R$_x$-Decision: A Decision Support Tool for the Optimal Prescription Drug Plan for Patients

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Abstract—**The healthcare system in the United States is undergoing changes aimed at affordable care, but the complexity of the healthcare industry prevents patients from making optimal healthcare and insurance decisions, and achieving the full potential of healthcare reform. As a consequence of healthcare reforms, digital medical records have facilitated the widespread availability of publicly available, statistical data. Feeding the pool of expanding data is the patient-doctor interaction; averaging twenty minutes, physicians assess the patient's complaint and prescribe a course of action. Pharmaceutical and insurance companies work together to build suitable products for consumers. The intricate relationships in the healthcare industry exacerbate the runaway healthcare costs facing the American public. The data collected provides the basis for a decision support tool for patients to compare and rank Medicare Part D Prescription Drug Plans based on a patient's individual situation and preferences. The tool will provide explicit information that will assist the patient in determining the most suitable prescription drug plan, taking into account the individual importance of plan attributes. Utilizing historic data, comparisons on prescription spending will be made to past patients who have a similar health-profile as identified by the current patient. The results of the tool will change for every user, based on their health profile. Along with the plan rankings, the tool also relays the monthly premium, deductible, number of prescription drugs covered, and estimated savings based on selected plan. Savings per patient averaged $1,243 per year, with a range from -$322.40 to $1,978.10. Tools such as the one described in this paper enable patients to make decisions with a full understanding of choices, associated risks, and sensitivities.**

I. INTRODUCTION

THE national deficit has reached levels never seen before, maybe even unsustainable in the future. The healthcare system has been a leading contributor. Healthcare expenditure in the United States has increased dramatically over the past three decades. In 2007, the Organisation for Economic Co-Operation and Development (OECD) compiled a report showing each country's health expenditure as a share of their GDP; of which the U.S. was nearly double the OECD average, as shown in Fig. 1. "Expenditures in the United States on health care surpassed $2.5 trillion in 2008,

more than three times the $714 billion spent in 1990, and over eight times the $253 billion spent in 1980" [1]. This is a dramatic change that cannot be ignored.
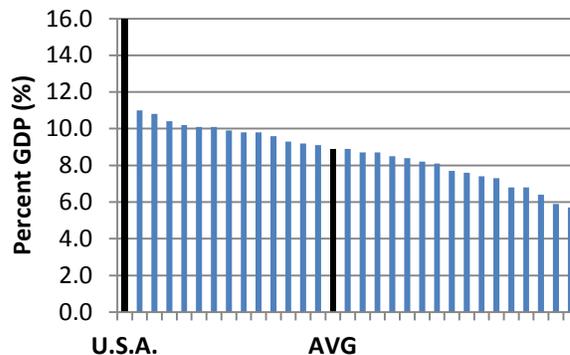

Fig. 1. Health expenditure as a share of GDP, OECD countries, 2007. Illustrates how the U.S. (left-most bar, 16% of GDP) spent almost 50% more than the average of 34 countries (center bar, 8.9% of GDP) on healthcare.

Healthcare reform has brought numerous changes to the industry, such as the availability of data. Electronic Medical Record (EMR) systems have enabled a heightened understanding of the effects of healthcare and the industry as a whole. Legislation passed by President Obama in March, 2010 (Affordable Care Act) provides incentives for physicians to implement the use of EMR systems; as much as $40,000 to lessen the burden of their initial costs [2].

The promotion and implementation of EMR systems will aid in creating a National Health Information Network (NHIN). This idea of interoperability will allow for further information transfer in order to scientifically study the broad range of effects encompassing the healthcare industry. It has been the use of EMR systems that have created the mass quantities of data available to the public. The CMS has compiled the PUF dataset using 2008 claim information [3].

