what that decision might be. It is true that end-
of-life counseling has been shown to increase the utilization of palliative care at the end of life, thereby reducing expenditures. However, it is important to remember that this is not a government or insurance company mandated reduction in spending. Rather, these are patients deciding to spend less for their own benefit, for the betterment of their own quality-of-life. It is the desire of this paper that palliative care continue to gain more visibility via end-of-life counseling and the creation of effective advanced directives. All of this is so patients can continue to make their own informed decisions as to what is best for each of their respective situations.


14. McCarthy, Ian M., PhD, Chessie Robinson, MS, Sakib Huq, Martha Philastre, and Robert Fine, MD. "Cost Savings from Palliative Care Teams and Guidance for a Financially Viable Palliative Care Program." *Health*


