RISK ASSESSMENT AND MANAGEMENT TO ESTIMATE HOSPITAL CREDIBILITY SCORE OF PATIENT HEALTH CARE QUALITY

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1 Introduction

The purpose of this chapter is to study how to assess patient-centered health-care quality and as a follow-up, how to mitigate the unwanted risk to a tolerable level, through automated software utilizing game-theoretic risk computing. This chapter overall seeks methods about how to improve patient-centered quality of care in the light of uncertain nationwide health care quality mandate to disseminate and utilize results for the "most bang for the buck". A patient-centered composite 'credibility' or 'satisfaction' score is proposed for the mutual benefit of patients seeking quality care, and hospitals delivering the promised healthcare, and insurance companies facilitating a financially accountable healthcare. Patient-centered quality of care risk assessment and management are inseparable aspects of health care in a hospital, yet both are frequently overlooked. In Alabama State, a 2004 study by the Kaiser Family Foundation found substantial dissatisfaction with the quality of health care. In response to whether they were dissatisfied with the quality of healthcare, 44% of Latinos, 73% of Blacks, and 56% of Whites said "Yes". When asked whether health care has gotten worse in the prior five years prior, 39% of Latinos, 56% of Blacks, and 38% of Whites reported dissatisfaction [1].

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Being overly optimistic, and not considering or preparing for possible detrimental events could be severely damaging to both the patient and hospital management. Characterizing and assessing the patient-centered quality of care (service) risk situation or how to cost-optimize the undesirable risk to a tolerable level within the available budgetary and personnel resources, is not a task one can simply over- or underestimate using a hand calculator. To address this need, the authors will investigate the foundational aspects within an associated automated software tool for cost efficient quantitative risk management. The primary author's innovation, i.e. RoM (Risk-O-Meter), will provide a measurable patient-centered quality of care risk, associated cost, and risk mitigation advice for vulnerabilities and threats associated with automated management of health care quality in a hospital or clinic. The RoM will be demonstrated to assess and enhance quality in the case of an ambulatory or non-ambulatory patient seeking health care at a local hospital. The Quality of Service (QoS) or conversely Risk of Service (RoS) out of a scale of 100 will be estimated [2]. The RoS metric will be followed up by a cost-optimized game-theoretic analysis of how to bring an undesirable risk to a tolerable level by determining what priorities to be taken for which cautionary actions prioritized [3].

The purpose of this chapter is to study how to assess the quality (of care) which is defined as a measure of the ability of a doctor, hospital or health plan to provide services for individuals and populations that will increase the likelihood of desired health outcomes. These said outcomes are to be consistent with current professional medical knowledge. Good-quality healthcare means doing the right thing at the right time, in the right way, for the right person and getting the best possible results. According to the mantra for the quality improvement movement [4], care should be "safe, effective, patient-centered, timely, efficient and equitable."

To achieve quality improvement, methods should be available to determine "Quality Measures" as the mechanisms used to assign a "quantity" to wellness of care by comparison to a criterion, which in our case constitutes "patient-centered healthcare quality satisfaction" [5]. This chapter aims for these mechanisms through automated software. The chapter content aims to mitigate risk and minimize the risk-mitigating investment costs to achieve goals.

In the healthcare context, the goal of quality improvement strategies is for patients to receive the appropriate care at the appropriate time and place with the appropriate mix of information and available supporting resources. In many cases, healthcare systems are designed in such a way as to be overly cumbersome, fragmented, and indifferent to patients' needs. The patient centered approach is the newest model of many to come down the halls of medical care. The new approach involves a care team, rather than being physician centric, i.e. the pharmacist, primary care doctor, psychologist, pharmacist, dietician, and nurse, seeing multiple patients in a group setting. The co-author's prediction is that this approach may be very useful (that is shared appointments) in certain patients, especially in terms of education efforts.

Quality improvement tools range from those that simply make recommendations but leave decision-making largely in the hands of individual physicians (e.g. practice guidelines) to those that prescribe patterns of care (e.g. critical pathways). Typically, quality improvement efforts are strongly rooted in evidence-based procedures and rely extensively on data collected about processes and outcomes. This is what the proposed algorithmic software will achieve through an aggregate data collection by running quality risk assessment and risk mitigation using non-subjective risk priority optimization.

2 Motivation

According to the National Healthcare Quality Report (NHQR) of 2007, the quality of healthcare has only improved at a modest pace; and more importantly the rate of improvement appears to be slowing [5]. Additionally, an important goal of improving healthcare quality is to reduce variations in the quality of care delivery from state to state. Ideally, patients would receive the same high level of quality care regardless of state [6]. The difference between the best and worst performing states, however, can be dramatic as in the NHQR example of diabetes-related hospital admissions (14 times more frequent for worst performing vs. best performing states). Reducing such variation is critical to cost savings. In the case of diabetes-related hospital admissions, had all states been at the level of the best performing states, 39,000 fewer patients would have been admitted with a cost savings of $217 million, according to NHQR. And that is merely for one outcome of just one condition. Another example is the cost attributable to medical errors in lost income, disability, death, and the accrual of additional healthcare costs. That alone is estimated to be $17 to $29 billion [7]. Extrapolating from these two examples, potential cost savings of several hundred billion dollars over several years can be envisioned [8]. On the national front, a recent article in the Wall Street Journal highlights the need for hospitals to ensure high quality patient-centered care, particularly in emergency rooms (ER) [9]. The intense and frequently chaotic nature of ER settings, which lack substantial patient data, makes precise patient diagnosis difficult. Anywhere from 37% to 55% of ER-related malpractice suits stem from these diagnostic errors. It is estimated that such malpractice suits cost over $1 billion in 2009 alone. This proposed algorithmic software, RoM, signifies a critical need for enhancement of patient-centered care quality which will be equally beneficial to hospital quality standings, and nation's rising healthcare costs to avoid misuse, underuse and overuse of equipment and facilities.