A. Choosing an Insurance Plan

The optimal insurance policy for a patient would include the greatest coverage with the lowest monthly premium. This is not realistic; thus the customer must look at their individual situation and place importance levels on each aspect that comprises an insurance policy. Insurance is a contract between the customer and the company. They promise to provide services in exchange for premium dollars. Insurance companies provide pre-determined packages of coverage to their customers, and can be very different from company to company, or region to region. A

tradeoff analysis must be done for each potential insurance customer.

B. How Medicare Part D Works

Medicare uses private insurance companies to offer individual prescription drug plans (PDPs). Due to this regulated relationship and the nature of our economy, monthly premiums for a PDP can vary widely. Not all plans cover the same medications, offer them at the same rate, and coverage of the medications may change during the service plan.

PDPs are offered as stand-alone plans with pricing based on the insurance attributes that define the PDP (drug formulary, deductible, cost sharing, gap or doughnut hole coverage, etc.). The four phases of a basic PDP with a $320 deductible, cost sharing, gap coverage, and catastrophic coverage is shown in Fig 2.
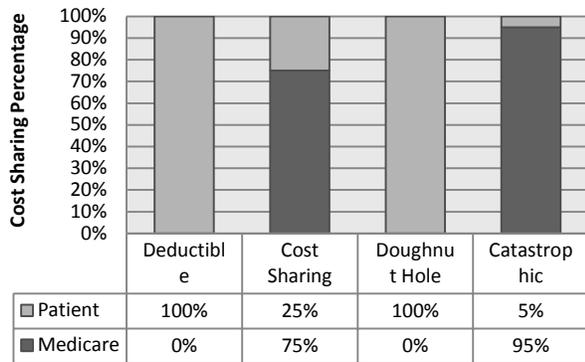
	Deductible	Cost Sharing	Doughnut Hole	Catastrophic
▢ Patient	100%	25%	100%	5%
▪ Medicare	0%	75%	0%	95%

Fig. 2. Cost sharing of a Medicare Part D PDP, illustrating the "Doughnut Hole" in which a patient receives little coverage.

The first phase is the deductible phase, whereby the patient must pay the first $320 for all covered expenses. The second phase begins the cost sharing phase; Medicare covers expenses on a cost sharing basis (either by way of co-pay or a co-insurance split). During the cost sharing phase Medicare continues sharing the cost until total prescription costs reach $2,930. The third phase is the "doughnut hole". Prior to 2012 Medicare did not cover any prescription costs during this phase. The Affordable Care Act has implemented a time-phased approach to reduce the burden on the patient; currently offering a 50% reduction in brand-name drug cost and 14% reduction in generic drug cost for the next $4,700 in total drug cost [3]. The fourth phase is the catastrophic coverage phase. This phase has no upper limit of coverage, and Medicare offers up to a 95% reduction in drug cost.

II. STAKEHOLDER ANALYSIS

A. Patients

In 2005, chronic conditions contributed to 7 out of 10 deaths. Heart disease, cancer, and strokes account for more than 50% of deaths each year [4]. The U.S. population is using more healthcare services, including the physician services, hospital care, and the use of prescription drugs [5].

Currently, there is no software, or tool, that consumers can use to find the most effective prescription drug plan from all the plans available. There is a lack of consolidated public information about healthcare coverage plans and their providing companies. Individuals must call these companies, or sign-up online, and reveal a multitude of personal information in order to get information about the plans for which they qualify. There is no comparison shopping or information about competitor plans, which leaves many consumers under-informed, often frustrated, and unable to make the optimal decision; thus adding to the runaway healthcare costs.

B. Physicians

Physicians are entrusted to abide by the Hippocratic Oath; obligating them to practice medicine ethically, and for the betterment of the health of their patients. Physicians want to reduce their administrative, managerial, and operational costs. Since throughput of patients equates to more money, increasing efficiencies in day-to-day operations is important to them.

"In order to promote sales, drug firms create financial relationships that influence physicians' prescriptions and sometimes even reward physicians for prescribing drugs. There are three types of rewards that are offered in this relationship: kickbacks, gifts, and financial support for professional activities" [6].

