Spring 5-2020

NUDGING QUALITY IMPROVEMENT IN CANCER CARE: INFLUENCE OF A CLINICAL DECISION SUPPORT SYSTEM TO NUDGE ADHERANCE TO EVIDENCE BASED GUIDELINES IN ADULT CANCERS

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Presented to the Faculty of The University of Texas

School of Public Health

in Partial Fulfillment

of the Requirements

for the Degree of

DOCTOR OF PHILOSOPHY

THE UNIVERSITY OF TEXAS
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Houston, Texas
May 2020

PREFACE

Gandhi says "Be the change you wish to see in the world." A lifetime of education and now clinical practice in cancer care has put me in a unique position to bridge between health care delivery, informatics, healthcare policy, and clinical operations. It is clear that systems that support health care delivery have not yet realized their potential in optimizing quality control and efficiency, and faster progress is necessary. We need to make greater strides in improving the value of health care delivery, improving health care quality on a larger scale, and implementing improvements in a way to allow doctors to be doctors with systems that support clinical effectiveness and efficiency. I have had a great privilege of substantial education in these areas, the good fortune of generous mentorship from many, and constant sounding boards of patients and partners who share the common goal of improving care from where we are today to a better future. These unique experiences allow me to be a better bridge between where we are today and the collaborators we need to get where we need to go on our journey towards progress. As physicians are autonomous creatures, information systems like decision support can nudge actions in the service of patients.

ACKNOWLEDGEMENTS

There are many to thank for assistance in helping me to complete this work. My advisor, Dr. Paul Rowan, who is constantly patient with me as I balance my competing priorities and had faith that this was important enough to get done. I want to thank Dr. Stephen Linder who served on my committee, but more so because my experience in seeing public health through his eyes gave me a different perspective twenty years ago that forced me to look at important healthcare policy questions from many different perspectives and has been a compass on my career journey. I appreciate Dr. Swartz and his council regarding statistical modeling for this project and others. The team from the US Oncology Network has been instrumental in completing this work. Jody Garey and Dr. Marcus Neubauer have carried the vision of pathways and evidence and value-based care through a decade of improvements to get us where we are today and constantly consider how we improve upon the status quo. I want to thank both a for their integral knowledge of our data systems that support care delivery improvements. Hank Head's work on clinical decision support allowed the systems to be developed and continues to elevate this space. Dr. Barry Brooks for his counsel and feedback on optimizing decision support in cancer care. Bo He was instrumental in structuring the data for analysis. Wei Zhang was instrumental in coding statistical analysis. I want to thank my partners and my patients for providing constant inspiration to improve upon the systems we have today and the opportunity to help guide and develop those systems and processes. I want to thank my practice president Dr. Steve Paulson for his support in this journey. I want to thank my family for their patience and understanding and continuous support of these efforts. In particular, I want to think my husband Dr. Hanoch

Patt who is my constant sounding board and usually the barrier of grounding wisdom to help me think about how to make things better.

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Summary

Cancer care is changing rapidly. Understanding of the increasing subtypes of cancer and exponentially increasing therapeutic interventions are unprecedented due to the rapid pace of scientific discovery and clinical innovation. This immense change within the field, lends itself to quality control initiatives, especially among general oncology providers who see a wide array of cancer types as general oncologists will see many different tumor types, and most of which have several potential treatment choices that have grown over time.

Evidence-based pathways are an effective way to nudge quality control by presenting choice architecture at the point of care to facilitate guideline compliance among a wide array of therapeutic choices. This evaluated the impact of a clinical decision support system
(CDSS) tool, a "nudge" within the electronic health record among a network of oncology providers. This study examined the results of its implementation across 9 statewide practices over 6-month interval. We evaluated the effects of the CDSS on regimen compliance with value pathways across practices, within practices, and the influence on physician compliance

with value pathways across the study interval. SAS 9.4 software was used to evaluate the hypothesis using multi-level modeling.

Across the 29,926 regimens included in the study, the CDSS tool significantly impacted compliance to evidence based pathways. By applying a multi-level logistic regression model to the entire cohort, and segregating the levels as patients as level 1, doctors as level 2, and practices as level 3, the post CDSS implementation odds ratio of compliance to evidence based pathways was 1.48 (1.25;1.76). When we segmented the cohort by practices, the majority of individual practices had a significantly higher likelihood of evidence based pathways compliance after implementation of the CDSS tool with odds ratios of 1.60 (1.33;1.94), 1.13 (0.88; 1.45), 1.39 (1.08; 1.79), 1.85 (1.53; 2.24), 1.76 (1.32; 2.36), 1.71 (1.38; 2.11), 1.23 (0.96; 1.57), 1.37 (1.12; 1.67) and 1.46 (1.30; 1.63). In addition, each oncologist's compliance was evaluated and, while we did not demonstrate a statistically significant improvement in compliance with the limited number of evidence based pathways prescribed by each oncologist with implementation of the tool, the number of regimens by oncologist was very low. Using McNemar's test we did find that the percentage of oncologists who reached an individual benchmark of 75% compliance was significantly higher with implementation of the CDSS tool: among the 560 physicians included in this study, 327 (58%) were at or above a benchmark of 75% compliance prior to the CDSS tool and 402 (72%) achieved that benchmark after implementation of the CDSS tool ($p<0.001$).

In conclusion, implementation of the CDSS tool can be a successful mechanism to increase compliance to evidence-based pathways overall, and within most individual practices. In addition, physician compliance to benchmark performance of 75% compliance

with evidence-based pathways can be improved by implementing a CDSS tool embedded within the EHR.

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BACKGROUND

Complexity in the Cancer Landscape

The knowledge base and understanding of the many diseases that comprise "cancer" has grown and differentiated substantially in the last 60 years. While initially this was a slow steady pace of change, the complexity and therapeutic innovation in cancer care increases with steep exponential growth. As a result, the understanding of sub-types of cancers and effective strategies to manage their treatment have changed considerably and become increasingly more complex. As diagnosis and therapeutic choices become more complex, platforms to navigate the complexity and facilitate quality are increasingly important.

Cancer therapy has evolved

While surgery has always been an effective modality of cancer treatment, and radiation therapy continues to evolve, the use of chemotherapy regimens to treat cancer is relatively modern, and the complexity of molecular targeted therapy and immunotherapy is contemporary. Cancer has been treated effectively with the blunt instruments of surgery, radiation, and multi-agent chemotherapy, but only in 2000 did targeted therapy emerge, and immunotherapy was first approved in 2014 and today is a mainstay of cancer care. Frequently these treatment strategies are combined to improve outcomes in patients. As cancer and chemotherapy regimens have become more complex over time, treatment planning to optimize cure has also become more nuanced in combination of therapeutic agents, and sophisticated with regards to sequencing various treatments. Cancer treatment planning is more complex for two reasons: There now exists a heightened complexity of cancer subtypes by both pathology and molecular characteristics that offer opportunities for

therapeutic intervention, and more systemic treatment therapy options exist as systemic treatment regimens have grown from chemotherapy to combined chemotherapy, targeted therapy, and immunotherapy, and combinations thereof. For example, breast cancer is not just defined by stage, presence of estrogen receptor, and amplification of Her 2 neu, but also immunologic susceptibility with the expression of PDL-1, PIK3Ca susceptibility as managed by a mutation in PIK3CA, and PARP inhibition by mutations in the BRCA or associated genes. The chronicity of treatment has changed as many historical short courses of highly toxic treatment have been replaced by chronically acting less toxic therapy, and there our expectations of improved cancer outcomes have changed as many cancers today are treated like a chronic disease akin to diabetes or hypertension. Many cancers are no longer something that requires a short course of treatment, but it is a chronic illness that requires continuous long-term therapeutic intervention.

Historical Changes in Cancer Treatment

While a description of cancer can be found as early as from the time of Hippocrates, cancer innovation and effective treatment is relatively recent with most discoveries with therapeutic benefit being described in the last century. In the late 19th century Beatson discovered the influence of hormones on cancer growth. At the turn of the 20th Century, there was appreciation for radiation therapy as a treatment for cancer; however cancer therapy was largely surgical and seldom curative. (Faguet, 2015) The use of chemotherapy to treat cancer began in the middle of the 20th century, because it wasn't until after World War II and the effects of drugs that evolved from war-related programs that led to the

development of the Cancer Chemotherapy National Service Center. Born out of experiments with nitrogen mustard, experimental testing began in the 1940s that demonstrated responses to exposure in lymphomas. Early chemotherapy understanding also born out of WWII was the anticancer effects of some antibiotics and 5-fluorouracil. In 1949 the first chemotherapy drug was approved for cancer. The 1950s were largely disappointing with chemotherapy innovation as there was evidence of effective compounds but cures were not possible. By the mid-1960s, the Cancer Chemotherapy National Committee was incorporated into the National Cancer Institute and up until that point oncology was not even as subspecialty of medicine, because effective therapies were rare. The mid 1960s through 2000 was considered "The Age of Chemotherapy." If we consider navigating cancer care like transportation, this era is akin to a transition from a horse and buggy to the motorized vehicle and assisted by the development of more sophisticated roads. Tools that enabled us to support patient care, including anti-nausea medication, hydration, transfusion of blood products, permitted appropriate support of patients at the same time that our tools could be used in combination to make the journey of cancer treatment less toxic to the patient while our vehicles of therapeutic delivery in multi-agent chemotherapy were more effective. In the mid-1960s, progress in cancer care began in the translation of chemotherapy to cure in patients. Despite this progress, effective chemotherapy regimens were relatively simple with only a few chemotherapy drugs included in a regimen, and treatment planning for diseases was relatively straightforward as the evidence bank with which we drew from had minimal information. After the appreciation in the 1960s that cancer could be cured with multi agent chemotherapy regimens, combination chemotherapy regimens evolved.