So what can be done to improve the delivery of patient-centered quality of care nationally as well as across all states? This is the ultimate goal where automated software is needed and implemented.

One of the primary functionalities of the NHQR is to track improvements in providing safe healthcare. Such tracking is difficult, complex, and must be context-sensitive. The NHQR of 2007 states, "There is still much room for progress in advancing the development of better measurement tools that can help assess whether Americans are obtaining true value in healthcare." What measurement tool is available that can provide this progress?

The answer in part to the above questions is the proposed Risk-o-Meter (RoM). This tool will aid in the improvement of patient-centered quality of care delivery with two critical functionalities:

1) The RoM will provide an objective, extensible, and adaptable means for tracking the quality of care improvement rate at both the state and national levels.

2) Further and most importantly, the RoM will identify areas that threaten the delivery of patient-centered quality of care and identify appropriate and cost-effective means to counteract those threats. *No other existing technology provides these unique traits of both cost-savings and improvement of care. The existing ones all fall short of these qualifications* [10].

It is increasingly vital that hospital physicians, other clinicians and auxiliary personnel understand the healthcare system’s quality requirements so that they can advocate effectively for their patients and actively assist in health system improvement efforts. The input set of the RoM is an input diagnostic questionnaire designed to measure quantitative attitudes among medical professionals, both clinicians and clinicians-in-training and auxiliary personnel such as nurses, and pharmacists and others, towards aspects of quality of medical practice associated with managed care. This detailed, yet unobtrusive information-gathering quality-control questionnaire includes close-ended opinion statements that could propel changes in the healthcare system, the involvement of alternative health plans, and effective techniques for managing the care of patients and populations. This study also plans to make the algorithmic survey available to UAB (University of Alabama at Birmingham, which controls the Baptist Health System) medical school faculty as a positive instructional tool to educate students, and shape operational attitudes and opinions about the patient-centered healthcare system in which they will eventually practice.

A number of institutions have established their own Health Assessments such as the Mayo Clinic and Tufts Health Care Institute's Online Content Pre/Post Assessment. In contrast to the existing assessments, this chapter’s focus is to provide a generic assessment of a patient’s quality of healthcare, once that patient is out of the hospital where he/she was supposed to have been treated to his/her full satisfaction. Interviews with commercial healthcare corporations indicate that there is no such dynamic and interactive tool on the market being used for this purpose [10].

In summary, the study provides healthcare executives and decision makers with an easy, objective, quantitative “patient-centered quality of care risk” assessment and management tool, RoM. In addition to providing an assessment of IT resources vulnerabilities, the RoM offers an objective mitigation advice list in the form of specific recommendations and dollar-based figures about how to enhance quality. Therefore, the RoM is a unique tool that offers healthcare decision makers an innovative alternative in terms of assessing the quality of patient care in a hospital setting. The tool provides specific, practical advice to mitigate the identified vulnerabilities. It also provides a mechanism for the allocation of funds with dollar figures and priority orders to mitigate risk [11]. Working recursively, RoM users can see how much they have lowered their risk so as to take further countermeasures to recursively reduce the risk. This signifies a nonstop 24/7 surveillance and unobtrusive information gathering activity from the actual patients who have entered their hospital portal to take RoM's "satisfaction questionnaire." Therefore, we need a patient-centered quality of care risk assessment device in a non-ambulatory hospital setting, provided the target risk we are after is numerically measurable and improvable in terms of numbers, rather than just qualitative attributes which cannot translate to dollars and cents. Note that *quality measures* are defined as mechanisms used to assign a "quantity" to care, not to append as descriptive adjectives.

3 Context and Methodology

On top of providing an assessment of IT resource vulnerabilities, the Risk-O-Meter provides an objective mitigation advice list in the form of specific recommendations and dollar figures. The RoM is a unique tool that offers healthcare decision makers an innovative alternative in terms of assessing the degree of QoS (Quality of Service) improvement needed. Based on stakeholder responses, the said RoM as automated software identifies systemic (thorough but specific) vulnerabilities. Maintaining the quality level of patient care at hospitals cannot be accurately accomplished without a risk assessment first and then a risk management of smaller healthcare subsystems, such as smaller pieces of a puzzle, constituting the larger system. The RoM will greatly facilitate conducting an accurate and thorough assessment of the potential risks and vulnerabilities of hospital patient-centered healthcare utilizing the following exhaustive list of vulnerability factors:

1) Admissions, Billing and Accounting
2) Hospital Support Services
3) Outpatients and Daily Visits
4) Inpatients
5) Surgery
6) Emergency Room (Services)
7) Radiology
8) Central (all purpose) Labs
9) IT Resources
10) Physicians and Interns
11) Nurses and Auxiliary Personnel
12) Pharmacy

Unlike other risk indices that portray risk in terms of a subjective, qualitative high-medium-low scale, the RoM tool offers an objective, quantitative means to identify risks and vulnerabilities. The RoM tool will thus greatly enhance the ability of healthcare executives, decision makers, healthcare insurance providers and IT professionals to maintain patient-centered QoS in a hospital ambience.