"Drug firms have paid kickbacks for prescribing drugs, purchasing drugs, switching brands prescribed, adding a drug to a hospital formulary, enrolling patients in post-marketing clinical trials, and writing practice guidelines that encourage the use of certain drugs" [6].

In 2007, the Senate Committee on Finance investigated industry-funded Continuing Medical Education (CME) and concluded that the latest standards by the Accreditation Council for Continuing Medical Education (ACCME) were inadequate because the "provider can technically maintain 'control' of content…while continuing to accommodate suggestions from the companies that control their funding," thereby "afford[ing] drug companies the ability to target their grant funding at programs likely to support sales of their products" [7].

C. Pharmacy Benefit Managers (PBMs)

Pharmacy benefit managers (PBMs) are part of private companies that administer pharmacy benefits and manage purchasing, dispensing, and reimbursing of prescription drugs. These PBMs provide their services like private consultants working for health insurers, large healthcare purchasers (e.g. public employee systems), government agencies, and labor union trust funds. PBMs negotiate rebates and discounts from pharmaceutical manufacturers, process claims for prescription drugs, negotiate price discounts from retail pharmacies, develop formularies, and manage utilization of certain drugs through previous authorization or utilization reviews.

PBMs are contracted to manage the prescription drug benefits of the plans that cover participants in the Federal

Employees Health Benefits Program (FEHBP), the largest employee-sponsored health insurance program in the US, which covers "most federal employees, retirees, and their dependents" [8].

Recently, PBMs had an unparalleled, egregious record of consumer protection violations that have resulted in hundreds of millions of dollars in damages to states, plans, and patients. Between 2004 and 2008, the three major PBMs have been the subject of six major federal or multidistrict cases over allegations of fraud, unjust enrichment through secret kickback schemes, failures to meet ethical and safety standards, and misrepresentation to plan sponsors, patients, and providers.

D. Insurance Providers

Insurance companies offer packages of coverage to consumers through agreements of regulation and contracts with the U.S. Insurance companies want to cover as many people as possible, while providing optimal levels of coverage. In doing so, this stakeholder attempts to promote low cost procedures and low cost prescription drugs, attempting to profit from the insurance premiums.

Districting the availability of plans enables providers with the ability to market one family of plan while not another, based on geographic restrictions. For example, in the state of Virginia, Anthem does business as part of Blue Cross and Blue Shield (BCBS), but its service area is the "State of Virginia except for the City of Fairfax, the Town of Vienna, and the area east of State Route 123" [9].

III. PROBLEM STATEMENT, NEEDS STATEMENT, AND SYSTEM SCOPE

A. Problem Statement

Patients are not making the optimal health decision regarding their physical and financial well-being due to the high level of complexity in the options with which they are faced (e.g. insurance options are numerous and coverage is diverse). Secondly, there is a high level of uncertainty regarding the prescribed course of action.

B. Needs Statement

A decision support tool (DST) is needed in order to inform the consumer of currently available PDPs and the attributes that constitute them. The DST is needed to consolidate information across the insurance carriers that Medicare has entrusted to serve the public, minimize the time spent doing research, and answer questions about Medicare plans, products, and the covered regions.

C. System Scope

As each insurance carrier offers different plans, to different regions, at different costs, covering different aspects of a patient's medical need, certain scoping assumptions need to be made:

1) *Plans Available:* We have limited our search for PDPs to the state of Virginia. Virginia has 30 stand-alone Medicare Part D PDPs available to the consumer. The PDPs forming the trade-space offer multiple levels of plan attributes from which the DST will compile results.

2) *Formulary List:* The formulary (medications covered) list is given by the number of medications covered by the individual plan. We assume economies of scale.

3) *Previous Customer Experience Ratings:* The star rating used by the listing of available plans in Virginia has been converted to a scale of 1-5. We assume economies of scale.