Modern era chemotherapy treatment regimens became curative for the first time in the mid-1960s with multi-agent chemotherapy regimens for childhood leukemia and, shortly after, the introduction of platinum salts in the treatment of testicular cancer. (Hanna, 2014) In the 1970s we explored the use of multi-agent chemotherapy and different formulations in the adjuvant treatment of cancers. In this way, after cancer had been optimally resected, chemotherapy regimens given in addition to the surgery could kill any cells that were already microscopically present in the bloodstream, lymphatic system, and distant organs preceding a patient's diagnosis. By delivering these adjuvant chemotherapy regimens, cure was more likely. Developments of new chemotherapies and cocktails of regimens combining different therapy types continue to complicate cancer therapy and largely dominated our medical interventions until about the turn of the century. Chemotherapy and hormonal therapy regimens of rapidly increasing complexity was the mainstay of cancer treatment until the 1990s when the molecular basis of cancer was better appreciated, and differentiating tumor types based on molecular classifications became more important because of molecularly identified targets for therapeutic intervention. Within a 15-year time frame, Non-Small Cell lung cancer went from a disease with a poor prognosis, treated with chemotherapy alone, to a molecularly differentiated collection of diseases with various targeted molecular therapy regimens as interventions in addition to standard chemotherapy regimens, and now even immunologically mediated interventions with variable prognoses based on molecular characteristics and immunologic expression. (Wakelee, 2014) (De Vita, 2008) As an example of this progress, visualize the broad category of non-small cell lung cancer and the small number of targeted therapies in 2013 rendering much of advanced non-small cell lung

(NSCLC) cancer to be treated with chemotherapy, shortly after, the understanding of molecular drivers of growth in NSCLC transitioned to a large portion of targeted therapies shortly thereafter that greatly expanded the chronic targeted therapeutic opportunities (Berge & Doubele 2014).

As an example of the heightened diagnostic complexity, non-Hodgkin's lymphoma historically was categorized as one entity, and only in later years was it sub-classified as indolent (follicular) and aggressive (by different cellular histologic characteristics). In contrast, today we have an appreciation for very aggressive, aggressive, and more indolent types of lymphoma in addition to different subtypes of lymphoma by clinical presentation, protein expression and molecular characteristics that comprise more than 60 different distinct subtypes of non-Hodgkin's Lymphoma.

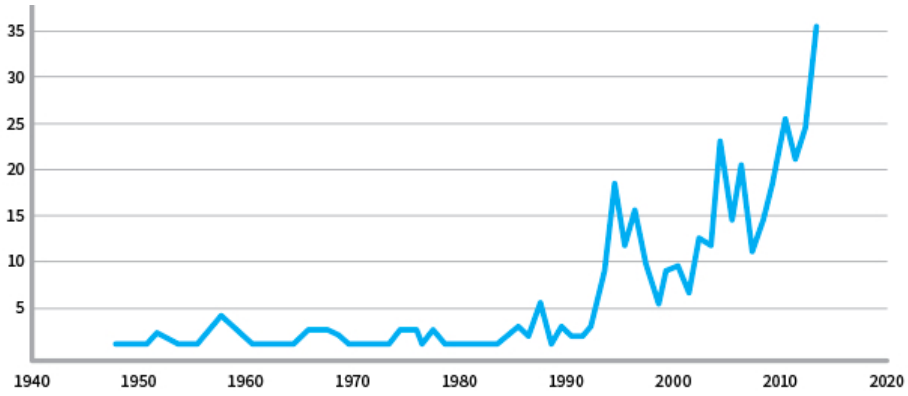
Major breakthroughs and targeted therapy did not become standard practice until 2000. The first of these breakthroughs was when the New England Journal of Medicine published the first reports of chronic myeloid leukemia being treated with a pill-based treatment regimen that blocked the protein byproduct of the 9;22 translocation that made the fusion protein BCR-ABL. This was an oral, targeted treatment designed to alter the molecular driver of chronic myeloid leukemia. Overnight, the 5 year survival of patients with newly diagnosed chronic myeloid leukemia went from 50% to over 90%, and the era of targeted treatment regimens to treat cancer was born. (Druker, 2001) This allowed clinicians to fight cancer differently by understanding and attacking the driver mutations that influence growth in various cancers.

From 2000 to present day has been “The age of targeted therapy” and “The age of immunotherapy,” with a greater understanding of cancers that are driven by molecular characteristics and immune response. It is this designation of targeted and immunologic susceptibility that renders cancer susceptible to targeted and generally more chronic therapeutic intervention with treatment regimens that are frequently administered over a longer time interval.

Chronic therapeutic intervention is a paradigm shift in cancer therapy as instead of acute phases of treatment, many cancers are treated like a chronic disease similar to hypertension or diabetes. In addition to targeted therapies based on molecular characteristics, there is now heightened appreciation for how immunologic response directs the body to destroy cancer. Immunotherapy treatment regimens are used alone and in combination with other treatment modalities to treat a variety of cancers beginning with melanoma and renal cell carcinoma, but now even moving on to breast cancer, lung cancer, liquid tumors, and other malignancies. (Voena, 2016) This progress in medical innovation is shifting the paradigm of cancer care from acute to more chronic care.

Evidence of this progress and complexity can be seen by looking at the number of new cancer drugs approved each year by the American Food and Drug Administration. The sheer magnitude of new cancer drug approvals is reflective of new therapeutic opportunities as generally these treatment changes are additive and often do not simply replace historical treatment options.

The exponential rate of new drug approvals for cancer care from the FDA is one contributor to the complexity of medical decision making. (Figure 1) Usually cancer therapies are approved in only certain disease conditions or stages for any particular cancer, adding sequencing of therapy to the complexity of treatment choices.



FDA Cancer Drug Approvals by year (Hope Cristol, The American Cancer Society, 2016.)

Treatment strategies between the now-over-60 different classifications of non-Hodgkin's lymphoma have similarities, but it is now recognized that these are remarkably different, with some of the subtypes managed by observation, others by targeted therapy alone, others requiring chemotherapy, others requiring chemotherapy quite urgently, and others requiring multi-modal therapy. This new recognition of the clinically heterogeneous phenotypes of even non-Hodgkin's lymphoma conveys phenotype specific patterns of disease, recurrence, survival, and appropriate therapeutic interventions. This deeper understanding represents tremendous progress, but also is an example of this complexity in clinical decision making.

(Glass, 2016) Guideline-based care has gone from something that was relatively straightforward to elaborate decisions requiring additional diagnostic information and having sophisticated complexity in therapy regimen choice. These specifying features must be appreciated to partner the patient burdened with the disease with appropriate therapeutic interventions.

All of these developments represent incredible progress in cancer care, but it also means that cancer care has become more complex. Instead of just having a designation of "non-Hodgkin's lymphoma," there now are over 60 different described subtypes of non-Hodgkin's lymphoma that all have slightly different defined therapeutic regimen strategies based on cellular characteristics, patient presentation, cell surface protein expression, and sometimes molecular mutations. The guidelines that direct clinicians to appropriate therapeutic intervention formulate decision trees populated with multiple nodes of data input to help guide decisions about appropriate treatment regimens.

The heightened complexity of a cancer diagnosis and pace of innovation in treatment makes it more difficult for clinicians to provide evidence-based cancer care, and increases the need for systems to facilitate evidence-based treatment choices in the form of therapeutic regimen selection for systemic treatment, akin to maps to navigate the increasingly complex environment.