What-if questions about how to bring the undesirable RoS (Risk-of-Service) factor as the complement of QoS down to a tolerable percentage will follow. These will be resolved with a roadmap of guidance and a cost effective financial recursive feedback. RoM can also work for the hospital before launching a new enterprise to tailor it (note the Comparative Effectiveness Portfolio) when it is most malleable, so that risks are avoided whenever possible. This entails cost-benefit analyses, risk identification, and assessment with further strategy evaluation through recursive risk management and feedbacks on a continual basis.

The proposed method will also make critical check-listing within hospital healthcare and their follow ups possible and easier than by other non-digitized methods. Dr. Atul Gawande’s Checklist Manifesto emphasizes this habit as done in airlines (e.g.: US Air pilot “Sully” Sullenberger used such a procedural checklist in landing on the Hudson River in Jan 2009) and other settings having complex procedures [12]. Dr. Gawande’s key message is that the volume and complexity of knowledge today has exceeded any single individual's ability to manage it consistently without error despite material advances in technology, increased training, and super-specialization of functions and responsibilities. Despite demonstrating that checklists produce results, there is widely accepted resistance to their use because our jobs are either too complex to be reduced to a checklist, or because checklists are too rigid and don't force us to look up and think ahead. Yet such a checklist is needed in a complex environment where routine matters that are easily overlooked under the strain of more pressing matters overwhelm people. The RoM software is a scientific methodology and soft technology to get checklists done systematically without having to recall or memorize them one by one, infeasible to do.

By developing and implementing a process checklist for critical processes and decisions regarding a patient’s hospital care as ideally described by the books, a disciplined adherence to essential procedures—by checking them off a list—can prevent potentially fatal mistakes and corner cutting. This is what the proposed RoM aims to do by assessing the lack of hospital service quality regarding patient-centered care and by making sure checklists are duly met. Moreover, the proposed study advances planning with a definitive roadmap via a game-theoretical, cost-cutting, and resource-minimization algorithm that is computationally intensive. This process can be performed solely in an automated software engineered environment. Within all these avenues, RoM will guide and help identify the relevant risks relative to each other and work to optimally minimize them to ensure the success of hospital management. This algorithmic software proposed will increase quality of healthcare by proper assessment and mitigation of risk in patient-care using a digital technology through an automated hands-off and objective (not subjective or haphazard or convenient to prove one’s opinions) software tool. The advantages are plentiful, but require properly collected authentic and aggregate (composite) patient data analysis. The ultimate goal is to help reach a hospital patient-centered culture of best practices to improve healthcare. Best practices are the most current patient care interventions, which result in the best patient outcomes and minimize patient risk of death or complications to benefit all sides.

4 Innovation

Quantitative methods are widely employed in healthcare management areas such as forecasting, decision making, scheduling, productivity, resource allocation, supply chain and inventory management, quality control, and project management. Yet when it comes to risk assessment and mitigation of Health IT system risks, qualitative methods currently predominate. The qualitative approaches may be somehow adequate except for periods when budgetary resources are scarce such as during current economic times (2007-present). Consequently, one does not know how to prioritize risks without following an objective computerized plan about how to frugally meet the demands when dealing with only pure adjectives (bad, medium or good). A literature search using the term “quantitative methods for healthcare IT” turned up infrequently. Most of the literature uncovered dealt with qualitative methods, thus showing how little has been done to employ quantitative methods in healthcare IT risk assessment and management [13]. There are very few books and research papers on the topic of quantitative methods in healthcare management [14, 15]. The RoM tool therefore is unique in applying a more rigorous and objective quantitative approach to patient-centered healthcare risk assessment and financial management. There are some new books which address quantitative notions such as “Risk and Exposure Assessment” [Chap. 9, 16] similar to what is proposed here but in a different context. The referenced authors’ probability of risk corresponds to a cross-product of vulnerability (=hazard) and threat (=exposure) probabilities. Once treated with a dose of countermeasure, we end up with a residual risk, a concept which in the same book is cited as “precautionary principle”. Similarly, “consequence weight” in the cited “Public Health Foundations, Concepts and Practice“ by Andresen and Bouldin corresponds to RoM’s criticality factor (0.0 to 1.0) in this proposal where the highest criticality takes on a value of perfect 1.0 such as in a nuclear plant meltdown that happened recently in Japan. A college central computer may have a criticality of 0.4 to 0.5 [17] whereas a printer may have a weight around 0.2, if not crucial to the business at the specific time.

Risk assessment methods are typically are classified as conventionally qualitative [18-20], newly quantitative [2, 3, 21-23], and also hybrid [2, 3, 24, 25]. The RoM tool uses a quantitative approach for software assurance (the confidence in being free from intentional or accidental vulnerabilities) to determine and manage patient-centered quality of care risk and has the advantage of being objective in terms of dollar figure allocation of mitigation resources. Unfortunately, there is a widespread reluctance to apply quantitative methods [26, 27]. Despite these advantages, decision makers tend to lean toward descriptive risk assessments because they are easy to use and have less rigorous input data requirements. One primary reason is the difficulty in collecting trustworthy data regarding quality breaches elevating risk [28]. A well-known management proverb says that you *can* quantify risk: "What is measured is managed" [29]. The practicality of the proposed method relies crucially on the validity and reliability of the information source for input aggregate data received from the patients.