IV. METHOD OF ANALYSIS

A. Primary Data Source

The primary data source used for this decision support tool was a 2008 Public Use File (PUF), which was supplied by the Centers for Medicare and Medicaid Services (CMS). The PUF was designed so that utilization of various Medicare services can be compared for different types of beneficiaries. The data includes information for Medicare Part A, B, C, and D pulled from over 23 million patients with chronic illnesses. Since this support tool is a tool to help select the most suitable prescription drug plan, all useful data was pulled from the Medicare Part D section (prescription drug coverage), and all other data was disregarded, as it was deemed unnecessary for this analysis. Useful data extrapolated from the PUF includes Medicare Part D information on the count of beneficiaries, the average number of prescriptions per beneficiary, and the average drug cost per beneficiary. The PUF itself contains over 16,000 data points, each containing averages derived from the aforementioned patients based on unique combinations of age, gender, and chronic illnesses and each unique combination makes up one PUF profile. Each unique PUF profile can then be assessed by the decision support tool to see whether or not there is a match with the current user input. Once the tool finds a match between the current user and a PUF profile, analysis is performed and information is relayed to the user based on historical data from the PUF.

B. Description of the Tool

The DST is designed to help patients choose the most suitable Medicare Part D PDP. The tool requires the user to numerically rank their preferences of insurance attributes based on personal importance of previous customer experience (of insurance company), plan cost, and formulary choices. Within these three attributes, the tool further breaks into the sub-attributes of previous experience and plan cost. Previous experience is broken down into satisfaction rating, customer service, member plan experience, and prescription cost rating. Plan cost is broken down into premium, GAP coverage, cost sharing (co-pay/co-insurance), and deductible. Once the tool has all the user's preferences and rankings for their plan attributes, weights are given to each plan attribute and analysis is performed.

The following top-tier objectives are considered from the decision criteria:

1) Previous Patient Experience (Higher => Better)
2) Formulary Coverage (Higher => Better)
3) Cost of Plan (Lower => Better)

These top-tier objectives were measured by normalizing each objective linearly on a scale of 0 to 1 using the following equation, with Raw Rank = rank given by the patient, worst = lowest ranked attribute score, and best = highest ranked attribute score (1):

$$R(x) = \frac{RawRank - Worst}{Best - Worst} \qquad (1)$$

Mean Reciprocal Rank (2) is used to rank the attribute's importance in selecting the desired insurance plan. Mean Reciprocal Rank (MRR) is a statistical method to measure the performance of the predicted results [10].

$$MRR = \frac{\sum \frac{1}{Rank_i}}{\# ofRanks} \qquad (2)$$

Mean Reciprocal Rank (MRR) has been used in matching queries, search engines, matching the profiles from the databases, and many more.

Overall weights for each objective are measured by using the sensitivity analysis for weights formula (3):

$$w_j = (1 - w_i)\left(\frac{w_j^0}{\sum_{k \neq i} w_k^0} \right), \Box j \neq i \qquad (3)$$

C. Sensitivity Analysis

Sensitivity analysis is used to validate the model to calculate a wide range of possible plan rankings. There were three combinations under which the sensitivity analysis was conducted:

1) Attribute rankings were equally distributed
2) Attribute rankings were incrementally distributed
3) Two attribute rankings were tied

The results relayed to the user by the tool include the most suitable PDP, as determined by the utility function and the estimated yearly drug costs, based on both the historical data and the user input.

D. Decision Tool Output

The results relayed to the user by the tool include the top 10 most suitable prescription drug plans as determined by the utility function, the monthly premium, deductible, and number of drugs covered by each plan. Also displayed are their estimated yearly drug costs based on past data and user input, as well as an interactive graph where users can select one of the top 10 ranked plans from a dropdown menu, and perform a direct comparison of their annual out of pocket

drug cost (assuming no insurance coverage) and their out of pocket cost to the selected insurance plan. Users can see where the two cost curves intersect and can determine the approximate month that they will hit a breakeven point, and their insurance costs will either surpass or reduce their out of pocket drug costs. All of this output combined gives the user more knowledge and insight when making their final decision on selecting a Medicare Part D PDP. A portion of the decision tool output can be seen in Fig. 3-5.