The Development of Current Cancer Treatment Guidelines

The advent of professionally-developed guidelines for cancer care has been fairly recent. Most of the guidelines in use have been developed by a group called the National Comprehensive Cancer Network, or NCCN. In 1995, NCCN was announced as a national alliance to develop and institute standards of care of the treatment of cancer and to perform outcomes research. The first clinical practice guidelines in oncology were published by NCCN in November 1996, and in 1998 NCCN launched a website for clinicians to serve as a resource to facilitate guideline adherence. In December 2001, the first complete library of NCCN guidelines was made available for free to clinicians. These guidelines are based on available evidence and on expert consensus, and weighted differently based on the level of evidence that supports the general guideline recommendations. The structure of the main guideline is like a decision tree linked to additional content, is general, and while it may include more detailed information around dosing and schedule it is general. The large oncology professional organization, the American Society of clinical oncology ASCO, also develops guidelines on cancer care. Historically these have been more categorical to address particular topics and are general in nature as opposed to comprehensive treatment choices and the content is assembled as a treatise update usually published as a review guideline update in an ASCO journal. To use a modern directional analogy, guidelines are ways to navigate regimen treatment path choices, and ASCO guidelines give general directions such as “go west for 10 miles,” NCCN guidelines give more specific directions such as to travel west for 10 miles and turn left at the fork. What has never been available for decision support is a smartphone-ready map application to be used at the point of care.

Cancer treatment compliance with national guidelines is weak

While the heightened complexity of cancer care has been partnered by emergence of national guidelines, guideline compliance is not routinely tracked, and, when it is tracked, compliance is limited, and within standard national guidance there is not assessment or weight placed on the value of care delivery. Among patients with recurrent ovarian cancer, therapy with a platinum salt is the standard of care, yet only 33% received therapy with a platinum salt after recurrence. (Champer, 2018) In patients with stage III colon cancer, a recent study demonstrated that only 63% of patients received the guideline-appropriate adjuvant chemotherapy despite the fact that in clinical trials it conveyed a 20% improvement in overall survival at 5 years. (Guerrero, 2018) Some single institution studies have reported 89% and 91% compliance with adjuvant endocrine therapy and chemotherapy for breast cancer, while other institutions report compliance at 40% or 60% with no expectation of regular reporting of compliance, and a publication bias of studies showing poor compliance being under reported. (Adebboyega, 2015) (Sacerdote, 2018) Overall, there is substantial variation regionally and institutionally in guideline compliance and quality measures. (Kantor, 2018)

How Oncologists Prescribe Chemotherapy

Despite the evolution of guidelines, how oncologists prescribe cancer therapy remains highly variable. Prescribing chemotherapy can be as primitive as oncologists writing regimen recipes from memory, calculating doses by hand or handheld calculator based on height and weight, and writing orders on a blank sheet of physician order entry paper. When oncologists are supported by tools to write for chemotherapy, frequently they are on a web-based interface outside of the electronic health record requiring engagement with an additional platform that is usually not at the time and point of care. To accomplish this, often oncologists will write all of their chemotherapy orders over lunch or at the end of the day when they have the ability to focus and aggregate a number of tools.

An Emerging need for Clinical Decision Support

Although the process of developing treatment guidelines has matured, the field has been relatively limited in developing tools for clinicians to navigate this new landscape effectively. Clinical decision support systems are tools that can facilitate evidence-based decision-making in cancer care by providing timely point of care evidence-based guidance. By delivering this evidence through the EHR, the opportunity can be made to have the recognized, up-to-date treatment regimen be the default option, with clinicians having the option to opt out and begin with a different regimen. This is the matter of choice architecture: a clinician has full autonomy, but a valued decision is facilitated by the "architecture" of the decision-making process. By nudging therapeutic choices with presentation of disease-

specific choice architecture, physicians still retain autonomous decision making, but evidence based compliance is facilitated with a “nudge” in the direction of evidence based choices.

Decision Support: One Aspect of the Recent Quality Improvement Movement

In 2013, The Institute of Medicine published their report, "Delivering High-Quality Cancer Care: Charting a New Course for a System in Crisis.” This report characterized the need for specific improvements in cancer care over time. (Levit, 2013) Some of the recommendations included improving information technology as a means for addressing the evolving complexity in cancer care, and the need to measure quality of care. These directives have guided subsequent work to improve the quality of cancer care.

Quality Improvement Science has evolved to give healthcare organizations multiple avenues for enhancing quality improvement. (Shojania, 2004) This quality focus was prioritized in the IOM report in 2004 with the goal of making the nation’s healthcare system more responsive to the needs of patients and more capable of delivering science-based care. The guiding principles within that report state that there should be a systems approach to improving the quality of care, that chronic conditions should serve as the focal point for priority areas, and that quality improvement strategies should take an evidence-based approach. (Adams &Corrigan, 2003)

Historical Development of the Science of Quality Improvement

These trends in promotion of quality in cancer care are part of a bigger trend in health care quality. The science of healthcare quality improvement in implementation research has changed substantially over the years. Initially, quality improvement was felt to occur via passive diffusion, relying predominantly on clinicians acting on new published evidence. This "if you publish it, they will come" mentality pre-supposes the flow of evidence from medical journals to practitioners, despite the great amount of new medical knowledge to implement. The second phase of quality improvement in healthcare was based more upon guidelines and systematic reviews. Because tackling ever-increasing volumes of evidence for new therapy regimens in oncology became increasingly complex, practice guidelines evolved to help guide and direct the quality improvement process. These guidelines have been present in cancer care, and professional organizations like the National Comprehensive Cancer Network (NCCN) and American Society of Clinical Oncology (ASCO) would frame them and make them available for use as a reference. But barriers to optimal implementation are numerous. While these guidelines are incredibly useful, they often provide general direction, as opposed to formulating a detailed map of directions to optimizing successful treatment planning. The third stage of quality improvement in healthcare was more "industrial style" quality improvement. This is best represented by the typical "plan-do-study-act" model, from total quality management and continuous quality improvement. This kind of quality improvement process was much like managerial accounting and lent itself to typical operational implementation measures such as "Six Sigma" lean operational business processes. Finally, systems re-engineering emerged. This fourth and present stage of quality improvement occurs in conjunction with the total quality management and continuous quality

improvement methodologies. This approach often uses system re-engineering, and that is frequently facilitated by information technology systems as a means of achieving more optimal streamlined delivery of quality improvement in addition to measurement. (Shojania, 2005)

Clinical Decision Support at U.S. Oncology

The clinical decision support system implemented in this study is built as a web-based tool within the electronic health record at the point of care making it systems-engineering and a just-in-time mechanism to implement guideline-based care through value pathways at the point-of-care delivery. Unlike guidelines which provide general direction, they provide specific regimen directions regarding combination therapy treatment regimens, dose, and schedule within the electronic health record (EHR) to implement a therapeutic plan. They do this largely by drawing upon oncology "clinical pathways."

The pathways process has been described previously. (Zon, 2017) (Zon, 2018) While clinical guidelines provide general guidance for oncology care, oncology pathways are more specific. They incorporate specific patient presentations, and include characteristics such as stage of disease and type of disease. They are often more subtle than treatment guidelines by including aspects such as safety and toxicities, and molecular diagnostics that support more individualized cancer care, when possible. While multiple guidelines exist, the pathways process is evidence based, iterative, collaborative, and the pathways decision support system is a subset of well-established NCCN guidelines that have taken a subset of the general

guidelines and formulated actionable therapeutic regimens with complex combinations of therapy, dose, and schedule, and these have been partnered with appropriate supportive care drugs built in the EHR. While the CDSS built into the EHR provides a recognized treatment pathway as the default option for treatment initiation, the CDSS also permits therapeutic autonomy through an exceptions process. In this process, a clinician notes that he or she is initiating treatment in a different manner than the default, and notes the reason or reasons for this "exception." These exceptions undergo external quality review: the U.S. Oncology Pathways Task Force is a team of physician cancer sub-specialists and pharmacists that meets at least monthly to review recent drug approvals from the FDA and evidence presented at major meetings and within the literature. As the pathways have become 100% concordant within the general NCCN guidelines, NCCN updates are also reviewed regularly to ensure continued compliance. Evidence tables reviewing efficacy, toxicity, and cost, when available, of various therapy regimens studied under consideration are reviewed by this team of pharmacists and clinicians.

After careful review and discussion, all voting members are asked to cast a vote for inclusion or exclusion of each therapy regimen choice from the pathways system. When the votes are tallied, the decision to include or exclude therapeutic regimens goes out for review to the disease specific research committee of the cancer disease category of interest for feedback and comments. It then goes out to the entire national network of oncologists for review and comment. Only after this review and iterative comment and consideration

process are changes made within the system to include or exclude therapy regimens under consideration.

The Nudge: Choice Architecture

Influencing or facilitating compliance within physician groups is complex. It would be neither appealing nor practical to have a system of quality improvement that was not inclusive of general input nor iterative to consider input into the ultimate therapy regimen choice architecture tool. Physicians are autonomous professionals. They have had substantial education and training to develop a large knowledge base to make clinical decisions and to develop good judgment regarding management of the patients they serve. For this reason, it is preferential in healthcare, and probably many other specialties simply to "nudge" or facilitate appropriate behavior as opposed to push, force, or mandate change.