5 Approach

Hospital or patient-care centers should be equipped to have "wellness-scores" akin to those of individuals' financial "credit scores" with a list of advisory guidance on which to countermeasure to use improving these risk indicators. In the event of a patient-care center or hospital scoring higher than a standard risk percentage (like a standard or threshold patient-care satisfaction score) after activating and implementing the proposed RoM; the healthcare insurance provider will be authorized to send a warning to the said center to get its act together and remediate or else face the consequences of elevated premiums for their customers (patients). This crucial issue has been recently in the news where WSJ had headlines on its Marketplace section on May 16, 2011, "*Wellpoint Shakes Up Hospital Payments*" [30]. The article begins with the paragraph, "*Wellpoint Inc. is raising the stakes for reimbursing about 1,500 hospitals across the country, cutting off annual payment increases if they fail to deliver on the big health insurer's definition of quality patient care.*"

To circumvent these universally recognized problems, and hence deliver scientifically objective automated software for risk assessment and risk remediation to serve common purpose, the chapter entails the use of RoM. The said software tool will function as a most effective guide to advise the hospital management on how to take countermeasure actions indicated by a cost-optimal game-theoretical algorithm following a risk calculation. The RoM design provides the means in a quantitative manner that is vital in the risk assessment world. Figure 1 below illustrates the constants in the RoM software as the utility cost (dollar asset) and criticality constant; Figure 2 shows the tree diagram where the probabilistic inputs are vulnerability, threat, and lack of countermeasure all valued 0 to 1.

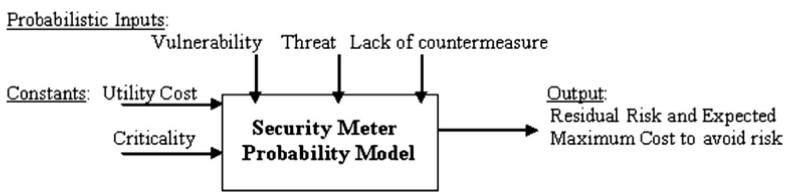

Figure 1, Risk-O-Meter Model of probabilistic, deterministic inputs, and calculated outputs.

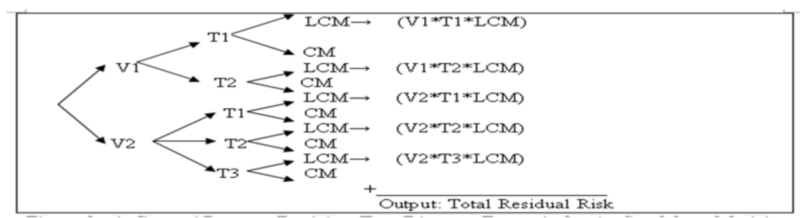

Figure 2, General-purpose tree diagram (V-branches, T-twigs, LCM-limbs) for the RoM software.

Risk is generally defined as the likelihood of the occurrence of an event. However, to be able to identify not only the likelihood of the event, but also its impact, we utilize the following definition of risk. Generally speaking, risk is the product of likelihood and impact,

*Risk = Likelihood * Impact* (Equation 5-1)

For example, the measure of an Information Technology risk is the product of threat, vulnerability and asset cost:

Risk ($) = Threat * Vulnerability * Asset ($) (Equation 5-2)

where, vulnerability (equivalent to an ecological component or asset that can become a weakness if exploited and/or misused) refers to the likelihood, and threat (such as an ecological stressor) on the other hand refers to the impact of occurrence, as in Equation (1). The Certified Information Systems Auditor (CISA) Review Manual, 2006, provides the following definition of risk management. *Risk management is the process of identifying vulnerabilities and threats to the information resources used by an organization in achieving business objectives, and deciding what countermeasures, if any, to take in reducing risk to an acceptable level, based on the value of the information resource to the organization.*

There are two things in this definition that may need some clarification. First, the *process* of risk management is an ongoing iterative process. It must be repeated indefinitely. The business environment is constantly changing and new threats and vulnerabilities emerge every day. Second, the choice of countermeasures (controls) used to manage risks must strike a balance between productivity, cost, effectiveness of the countermeasure, and the value of the informational asset being protected. The *residual risks (RR)*, i.e. the risk remaining after risk treatment decisions have been taken, should be estimated to ensure that sufficient protection is achieved. If the residual risk is unacceptable, the risk treatment process should be re-iterated. Here is where many private entities differentiate between internal costs, costs they must reasonably be expected to pass along to their customers in the pricing of their goods and services, and external costs, those they can pass along to the general public and taxpayers. Introducing the cautionary measures, risk metric is reduced by the probability of countermeasure (CM) action. If for instance, CM probability is perfect (100%), then the Lack of Countermeasure (LCM) is 1- CM = 0, reducing the Residual Risk to a merely nonexistent quantity. Residual risk (RR) is a probability between 0 (perfect countermeasure available) and 1.0 (no countermeasure).