Recommended Insurance Plan Based on User Preferences				
Top 10 of 25 Coverage Plans That Fit Your Monthly Budget				
Plan Ranking	Plan Name	Plan Advantages		
		Monthly Premium	Deductible	Number of Prescription Drugs Covered
1	Health Net Value Orange Option 2	$69.00	$0.00	3,995
2	Health Net Orange Option 1	$33.00	$320.00	3,995
3	AARP Medicare Preferred	$36.00	$0.00	3,614
4	Humana Enhanced	$37.60	$0.00	3,799
5	CIGNA Medicare RXx Plan Two	$62.30	$0.00	3,531
6	Medco Medicare Prescription Plan	$41.40	$320.00	3,178
7	Aetna Medicare Rx Premier	$78.10	$0.00	3,158
8	CIGNA Medicare Rx Plan One	$27.70	$320.00	3,363
9	United American-Preferred	$47.60	$100.00	3,249
10	Blue MedicareRx Plus	$68.00	$0.00	3,245

Fig. 3. Sample output: 10 highest ranked coverage plans based on user defined insurance preferences. Listing shows monthly premium, deductible, and the number of drugs covered by the plan.
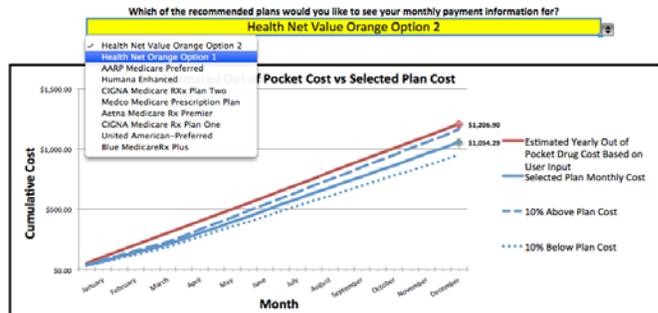

Fig. 4. Sample output: dropdown menu where users can select a different plan to compare yearly plan cost with out of pocket drug cost.
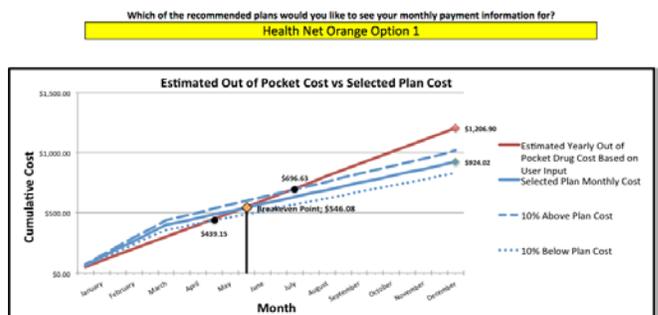

Fig. 5. Sample output: graphical comparison of plan with high deductible vs. out of pocket prescription drug costs. Breakeven point shown where cost curves intersect and insurance cost undercuts out of pocket drug cost. In this example the breakeven point is in May.

V. TASK ANALYSIS

Before using the DST, the patient should have access to pertinent information in order to complete the tool. The decision support tool is comprised of five user-related windows (i.e. Introduction, Personal Information, Chronic Illness, Insurance Information, and Results).

In the introduction tab, the tool has a brief overview of the tool and what the tool will provide to the patient, as well as a disclaimer that our tool does not replace discussing individual options with an insurance professional. The patient need only provide gender, age, and the state of residence (this paper scoped the prescription drug plans to Virginia). In the Chronic Illness tab, patients will select the chronic illness(es) that they are currently taking medications to treat or control. In addition In the Insurance tab, the patient will provide compulsory information, such as number of prescription taken and then rank the cost and coverage attributes. In the results tab, patients can go through the ten ranked PDPs formulated by the DST, the average prescription cost per year and the estimated out of pocket costs versus the selected drug plan cost.