More generally, as researchers consider how information systems and even artificial intelligence can enhance human behavior, in medicine, the idea of augmenting behaviors and facilitating optimal treatment choices is preferable to supplanting or mandating clinical choice preference. The concept of nudge is described by Nobel Laureate Richard Thaler and Cass Sunstein as a sort of libertarian paternalism facilitated by optimizing choice architecture to facilitate desirable decisions. (Thaler &Sunstein, 2008) The nudge is the alteration of the choice architecture thus making some choices preferential but not mandatory. In the case of clinical decision support systems, the preset choice architecture for value pathways facilitates evidence-based decisions among cancer therapy treatment regimens and tracks them;

however, it does not force clinician behavior. This is an important point, as optimal implementation of decision support systems within a physician environment has often been limited by concerns regarding autonomy in decision making. (Moja, 2019)

The Emergence of Pathways

The idea of value pathways was first conceived in 2005. The concept was that given escalating treatment options and escalating treatment costs that there may be opportunities to give optimal evidence-based treatment regimens with lower cost therapeutic choices when therapeutic regimen combinations of equal efficacy and toxicity had differences in cost. In addition, value pathways would take a more general guideline and clearly articulate dosing and schedule given patient specific parameters. The primary goal of pathway development was to facilitate evidence-based decision making to improve the quality of care, but the secondary goal was to lower the total cost of care when possible, given the many high cost treatment regimen choices. The need for quality control was evident given an escalating number of therapeutic regimen options, and the need for value was evident given the escalating costs of treatment. This was further exacerbated because some drugs which had been used for many years had come out of patent protection and their generic equivalents were substantially less expensive than higher cost alternatives which may or may not be therapeutically more effective. This concept of increasing costs was well illustrated by Peter Bach who noted that in 1990 the average cost of a new cancer drug was $1,000 per month, and in 2010 it was $10,000 per month. It also became more commonplace during this time interval for individuals to be treated with multiple drug regimen combinations thus further

increasing the total cost of care, and treatment duration was over longer treatment intervals, and sometimes even continuous treatments, thus further increasing the cost of care. (Figure 2)

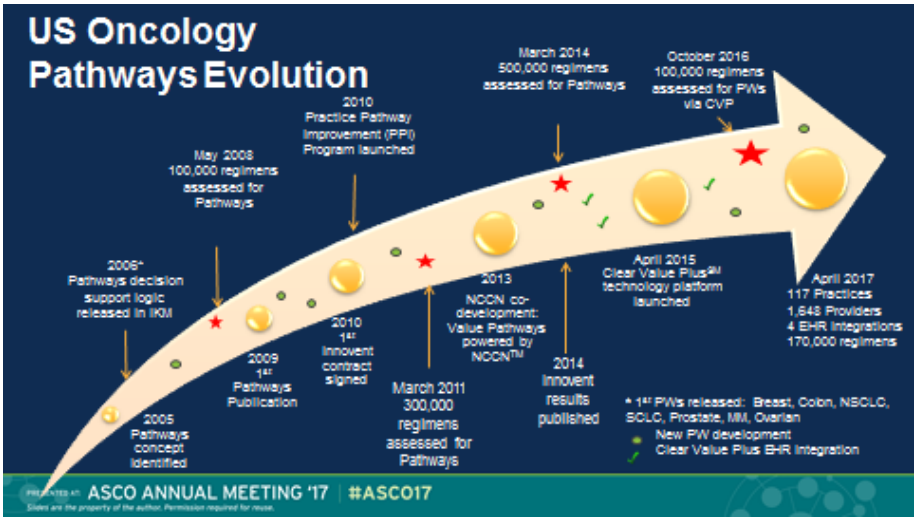


Figure 2: History of US Oncology Pathways Evolution

Process workflow of Value Pathways: A collaborative and iterative process

The value pathways are created by a Pathways Task Force and vetted in various ways to create engagement between the doctors they serve through an iterative approval and comment period feedback. In this way the guideline creation is iterative and clinicians at the front line are part of the process. When research is presented and new therapy regimens are approved or expected to be approved by the Food and Drug Administration, they are

discussed on disease-specific calls between the Pathways Task Force and a group of disease specific external consultants who serve to develop the guidelines for NCCN. The pathways task force is comprised of physicians with disease content expertise and pharmacists. The majority of the members have voting privileges set up by the by-laws, and all members provide transparency regarding any conflicts of interest that are made publicly available. Prior to discussion of a particular therapy regimen, a pharmacist creates evidence tables to review efficacy and toxicity and which are discussed by the task force at regularly scheduled web-based calls. Each decision is open for discussion, and after each call, voting commences. After a vote is decided, the vote goes out for input to relevant disease research committees and then pending feedback and responses, to the network of physicians as a whole for an open comment period for consideration of the therapy regimen prior to incorporation within the pathway. Originally this occurred in a paper-based system, but ultimately, as clinicians became more dependent upon the electronic health record, this system lacked integration, efficiency, and tracking capability. Inclusion of treatment regimens on pathways impacts providers because inclusion of a regimen within value pathways delineates a treatment regimen is given in concordance with evidence-based guidelines. Concordance with evidence-based guidelines is important as it usually facilitates high quality care. However, exceptions to guideline-based care are sometimes necessary as not all patients and diseases are similar, and some require variance from standard treatment for many patient or for disease specific reasons, which undergo individualized quality review. Quantitatively and qualitatively reporting variance gives insight into the reasons for warranted deviation and can help in understanding some of the limitations of a pathway and

future refinement of the pathway. Widespread studies of adherence have not been conducted prospectively, and available data limitations clouds routine assessment.

Measurement of effective implementation:

There are many data limitations in quantifying optimal implementation of guideline-based prescribing in cancer. Determining stage is a critical initial step in the care of patients with cancer and is essential for determining prognosis and optimizing therapy. [i]In addition to stage and other critical elements being critical decision points in determining therapeutic intervention that vary by cancer type, accurate characterization of critical elements in the electronic health record is paramount in determining guideline adherence, pathway valuation, quality improvement, and to use electronic health records for outcomes research and development of care delivery tools such as treatment and survivorship care plans. Treatment is often dependent on tumor origin, stage, histopathologic characteristics, and sometimes molecular markers, and thus these data elements are necessary to guide and measure pathway compliance.

Historically, electronic health records have been limited in their information on cancer stage and, without discrete information on stage and histopathologic characteristics of cancer that help determine optimal therapeutic intervention, assessment of guideline compliance is not possible. In addition, clear documentation of cancer stage in the EHR early in the course of disease is a metric of quality cancer care endorsed by the National Quality Forum and is an important metric of quality to be tracked in CMMIs alternative

payment model for oncology, the Oncology Care Model. (NQF) For all of these reasons, accurate reporting of stage and tumor characteristics that guide treatment decisions is imperative to determining compliance with treatment guidelines.

Recognizing that the paper-based system for ordering therapy treatment regimens was suboptimal, and utilization was variable for a number of reasons, organizations sought to enhance compliance with evidence-based treatment regimen choices by altering the choice architecture used when ordering chemotherapy regimens within the electronic health record. In altering the choice architecture, it is unknown if the ability to assess compliance with evidence-based treatment regimen decisions would improve because it was incorporated within the technology platform as a necessary step in treatment ordering, or that compliance with evidence-based treatment decisions would improve which would enhance quality.

Using Technology Platforms to Facilitate Quality Improvement Through Clinical Decision Support

Reporting of staging and relevant data for cancers in electronic health record (EHR) systems is limited, but, if improved, could be used systematically for reporting requirements, communication of prognosis, treatment planning, and measurement of compliance with regimen-based treatment guidelines. Oncologists' adherence to treatment pathways reduces variability in practice patterns, enhances quality improvement, and has the potential to reduce cost of care.

Following the health information technology incentives in the American Recovery and Reinvestment Act of 2009, and subsequent meaningful use stipulations, electronic health

records (EHRs) have increased utilization in oncology practice with the hope of improving quality, safety, and efficiency of health care. Despite these goals, EHRs have fallen short on delivering on this promise, with tremendous time and cost expended on quality reporting in EHRs and scant evidence of clear improvement in quality and efficiency. (Casalino, 2016) (Kharbanda, 2018) As frequently is the case, the devil is in the details. EHRs in and of themselves are not the problem, but only a tool to facilitate change. Facilitating optimal use of the tool in the systems that connect care delivery through ordering therapy regimens may lead to improved outcomes. Clinical decision support systems (CDSS) are some of these tools. CDSS is a tool that can foster improved choice architecture and lead to better adherence with pathways.