*Residual Risk($)=Risk ($) * Lack of Countermeasure* (Equation 5-3)
The game-theoretic set of equations for risk management follows:

MIN COLLOSS (0<Column loss<1), subject to:(See Figures 4, 6)
1cm11>0.765 (Equation 5-4)
1cm12>0.61 (Equation 5-5)
1cm21>0.61 (Equation 5-6)
1cm22>0.385 (Equation 5-7)
1cm23>0.465 (Equation 5-8)
1cm31>0.775 (Equation 5-9)
1cm32>0.725 (Equation 5-10)
1cm41>0.55 (Equation 5-11)
1cm42>0.545 (Equation 5-12)
1cm43>0.525 (Equation 5-13)
1cm51>0.61 (Equation 5-14)
1cm52>0.67 (Equation 5-15)
1cm61>0.33 (Equation 5-16)
1cm62>0.665 (Equation 5-17)
0.090077cm11-1Colloss<0 (Equation 5-18)
0.078754cm12-1Colloss<0 (Equation 5-19)
0.076336cm21-1Colloss<0 (Equation 5-20)
0.065728cm22-1Colloss<0 (Equation 5-21)
0.065728cm23-1Colloss<0 (Equation 5-22)
0.083834cm31-1Colloss<0 (Equation 5-23)
0.082999cm32-1Colloss<0 (Equation 5-24)
0.05495cm41-1Colloss<0 (Equation 5-25)
0.045216cm42-1Colloss<0 (Equation 5-26)
0.056677cm43-1Colloss<0 (Equation 5-27)
0.09cm51-1Colloss<0 (Equation 5-28)
0.09cm52-1Colloss<0 (Equation 5-29)
0.065192cm61-1Colloss<0 (Equation 5-30)
0.050692cm62-1Colloss<0 (Equation 5-31)
0.090077cm11+0.078754cm12+0.076336cm21+0.065728cm22+0.065728cm23+0.083834cm31+0.082999cm32+0.05495cm41+0.045216cm42+0.056677cm43+0.09cm51+0.09cm52+0.065192cm61+0.050692cm62>0.65 (Equation 5-32)

Optimal Solution: See columns 3 and 5 in Figure 4 to compare.
$CM_{11}=0.7795$, $CM_{12}=0.61$, $CM_{21}=0.61$, $CM_{22}=0.385$, $CM_{23}=0.465$, $CM_{31}=0.775$, $CM_{32}=0.725$, $CM_{41}=0.55$, $CM_{42}=0.545$, $CM_{43}=0.525$, $CM_{51}=0.61$, $CM_{52}=0.67$, $CM_{61}=0.33$, $CM_{62}=0.665$

Important to note that there may be other alternative solutions to satisfy the constraints. One generated above by the RoM algorithm will be the least costly due to the least amount of percentage sum of changes. See below Figure 3 an alternative solution, which amounts to % change of 100[(.802214-.61) + (.821968-.775) + (0.830238-.725) + (.765655-.61) + (.765655-.67)] = 100[0.59573] = 59.57%, which is more than the RoM's least sum change: 53.75%.

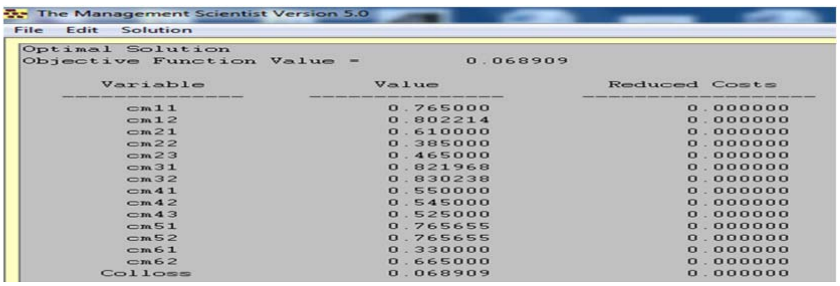

Figure 3, Alternative Solution generated by Management Scientist

The game-theory application software stabilized this lack of equilibrium with mixed strategy solution. This provides a list of countermeasure probabilities, CM_{11}=0.7795,.., CM_{51}=0.8995,…, CM_{62}=0.665. This is the optimal mixed strategy for Defense to minimize its expected loss while Offense maximizes its gain. There is no better game plan at equilibrium by altering CM_{ij}. The author also experimented with Nash equilibrium mixed strategy of probabilities, but the present Neumann approach with mixed strategy generated the scientifically optimal results by Sahinoglu et al. [31].

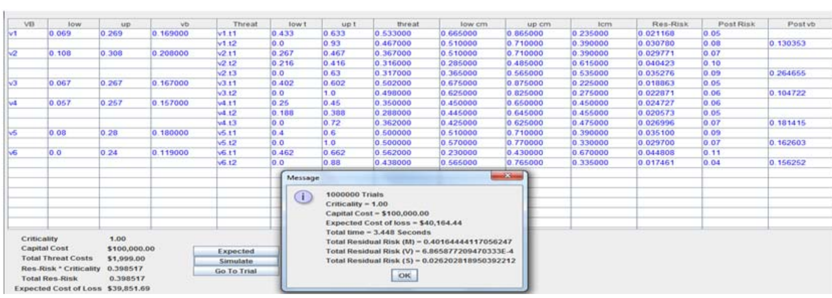

Figure 4, 1M Monte Carlo Simulation runs give Mean(M)=0.40 (expected=0.3985) and Standard Deviation(S)=0.026