VI. SIMULATION RESULTS

Utilizing Crystal Ball, Monte Carlo simulations were performed; 10,000 trials. Crystal Ball entered random values based on assigned distributions to the assumptive parameters of the simulation (see Table I). Each trial was completed by choosing a random health profile from the PUF (thus using real combinations of chronic conditions, average number of prescriptions per person, gender, and age cohort). Discrete uniform (DU) distributions were selected as there is equal likelihood that plan attributes will be ranked consecutively, equally throughout, or with ties.

TABLE I
ASSIGNED DISTRIBUTIONS FOR PDP ATTRIBUTES

Assumed Parameter	Distribution
Tier I-Price	DU(1,3)
Tier I-Previous Experience	DU(1,3)
Tier I-Formulary Listing	DU(1,3)
Tier II-Monthly Premium	DU(1,4)
Tier II-GAP Coverage	DU(1,4)
Tier II-Cost Sharing	DU(1,4)
Tier II-Deductible	DU(1,4)

The simulation is designed to show the range of rankings that each of the 30 PDPs will encounter during each of the 10,000 trials. Upon completion it was determined that the same PDPs were continuously ranking in the top 5 (see Fig. 6). Thus, an additional user-defined criterion was added to the DST; asking what the maximum monthly amount the user is willing and able to pay for any PDP. The distribution used was DU(1,10) giving equal likelihood that a user will choose one of the ten dollar cohorts (e.g. $35-$44, $45-$54, etc.). The additional question allowed for more PDPs to break into the top 10 (see Fig. 7).
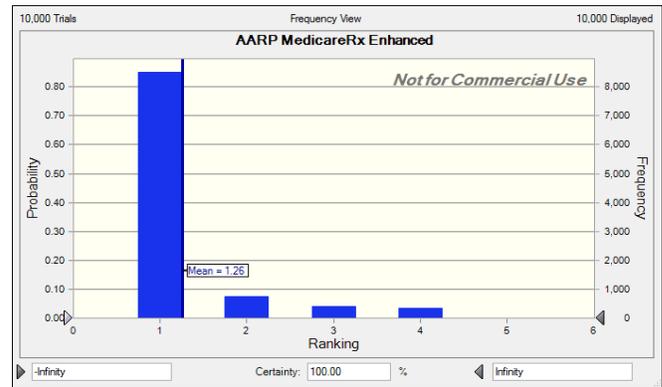

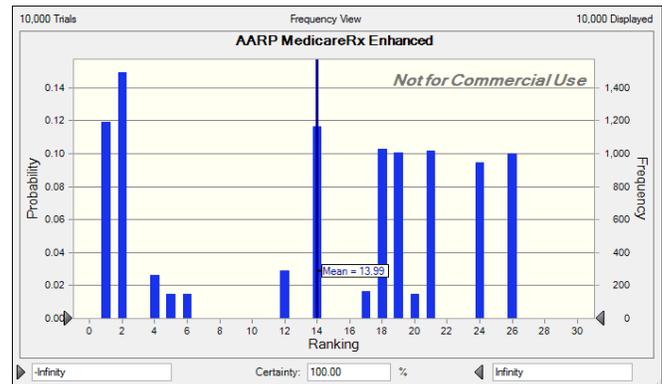Fig. 6. Simulation results showing AARP ranking mean = 1.26 and the rank ranging from 1-4.

Fig. 7. Adjusted Simulation showing AARP ranking mean = 13.98 and the rank ranging from 1-26.