CDSS are a way to utilize information technology infrastructure throughout clinical practice and provide clinicians with choice architecture to choose evidence-based regimen therapy. CDSS have been used to appropriately target the dose of therapies in the clinical setting (Evans, 2016), and predict risk of a negative outcome to provide insight in to follow up needs (Witteveen, 2015). They are being implemented in large centers of complex care to be incorporated into process workflow, facilitate communication, and assess guideline adoption by tracking compliance. With more and more clinical data utilized by providers to make regimen treatment decisions for their patients, CDSS have the ability to present all necessary documented clinical data at the point of decision making and tailor the options to patient and disease-specific factors. There is limited information available in the literature

evaluating CDSS's ability to capture and report similar programs in different CDSS or facilitate compliance with evidence-based treatment strategies.

To optimally measure and facilitate quality improvement, this project will measure the efficacy of a clinical decision support tool in our oncology specific electronic health record at facilitating value pathways compliance across the US Oncology network of independent community oncology practices. The use of the CDSS tool, as part of the electronic health record, to capture cancer stage and value pathway compliance, is important because the many practices under US Oncology are quite varied. They have a variety of compensation models, a variety of organizational structures, and each has its own history of adoption of the value pathways system. It will be valuable to determine the degree that the CDSS can promote quality care in the face of such a degree of practice variability.

Healthcare Value

While cancer care progress has skyrocketed, so too has the cost of cancer drugs. Recognizing that the cost of cancer drugs represents a tremendous healthcare cost, value pathways at their inception were designed to incorporate efficacy, toxicity, and cost, frequently evaluating the incremental cost effectiveness of the next nearest comparator. The cohort of therapy choices within value pathways frequently incorporates lower cost higher value treatment regimens. Retrospective studies evaluating compliance with value pathways and cost have demonstrated substantial cost savings. (Kolodziej, 2011) (Hoverman, 2011)

This is of escalating importance given that there is an exponential increase in the cost of new cancer drug therapies. (Figure 3)

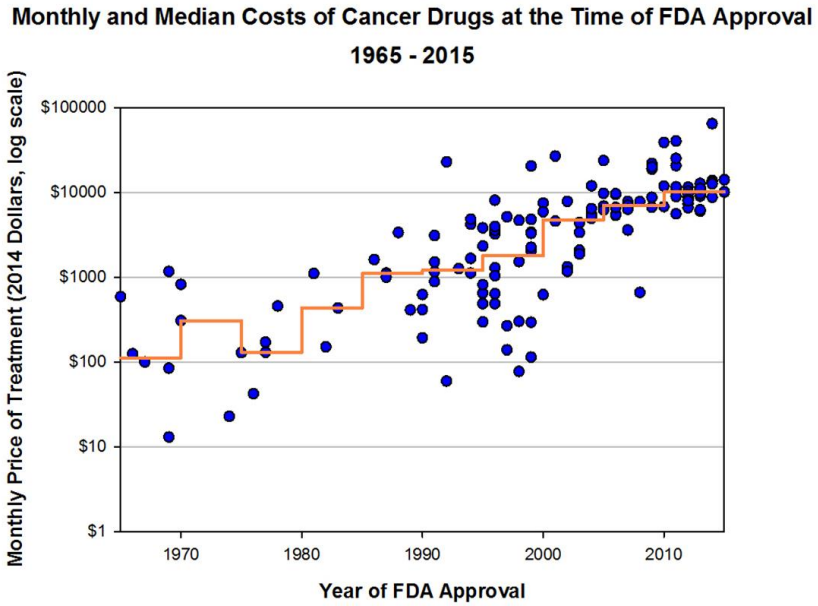


Figure 3. Monthly and Median Costs of Cancer Drugs at the Time of FDA Approval Source: Peter Bach https://www.mskcc.org/research-areas/programs-centers/health-policy-outcomes/cost-drugs **

This pattern of rising costs necessitates improved stewardship among clinicians while still acting as an agent for their patients. This heightens the public health importance of this project to not just a matter of quality control but also one of value stewardship. The rising cost of cancer drugs with the older age distribution of the population and

resultant increase in cancer prevalence is one contributor to the societal problem of growing healthcare costs. (Figure 4)

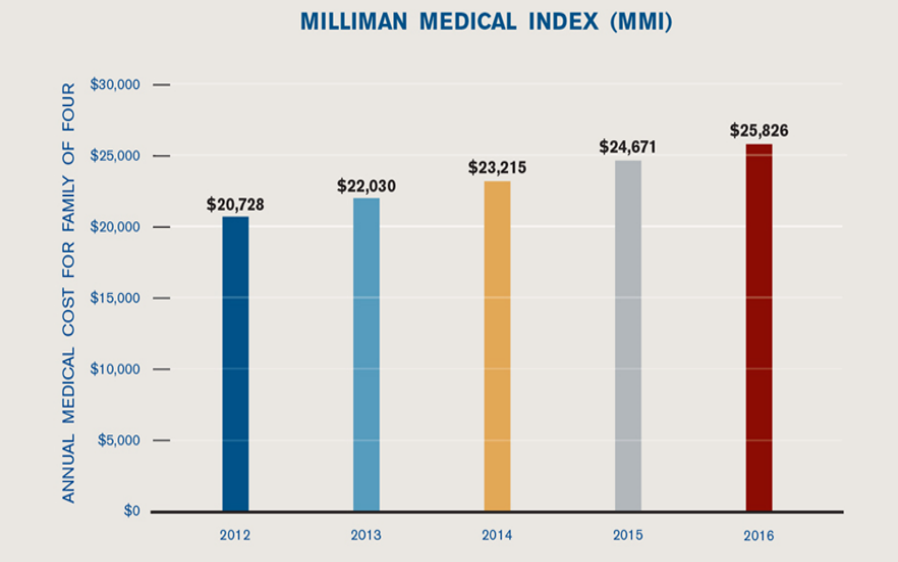


Figure4: Annual medical costs for a family of four Girod C. 2016 Milliman Medical Index. http://www.milliman.com/mmi/

These systems will be more important as we transition from volume-based to value-based care. One aspect of this is the adoption of alternative payment model contracts including the Oncology Care Model from the Centers for Medicare and Medicaid Innovation (CMMI). When a patient is diagnosed with a new cancer, they are referred to a doctor because of an abnormal screening test, symptom, or sign. Frequently patients will require physical examination, laboratory, or imaging tests to determine the stage of their disease, and usually a biopsy to understand the molecular characteristics

that drive growth. The patient will also have comorbidity assessed, as other health illnesses will often impact cancer prognosis and the ability to treat the patient. Some other factors that may influence treatment could also be the healthcare coverage of the patient and out of pocket financial responsibilities in addition to general patient preferences.

When these data are assembled by the treating physician, the patient and physician will make choices about their treatment regimen. As an optimal regimen-based treatment care plan is designed, there may be many therapeutic options that could be implemented that are within or outside of general treatment guidelines.

From this process, it can be seen that three are a few key ways in which EHR-based decision support might improve quality in health care. A leading model accounting for the various means by which health care information systems might "benefit" quality of care is DeLone and McLean's information systems "Benefits Effects" model. (DeLone&McLean, 1992) This Benefits Effects model includes three successive levels that align with Donabedian's structure process outcome model. (Donabedian, 1983) These benefits or "success dimensions" can be in system quality, information quality, system use, user satisfaction, individual impact, and organizational impact.

The transition to the Value Pathway system incorporated in the EHR in US Oncology, a large network of private community oncology practices providing cancer care across the country, notably affects the Systems Use component of the Benefits Effects model, and that is examined in this study. With the regular review of evidence regarding outcomes and costs

of oncology treatment by US Oncology's Pathways Task Force, and by using that evidence basis to develop standard evidence-based treatment pathways to be prompted and promoted, the CDSS should have an influence upon the regularity of implementation of these evidence-based pathways. In turn, patients should experience superior clinical outcomes, and, as an organization, US Oncology should be able to deliver this successful outcome more efficiently and effectively. Although the case is compelling that quality of care will benefit from CDSS use by these theoretically specified means, this has not been empirically established.

Public Health Significance

As noted, the uptake of evidence-based guidelines in oncology is not well-studied, but existing evidence shows that compliance with treatment guidelines, when provided for clinicians, is not strong. Thus, we are only modestly taking advantage of the great degree of empirical evidence being regularly generated regarding efficacious and value-based oncology care. The loss to the public is the use of less effective and less cost-effective therapies. The public is failing, to some degree, to benefit from available knowledge and available interventions. This study empirically examined the boost that decision support and decision architecture might provide in a representative real-world setting. If this strategy is shown to improve care, this style of care could be more widely supported and adopted.

Purpose

The question being examined in this project is whether a well-implemented, EHR-based Clinical Decision Support System, including stronger provision of relevant clinical

information and evidence-based opt-out clinical care pathways, increases the quality of oncology care as measured through value pathway compliance. Results would demonstrate that EHR-based decision support can improve the quality of care, if implemented well.