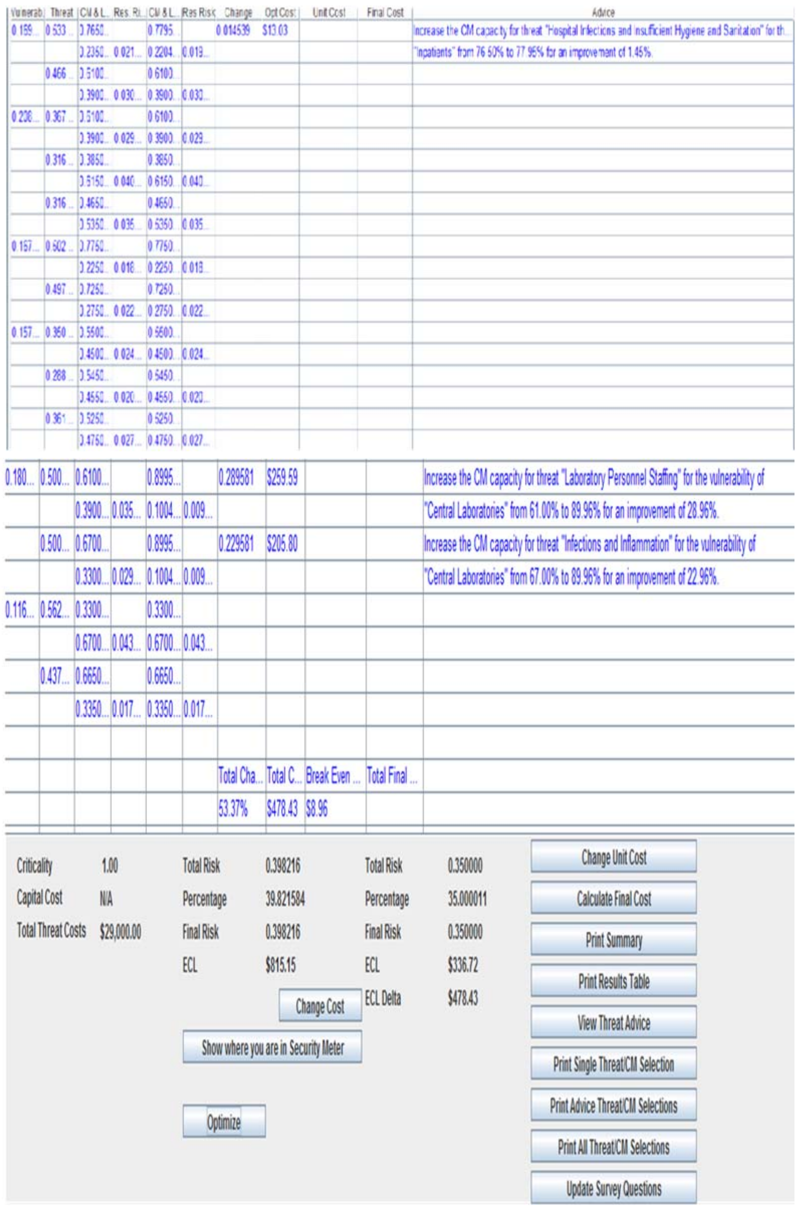

Figure 5, Risk-O-Meter Assessment (39.82%) and Management Plan.