The estimated savings for the user was also captured during the simulation (see Fig. 8). The plan chosen to estimate the user's savings was chosen from the top ten ranked plans randomly using a random number generator during the iteration.
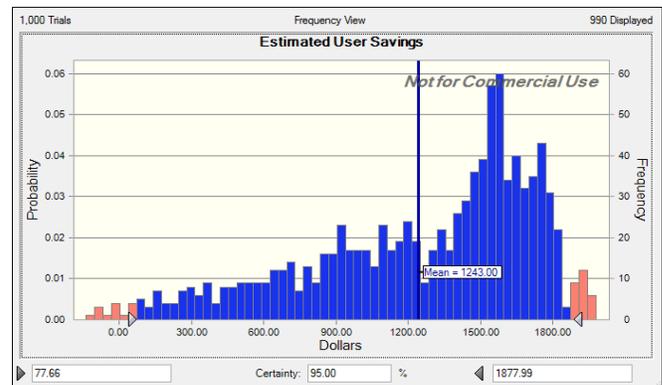

Fig. 8. Estimated Savings using profiles within PUF dataset provided by CMS. Estimated savings was $1,243; with a full range of -$322.40—$1,978.10.

VII. USABILITY

In performing usability tests, the rights of the human subjects need to be protected. The Human Subjects Review Board (HSRB) has been charged with the mission of assuring "that the rights and welfare of human research subjects are adequately protected" [11].

There are circumstances whereby exemptions for the need to apply for approval from the HSRB are allowed. Of the six, item four qualified the DST described herein for exemption under the qualification that sources were publicly available, and the recorded information creates an unidentifiable piece of data.

The test was designed to evaluate the intuitiveness and understanding of the tool. The test was administered to subjects with a minimum age of 55 years. The subjects participated in a timed run through of the DST, and then were expected to complete a questionnaire in relation to their individual results (i.e. find costs, interpret graphical output, etc.). See Table II for test hypotheses.

TABLE II
HYPOTHESES AND TEST RESULTS OF USABILITY TEST

Test-Hypotheses	Test Results
Time to Complete DST: • H_0: $\mu = 20$ minutes • H_A: $\mu > 20$ minutes	T-test Results: • $t_0 = -10.500$ vs $t_{.05, 10} = 1.812$ • **DO NOT REJECT H_o**
Time to Complete Questionnaire: • H_0: $\mu = 5$ minutes • H_A: $\mu > 5$ minutes	T-test Results: • $t_0 = 3.710$ vs $t_{.05, 10} = 1.812$ • **REJECT H_o**
Evaluation of Questionnaire: • H_0: $\mu = 2$ incorrect • H_A: $\mu > 2$ incorrect	T-test Results: • $t_0 = -3.180$ vs $t_{.05, 10} = 1.812$ • **DO NOT REJECT H_o**

Since the test shows the rejection due to time to complete the questionnaire, but not the amount of errors in questionnaire and time to complete the DST, we can conclude that the tool is easy to use, results are easy to interpret, but the results tab is too complex to interpret given a 5-minute time limit.

VIII. CONCLUSION

Data availability is increasing within the healthcare industry. Privacy related to this data will continue to draw the attention of industry, regulators, and the public alike. Incentives, such as those delineated in the Affordable Care Act, will continue to enable the collection of data now, and in the future.

By bringing data collection services together, patients and the general public will benefit from the knowledge it can provide, given a no-obligation query system that brings competitor data together in a place that allows the user to research their financial health options without the biased approach currently available.

We recommend the designed DST be implemented in the waiting rooms of physician offices; given the ease of use, and quick time to complete the survey. As more physician offices implement EMR systems, our DST can be upgraded to interface with the EMR system in order to pre-populate a user's information to offer the most up-to-date results.

Secondly, we recommend the DST be implemented on the websites of the insurance carriers contracted by CMS to offer PDPs. This will allow the user to compare all plans in their selected region, thus breaking the barrier to the insurance industry.

In the future, the authors would like to expand the research to include PDPs offered throughout the United States. Further research is also needed in order to include Medicare Part C, Advantage Plans and Special Needs Plans, which concentrate their offerings directly to those afflicted with the chronic conditions plaguing Americans.

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