Hypothesis: Implementation of an EHR-based clinical decision support system will result in increased physician compliance with initially recommended treatment pathway, per the EHR CDSS, across practices as well as within practices.

Hypothesis 1: Post-implementation of the EHR-based CDSS, a higher percentage of regimens will be concordant with value pathways evidence-based choices in comparison with pre-implementation.

Hypothesis 1A: Post-implementation of the EHR based CDSS, a higher percentage of regimens will be concordant with value pathways evidence-based choices in comparison with pre-implementation across the entire cohort of practices that implemented the CDSS tool over the study time frame.

A multi-level logistic regression model was used to determine the impact of CDSS on regimen compliance with evidence-based pathways. A multi-level regression model is most appropriate as it can account for inter-cluster influences that may impact the outcome such as categorical disease state (breast, lung, prostate, etc.), disease stage (localized, advanced), practice (practice 1-9), and doctor while the predictor to be examined is the influence of the CDSS tool on the outcome of regimen compliance (Y/N).

Hypothesis 1B: Post-implementation of the EHR based CDSS, a higher percentage of regimens will be concordant with value pathways evidence-based choices in comparison with pre-implementation across individual practices that implemented the CDSS tool over the study time frame.

A multi-level logistic regression model was used as it can account for inter-cluster influences that may impact the outcome such as categorical disease state (breast, lung, prostate, etc.), disease stage (localized, advanced), and doctor while the predictor to be examined is the influence of the CDSS tool on the outcome of regimen compliance (Y/N) within each of the nine practices. These are represented in nine separate models with the same structure to evaluate the influence on each practice.

Hypothesis 2: Post-implementation of the EHR based CDSS, a higher percentage of regimens ordered by each oncologist will be concordant with value pathways evidence-based choices in comparison with pre-implementation across the entire cohort of practices that implemented the CDSS tool over the study time frame.

A multi-level logistic regression model was used as it can account for inter-cluster influences that may impact the outcome such as categorical disease state (breast, lung, prostate, etc.), disease stage (localized, advanced), doctor and practice (practices 1-9) while the predictor being examined is the influence of the CDSS tool on the outcome of regimen compliance by each doctor (percentage point compliance before and after).

Hypothesis 3: Post-implementation of the EHR based CDSS, the percentage of regimens ordered by each oncologist will be more likely to be at least 75% concordant with value pathways evidence-based choices in comparison with pre-implementation across all practices that implemented the CDSS tool over the study time frame.

To measure the impact of the CDSS tool on the dichotomous variable, McNemar's test was used to compare each individual physician's value pre- and post- CDSS tool implementation to evaluate the effect of the CDSS tool on the benchmark of 75% compliance of regimens within the cohort of practices being adherent to value-pathways.

Methods:

Study design:

This is a retrospective observational cohort study evaluating the efficacy of the Clear Value Plus CDSS supporting value pathways embedded within an oncology specific EHR from January 1, 2014 through May 30, 2016 over a 9-month interval for each of 9 statewide practices, including 633 physicians, with rolling implementation across the country.

Sampling technique:

A four-month pre-implementation period was compared to a four-month post-implementation period, with a one-month washout immediately post implementation. All new patient specific regimens were evaluated for the pre-specified endpoints and total regimens per practice, total regimens per cohort of practices, and total regimens per doctor

were compared during the study interval for pathway adherence for the included diseases. Qualifying diseases include breast cancer, ovarian cancer, non-small cell lung cancer, small cell lung cancer, pancreas cancer, prostate cancer, colorectal cancer, multiple myeloma, diffuse large B cell lymphoma, follicular lymphoma, and chronic lymphocytic leukemia. The value-pathway compliance was measured categorically as on or off pathway by the number of regimens prescribed throughout the practice and the aggregate of practices.

All oral drugs ordered by electronic e-prescribing without accompanying regimen order and all hormone therapy regimens (for breast and prostate cancer) were excluded due to data limitations in capturing oral therapy during the study interval. Patient ages, comorbid illness, and case mix of cancer types vary by physician and by practice during the study period.

Variables assessed and measured:

Each new regimen is categorized as “on” or “off” pathway. Ordering physician, practice location, cancer type, and cancer disease stage (localized, metastatic) are abstracted from data available within the EHR.

Statistical analysis:

How the value pathways CDSS influences value-pathway compliance was evaluated by estimating an odds ratio using a mixed-effect logistic regression to measure the association between implementation of the CDSS tool and data completeness and pathways compliance. Fixed effects within the model included implementation of the value pathways

CDSS tool, cancer type and stage (localized or advanced). Clustering for doctor and practice was also accounted for by utilizing a multi-level model for doctor and practice. Improvement of physician compliance to the benchmark 75% of compliance were evaluated utilizing McNemar's test.

SAS 9.4 (trademark; Cary, NC) software was used to fit the multi-level logistic regression model and estimate the odds ratio of impact of the CDSS on the outcomes. SAS procedure GLIMMIX was applied. This study has been approved by the US Oncology Institutional Review Board exemption mechanism.

Inclusion/Exclusion Criteria and Statistical Analysis Plan:

1. Inclusion Criteria:
    - Regimens assessed during the time interval for:
        - Practice 1: 59 doctors
        - Practice 2: 29 doctors
        - Practice 3: 35 doctors
        - Practice 4: 34 doctors
        - Practice 5: 20 doctors
        - Practice 6: 72 doctors
        - Practice 7: 33 doctors
        - Practice 8: 49 doctors
        - Practice 9: 302 doctors

    - Study period: three cohort statuses determined by regimen assigned date.
        - Pre: 4 months prior to CVP implementation
        - Washout: 1 month after CVP implementation
        - Post: day 31 to day 150 after CVP implementation, 4 months data.
2. Exclusion Criteria: Disease types or regimens were excluded due to recent changes in the pathways or a high anticipated amount of oral oncolytics.

- Regimens assessed for Melanoma, Primary peritoneal cancer, Fallopian tube cancer, Chronic Myelogenous Leukemia, Esophageal Cancer, Gastric Cancer, Head and Neck Cancer, Myelodysplastic Syndrome and Renal Cell Cancer.
- Oral therapy ordered via e-Rx functionality without a concomitant regimen order
- Hormonal only therapy assessed for breast and prostate cancers. Either single agent or hormonal combinations of the below drugs.
  (Anastrozole, Tamoxifen, Letrozole, Exemestane, Degarelix, Leuprolide, Histrelin, Triptorelin, Goserelin, Flutamide, Bicalutamide, Nilutamide, Estrogen, Fulvestrant, Megestrol)

The resulting analysis is an evaluation of the degree that adoption of the EHR-based CDSS can shift providers to deliver cancer care that follows pre-determined, evidence-based clinical pathways. This specific analysis illustrates the value of evidence-based medicine and clinical decision support upon the quality of healthcare.

Results:

This analysis evaluated the degree that oncologists could be influenced to opt for initial, recommended, evidence-based oncology treatment regimens due to adoption of the noted EHR-based CDSS tool for total of 633 doctors across 9 practices. Practices ranged in size between 20 to 302 physicians, with 560 doctors included altogether, and 29,926 individual patient treatment regimens were included (Table 1).

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Pre-implementation, there were 14,009 eligible patients seen, and 10,623 of these were started on the recommended treatment pathway. Post-implementation, there were

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15,917 eligible patients seen, and 13,090 of these were started on the recommended treatment pathway. Patient counts by cancer type and by site are in Table 2a and Table 2b.

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When applying a multi-level logistic regression model to the entire cohort, modeling patients as level 1, doctors as level 2, and practices as level 3, the post CDSS implementation odds ratio of a patient being started on the CDSS tool-provided evidence based pathways was 1.48 (95 % CI 1.25; 1.76; Table 3). When the change in compliance with the recommended regimen was analyzed in a separate regression for each practice, all of the individual practices exhibited an increased likelihood of evidence-based pathways compliance after implementation of the CDSS tool, although the results for two of these practices did not reach statistical significance. For the statistically significant differences, these odds ratios ranged from 1.37 to 1.85 (Table 3).

The percentage point change in compliance was generally highest in practices where pre-implementation compliance with evidence-based pathways was lowest. Practice A improved from 61% to 74% compliance, a 13 percentage point change, practice D improved from 48% to 65% compliance, a 17 percentage point change, and practice E increased from 59% to 74%, a 15 percentage point change. In contrast, practices that had a high degree of compliance pre-implementation changed less. Practice B went from 77% to 78%, Practice F went from 75% to 84%, Practice H from 75% to 82%, and Practice I from 85% to 89% (Figure 5).