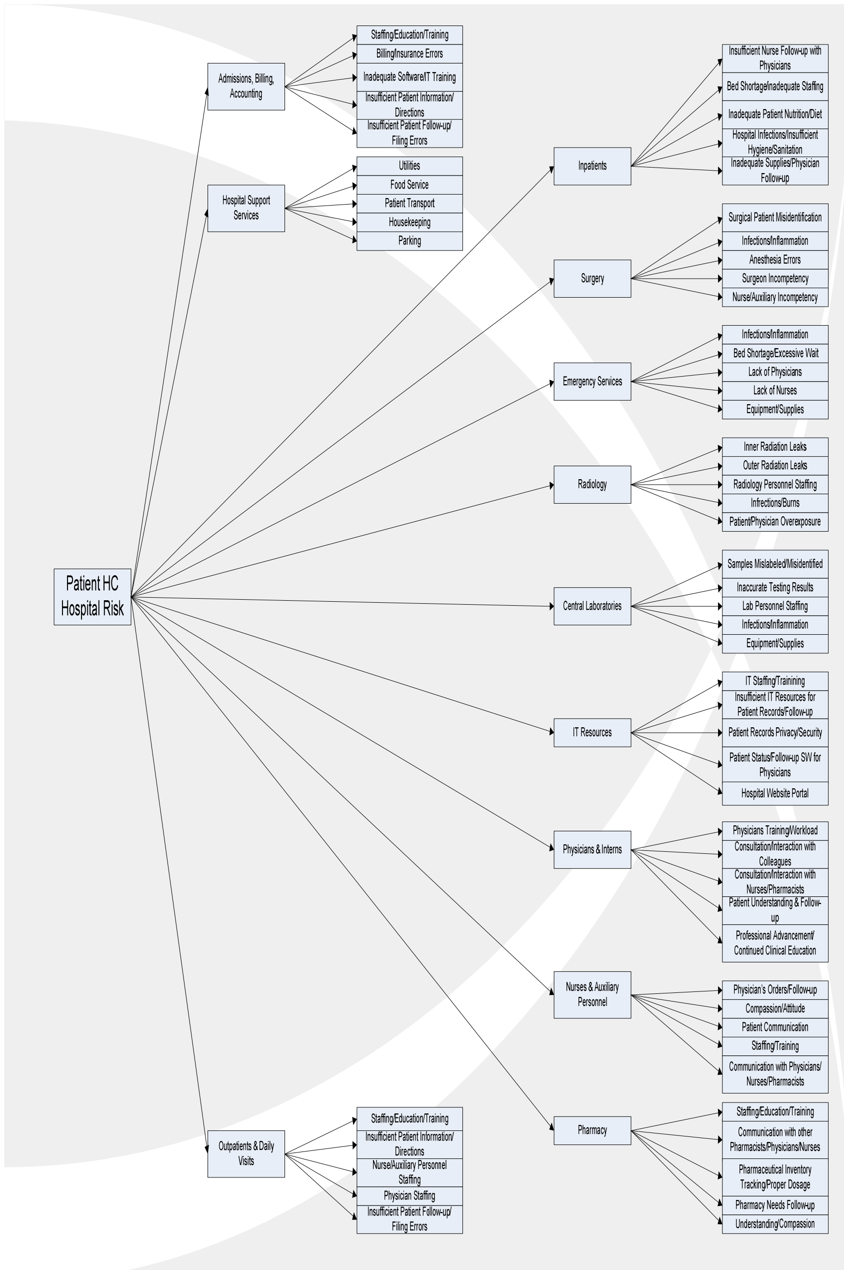

Figure 6, RoM: Hospital Patient Healthcare Quality Tree Diagram

Next, we plan to apply a scenario to the patient-centered healthcare service at a hospital setting with their set of vulnerabilities, threats and countermeasures as in Figure 6. These classifications of vulnerability-threat-countermeasure are specified by hospital dynamics in relation to their managed patient care implementations. The ultimate purpose is to cost-optimize and prioritize the precautions needed to meet hospital care check-list and quality requirements. This set of actions will improve patients' healthcare by assessing the quantitative risk with a roadmap of what-to-do list at what price and which priority to minimize the risk accrued during the hospital care of the visiting patient. These said goals are actually brainstormed daily, and contemplated nonstop by the hospital administrators who wish to improve conditions, but not readily expressed or delineated to perform in a cohesive manner due to lack of an automated software. RoM realizes the execution of what seems to be intangible goals to a tangible solution so that subjective reasoning is replaced by an objective algorithm for the common good of both patients and administrators, and medical personnel of the hospital. A sample study is drafted starting with Figure 6's tree diagram and a detailed action plan is advised as outlined in Figure 5. The computationally-intensive automated software tool, i.e. Risk-O-Meter will process the diagnostic cognitive (verbal or categorical) and evidential-experiential (numerical) confidence data. Figure 4 will verify Figure 5 using 1M simulations with satisfactory results.

Once the Risk-O-Meter is processed with the input data (the entirety of input test data pending for the main grant if awarded), the assessment output in Figure 3 will need to be interpreted. Using Figure 4 and the detailed Figure 3, to improve the entire operations by mitigating from 39.82% to 35%, one needs to implement the first-prioritized three counts of recommended 'Countermeasure' actions. 1) Increase the CM capacity for the vulnerability of "Inpatients" and its related threat "Hospital Infections and Insufficient Hygiene and Sanitation" from the current 76.5% to 77.95% for a performance improvement of 1.45%, 2) Increase the CM capacity for the vulnerability of "Central Laboratories" and its related threat "Laboratory Personnel Staffing" from the current 61% to 89.96% for a performance improvement of 28.96%, 3) Increase the CM capacity for the vulnerability of "Central Laboratories" and its related threat “Patient records” from the current 67% to 89.96% for a performance improvement of 22.96%. As indicated in 3, these actions are selected to be the most cost-saving countermeasures, which point out to a total investment of $478.43. This is advised for the breakeven cost of $8.96 per each 1% improvement. That is, total change of 53.37% times $8.96 per 1% = $478.43. The next step by RoM entails carrying on with the optimization to a tolerable percentage once the services are provided. Hospital may lower to 30% with a 5% improvement compared to the current 35% if the budget permits for more services. See a linear system of equations used towards game-theoretic risk computing, and pertinent risk expressions, as shown in Section 5.

The specific objective of this chapter is to plan to test and evaluate the RoM, a quantitative risk management tool, in both rural and urban hospital settings and disseminate results and offer feedback once the software is applied for eliciting field data. This process will enable hospital patient-centered quality of healthcare measurement planning, utilizing a definitive roadmap via a game-theoretical cost-cutting and resource-minimization algorithm that is computational intensive. In essence, the RoM software will guide and help identify the relevant risks relative to each other and work to minimize them as optimally as possible to ensure the success of the hospital management. This effort is for both sides of the isle (care seekers and care givers) in trying hard to reach optimal quality. The advantages are plentiful versus the small price of eliciting proper input data.

Validation of this proposal will be accomplished via recursive feedbacks of the RoM algorithm which allows the users in real-time to reconsider the hospitals’ varying risks and precautions. The hospital can undertake a review every 6 moths based on the aggregate data by the patients whether in actuality the new improved goal from an earlier undesirable risk level has been met.