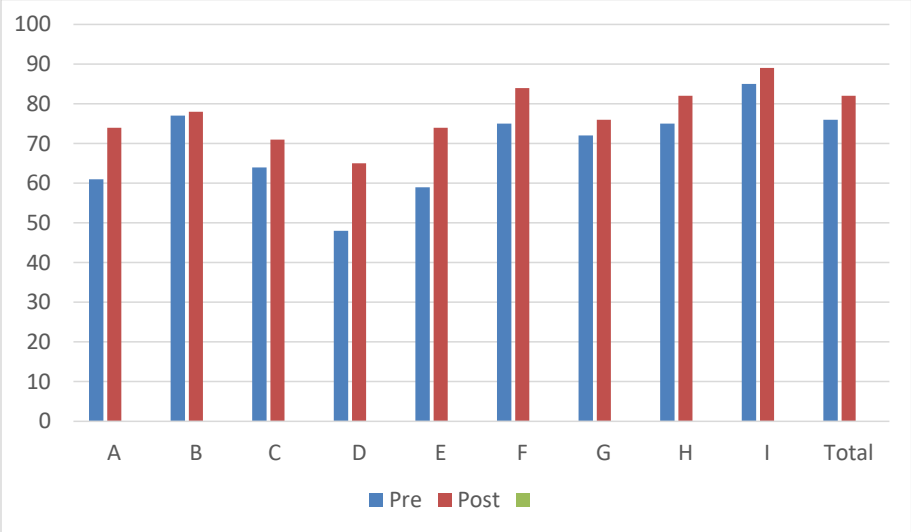

Figure 5. Average Compliance by Practice and Total Pre and Post Implementation

The number of physicians who were at 75% or greater pathway compliance for their patients was examined pre- and post-implementation. Among the 560 physicians included in this study, 327 (58%) were at or above a benchmark of 75% compliance prior to the CDSS tool and 402 (72%) were at or above that benchmark after implementation of the CDSS tool (Figure 5); this 14% increase was statistically significant when tested with McNemar's test ($p<0.001$).

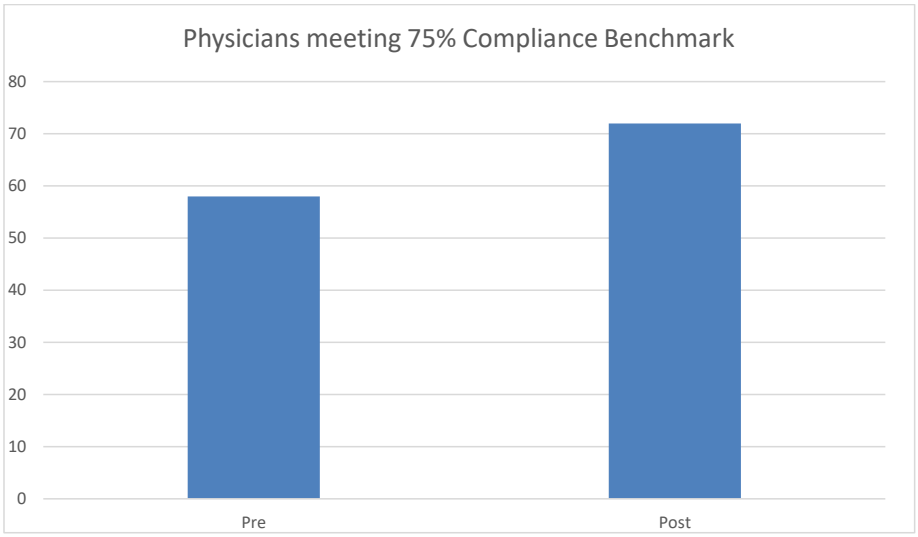

Figure 6. Percentage of physicians overall meeting the 75% benchmark of compliance pre and post CDSS ($p<0.001$)

Each oncologist's compliance with the CDSS-provided initial regimen, for his or her patients, was evaluated. While the majority of physician regimens on pathways became more compliant over the study period, this was not statistically significant; individual physician compliance change is presented in Table 4.

In conclusion, implementation of the CDSS tool was a successful mechanism to increase compliance to evidence-based pathways overall, and within individual practices. In addition, physician benchmark performance of 75% compliance with evidence-based pathways was improved by implementing the CDSS tool embedded within the EHR.

Discussion

This study is useful on many fronts. As we seek to implement clinical informatics tools in healthcare, implementing an iterative process may facilitate clinician engagement. This CDSS implementation was not entirely "top down" but instead the evidence-based pathways are agreed upon and feedback is received from clinicians within the network. Similarly, The Sunstein/Thaler concept of the "nudge" is so important in implementing clinical informatics solutions like decision support: the nudge of behavior is a strong suggestion, but not a mandate. Physicians are autonomous creatures who are highly educated and trained. It is insulting and inaccurate to think given the current level of decision support that CDSS systems should supplant clinician judgment, but augmenting judgment is better received. Operationally, it is useful to understand that this CDSS tool implemented in the EHR is at the point of care. It does not require an additional platform or interface and does not need to be delayed until the interaction with the patient is completed. Clinicians will usually discuss choices with their patients and use the CDSS system at the time of that interaction. For CDSS and other clinical informatics systems to be effective, they should be efficient, effective, and at the point of care.

Strengths of this study include its practical community-based setting, which is a generalizable operational laboratory given the location of these practices in different states and also generalizable to having broad application in oncology as most patients are treated in a community-based setting. Implementation has been assessed across actual community oncology practices where providers see a wide array of cancer types Some of the study's weaknesses include the small number of individual patient treatment regimens per physician

during the short interval studied gives the study low power to detect meaningful differences at the individual level. Similarly, as some of the practices are smaller in number, the study had low statistical power at the practice level. Despite this, there is a statistically significant result across the cohort of practices and a clinically meaningful result within each practice. This study may be underpowered to evaluate compliance improvement generally, at the physician level, but there was an obvious individual physician improvement in compliance to benchmark. This benchmark of 75% compliance is a useful benchmark level as it is used as a target for compliance in many alternative payment model contracts with payers.

Another limitation is that there are factors that can influence compliance with evidence-based treatment within each practice that could vary between the practices within this study and that could limit or enhance the effectiveness of this tool. For example, if one practice is culturally more aligned with evidence-based prescribing, if practice leadership prioritizes the initiative, if it has an individual pay-for-performance initiative implemented for evidence based prescribing benchmarks, or is in alignment with payers around alternative payment model contracts. Leadership support, pay for performance initiatives, and contract alignment with payers were highly variable between the practices included in this study. Among the largest practice with the highest degree of concordance with evidence based pathways, long standing leadership support, pay for performance initiatives to facilitate some level of compliance, and robust alignment with payer systems are all present. Among the least compliant of the practices, there is exists less robust leadership support, and there are no pay for performance initiatives, nor is there alignment with regional payers. That said, both groups demonstrated significant improvement with the clinical decision support system.

Cueing effects should also be taken in consideration as we evaluate the efficacy of CDSS in influencing compliance with evidence based guidelines. As the choice architecture of evidence based choices is visually directly in front of clinicians as a visual cue to comply with evidence based guidelines at the point of care with patients, the location of the choice architecture as part of the clinicians workflow is an important part of the CDSS architecture that can influence compliance with evidence based guidelines. In addition, this study evaluated a tool is within one EHR, and the conclusions may be limited if we seek to extrapolate the conclusions to effects on other EHR platforms that operate differently within a practice.

While this study conveys insight that CDSS tools will help increase compliance with evidence-based treatment guidelines, it also leaves many unanswered questions. It can be observed that some of the greatest improvements in compliance with evidence-based treatments occurred within practices that had low levels of compliance initially. It may be that if the goal of compliance is somewhere around 75-80% that CDSS tools can influence compliance less when a practice is closer to that target. We also observe that some practices have very high compliance rates initially while others do not. These may be due to differences within the practices. Some differences that may account for these changes could be compensation formulas and cultural differences. For example, a review evaluating reimbursement incentives and physician practice in oncology suggests that there may be instances where physicians alter treatment recommendations based on personal revenue considerations. (Mitchell, 2010). If this appears to influence treatment decisions, alteration of

compensation formulas to carve out drug revenue and participation in alternative payment models may be helpful ways to remove this bias.

Conclusions: Use of a CDSS tool within the EHR is an effective way to improve regimen compliance with evidence-based pathways across a cohort of practices, within individual practices, and is an effective way to increase individual physician compliance to a 75% benchmark of compliance. More broadly, an iterative process that engages physicians in solutions to nudge clinical decision making is an effective way to implement clinical informatics solutions in practice.