The model will effectively develop a monitoring capacity for the quality fulfillment of hospital managed care check-lists prior to fulfilling the patient care satisfaction. The RoM implementation of patient-centered quality of healthcare improvement through monitoring of the hospital check-list quality mandates as derived from the patient aggregate data will create a model for two local largest Central Alabama hospitals selected for a pilot study. RoM survey results will be obtained from hospital patients and personnel and be implemented as follows:

Patients: The hospital patients in and out of the hospital can go at will to the particular hospital portal with a given ID number, and take this written quality survey questionnaire's first stage (not the second stage cost-optimal management part which is primarily relevant to hospital administrators and stake holders). For example, if 101 patients who were treated at the hospital took it, then it will be converted by the RoM analyst to a representative one-person survey which would then result in the roughly similar risk assessment indicator as when the 101 participants were averaged. This (possibly the statistical median or the 50^{th} percentile, that is the 51^{st} ranked) could then be used by the hospital administration to execute the management stage of the survey to allocate procurement or mitigation dollars. Patient input is critical since, hospital staff (doctors, interns, pharmacists, and IT workers) cannot assume the role of patients in this survey. That can only be judged by the visiting patients who experienced treatment at a particular hospital to judge what went wrong or right. The more the patients enter their data, the more consistently the statistical inferences will reach true values with least error.

Hospital Personnel: An equal representative number of personnel such as 101 employees from a cadre of knowledgeable, experienced hospital staff can be asked to take this survey to form a characteristic response portfolio from the same hospital personnel. This sample input will then be converted by the RoM analyst to a representative one person survey (possibly the median or 50^{th} percentile, that is the 51^{st} ranked) which would then result in the roughly similar risk assessment central tendency indicator as when the 101 participants were represented. It would also be interesting to see to what extent patients and personnel agree with the quality of treatment they are receiving (or giving) in a setting where quality hospital treatment is the common goal for both parties on both sides of the isle.

6 Implementation of the Proposed RoM Algorithm

Baptist Health System (short for Health Care Authority for Baptist Health- an Affiliate of UAB Health System DBA) and Jackson Hospital & Clinic in Central Alabama may initially use the RoM to enhance two particularly crucial quality of care areas: patient safety and satisfaction. Striving for greater objectivity and precision, they may wish to move away from their current qualitative review of "problem lists" through "likert scales" of 1(least satisfied) to 5 (most satisfied), and various satisfaction tests to a more objective and automated approach that will identify threat zones, appropriate countermeasures and budgetary allocation for these countermeasures. These two hospital systems will work with the authors (Dr. M. Sahinoglu and Dr. Ken Wool) as a multidisciplinary team to implement the RoM and make the study medically viable. By assuring a high quality patient-centered level of care, they can improve patient care and hospital management. They further believe that these efforts will facilitate an environment of continuous improvement. From various meetings two recommendatory points were acknowledged. They will be addressed in stages 1 & 2 as follow:

<u>Stage 1</u>: The questionnaire should be transparent, objective and understandable to the full extent by the anonymous visitors of all levels of education in order to have a standard response base.

<u>Stage 2</u>: Costs associated with the threat factors that form the overall lump sum remediation cost to mitigate risk should be addressed by each hospital differently in the light of their operational conditions subject to a specific economic task-force analysis. The plans were mutually made to provide information on how to obtain the value of risk probabilities and redemption costs:

a) An overall allocated (subject to feedback) lump sum cost to meet the countermeasures will be distributed regarding the entirety of threats for the vulnerabilities on an individual basis. This will not be made public to the patients taking the quality questionnaire but will be kept internally until the second stage risk mitigation procedures take effect by the hospital authorities.

b) In estimating costs for threats, a task force in a particular hospital in conjunction with the hospital's IT personnel will analyze past and present costs adjusted by the inflation and depreciation factors to achieve this hurdle to minimize error. Since this is also a risk comparison effectiveness solution, the improvement can be cited as a percentage even if the dollar values are not exact.

It is planned that each participating hospital will create a web portal where individual patients can participate in the enhancement of the quality of patient-centered care by answering the assessment questions that provide the RoM with its input risk data once a large number of random sample size is attained. Although a random sample size of 15 to 30 is good enough to run statistical inferences utilizing Central Limit Theorem distributions, the proposed study wishes to have multiple samples of $15<n<30$ to have statistically robust estimators. The patient data will be amassed and an aggregate risk level determined. Implementing the RoM, they can then optimize the results, which present them with an objective (as opposed to subjective where human emotions are involved), econometric guide as to what countermeasures to apply to meet the identified threats and what funding to allocate for these countermeasures in which priority order. Additionally, hospitals can repeat the process on a periodic basis. Thus, with a baseline established and periodic assessments made, the hospitals can use this mechanism for continuous improvement, seeing where they rate currently versus previous time periods.

7 Conclusions

Can technology cure healthcare [32]? Medicine has been considered an *Art* for centuries and is finally moving into the molecular and microchip age. Likewise management of the business of medical care delivery is poised to make a quantum leap from the days of subjective decision making (educated guess work) to a new management paradigm of objective real time computer-generated risk and financially-based data [33-35]. This fact is evidenced by the practical applications of automated software such as what in the case of ROM can provide as hereby proposed [3], among others [36].

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