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Appendices

Appendix A: IRB Exemption Approval

Dr. Debra Patt
UT-H - School of Public Health
December 10, 2019
HSC-SPH-19-1043 - *NUDGING QUALITY IMPROVEMENT IN CANCER CARE: FACILITATING QUALITY IMPROVEMENT BY USING A CLINICAL DECISION SUPPORT SYSTEM TO PROMOTE ADHERANCE TO EVIDENCE BASED GUIDELINES BY ALTERING CHOICE ARCHITECTURE*
The above named project is determined to qualify for exempt status according to 45 CFR 46.101(b)
CATEGORY #4 *: Research, involving the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens, if these sources are publicly available or if the information is recorded by the investigator in such a manner that subjects cannot be identified directly or through identifiers linked to the subjects.*
CHANGES: Should you choose to make any changes to the protocol that would involve the inclusion of human subjects or identified data from humans, please submit the change via iRIS to the Committee for the Protection of Human Subjects for review.
INFORMED CONSENT DETERMINATION:
Waiver of Consent Granted
HEALTH INSURANCE PORTABILITY and ACCOUNTABILITY ACT (HIPAA):
Waiver for Retrospective Chart Review granted:
Information to be accessed: medical record
PHI to be retained: none
STUDY CLOSURES: Upon completion of your project, submission of a study closure report is required. The study closure report should be submitted once all data has been collected and analyzed.
Should you have any questions, please contact the Office of Research Support Committees at 713-500-7943.

Table 1. Number of physicians per practice and unique patients with regimens pre-implementation and post-implementation of CDSS, per practice.

Site	Number of Physicians	Regimens (Percent of Total), Pre-Implementation	Regimens (Percent of Total), Pre-Implementation
A	523 (9.3%)	1.251 (8.9%)	1,408 (8.8%)
B	27 (4.8%)	714 (5.1%)	799 (5.0%)
C	31 (5.5%)	648 (4.6%)	572 (3.6%)
D	30 (5.4%)	1,032 (7.4%)	1,306 (8.2%)
E	17 (3.0%)	318 (2.3%)	470 (3.0%)
F	56 (10.0%)	1,237 (8.8%)	1,377 (8.7%)
G	28 (5.0%)	645 (4.6%)	801 (5.0%)
H	45 (8.0%)	1,338 (9.6%)	1,546 (9.7%)
I	274 (48.9%)	6,826 (48.7%)	7,638 (48.0%)
Total	560 (100.0%)	14,009 (100.0%)	15,917 (100.0%)

Table 2a. Pre-CDSS implementation, number and percent of patients by type of cancer, by site.

	A	B	C	D	E	F	G	H	I	Total
Breast Cancer	385 (30.8)	210 (29.4)	237 (36.6)	323 (31.3)	98 (30.8)	418 (33.8)	196 (30.4)	443 (33.1)	2,507 (36.7)	4,817
CLL/SLL	32 (2.6)	16 (2.2)	16 (2.5)	19 (1.8)	6 (1.9)	23 (1.9)	9 (1.4)	32 (2.4)	126 (1.9)	279
Colon Cancer	117 (9.4)	105 (14.7)	59 (9.1)	108 (10.5)	28 (8.8)	92 (7.4)	62 (9.6)	122 (9.1)	719 (10.5)	1412
Diffuse Large B-Cell Lymphoma	32 (2.6)	24 (3.4)	22 (3.4)	19 (1.8)	9 (2.8)	41 (3.3)	27 (4.2)	63 (4.7)	227 (3.3)	464
Follicular Lymphoma	36 (2.9)	37 (5.2)	23 (3.6)	43 (4.2)	15 (4.7)	42 (3.4)	14 (2.2)	46 (3.4)	200 (2.9)	456
Hodgkins Lymphoma	10 (0.8)	10 (1.4)	7 (1.1)	13 (1.3)	2 (0.6)	8 (0.7)	13 (2.0)	22 (1.6)	85 (1.3)	170
Mantle Cell Lymphoma	8 (0.6)	2 (0.3)	7 (1.1)	6 (0.6)	1 (0.3)	10 (0.8)	4 (0.6)	15 (1.1)	57 (0.8)	110

Multiple Myeloma	70 (5.6)	46 (6.4)	38 (5.9)	51 (4.9)	20 (6.3)	65 (5.3)	53 (8.2)	116 (8.7)	410 (6.0)	869
Non-Small Cell Lung Cancer	266 (21.3)	115 (16.1)	76 (11.7)	189 (18.3)	54 (17.0)	192 (15.5)	136 (21.1)	177 (13.2)	1,045 (15.3)	2,250
Ovarian Cancer	116 (9.3)	34 (4.76)	71 (11.0)	29 (2.8)	11 (3.5)	69 (5.6)	9 (1.4)	63 (4.7)	314 (4.6)	716
Pancreatic Cancer	49 (3.9)	30 (4.2)	27 (4.2)	43 (4.2)	33 (10.4)	82 (6.6)	46 (7.1)	82 (6.1)	354 (5.2)	746
Prostate Cancer	39 (3.1)	14 (2.0)	22 (3.4)	81 (7.9)	8 (2.5)	89 (7.2)	20 (3.1)	58 (4.3)	183 (2.7)	514
Rectal Cancer	52 (4.2)	44 (6.2)	26 (4.0)	63 (6.1)	19 (6.0)	68 (5.5)	27 (4.2)	58 (4.3)	377 (5.5)	734
Small Cell Lung Cancer	39 (3.1)	27 (3.8)	17 (2.6)	45 (4.4)	14 (4.4)	38 (3.1)	29 (4.5)	41 (3.1)	222 (3.3)	472
Total	1,251	714	648	1,032	318	1,237	645	1,338	6,826	14,009

Table 2b. Post-CDSS implementation, number and percent of patients by type of cancer, by site.

	A	B	C	D	E	F	G	H	I	Total
Breast Cancer	466 (33.1)	230 (28.8)	194 (33.9)	397 (30.4)	112 (23.8)	473 (34.4)	235 (29.3)	561 (36.3)	2,772 (36.3)	5,440
CLL/SLL	37 (2.6)	24 (3.0)	29 (5.1)	26 (2.0)	16 (3.4)	40 (2.9)	24 (3.0)	57 (3.7)	181 (2.4)	434
Colon Cancer	108 (7.7)	86 (10.8)	46 (8.0)	123 (9.4)	47 (10.0)	78 (5.7)	75 (9.4)	108 (7.0)	721 (9.4)	1392
Diffuse Large B-Cell Lymphoma	33 (2.3)	37 (4.6)	19 (3.3)	54 (4.1)	12 (2.6)	37 (2.7)	29 (3.6)	59 (3.8)	224 (2.9)	504
Follicular Lymphoma	45 (3.2)	29 (3.6)	18 (3.2)	24 (1.8)	13 (2.8)	43 (3.1)	16 (2.0)	41 (2.7)	215 (2.8)	444
Hodgkins Lymphoma	23 (1.6)	10 (1.3)	4 (0.7)	14 (1.1)	3 (0.6)	7 (0.5)	17 (2.1)	29 (1.9)	78 (1.0)	185
Mantle Cell Lymphoma	10 (0.7)	12 (1.5)	5 (0.9)	22 (1.7)	2 (0.4)	5 (0.4)	7 (0.9)	24 (1.6)	67 (0.9)	154

Multiple Myeloma	94 (6.7)	60 (7.5)	43 (7.52)	70 (5.4)	41 (8.7)	69 (5.0)	75 (9.4)	162 (10.5)	503 (6.6)	1,117
Non-Small Cell Lung Cancer	252 (17.9)	130 (16.3)	71 (12.41)	259 (19.8)	98 (20.9)	253 (18.4)	157 (19.6)	171 (11.1)	1,186 (15.5)	2,577
Ovarian Cancer	133 (9.5)	40 (5.0)	48 (8.39)	35 (2.7)	18 (3.8)	62 (4.5)	8 (1)	61 (4.0)	346 (4.5)	751
Pancreatic Cancer	57 (4.1)	40 (5.0)	23 (4.02)	69 (5.3)	43 (9.2)	71 (5.2)	42 (5.2)	79 (5.1)	412 (5.4)	836
Prostate Cancer	44 (3.1)	35 (4.4)	33 (5.77)	91 (7.0)	16 (3.4)	127 (9.2)	47 (5.9)	76 (4.9)	243 (3.2)	712
Rectal Cancer	70 (5.0)	44 (5.5)	30 (5.24)	61 (4.7)	24 (5.1)	60 (4.4)	38 (4.7)	68 (4.4)	407 (5.3)	802
Small Cell Lung Cancer	36 (2.6)	22 (2.8)	9 (1.57)	61 (4.7)	25 (5.3)	52 (3.8)	31 (3.9)	50 (3.2)	283 (3.7)	569
Total	1,408	799	572	1306	470	1,377	801	1,546	7,638	15,917

Table 3. Odds ratio of regimen compliance, post versus pre CDSS implementation, overall and for each individual practice.

Site	Odds Ratio	95% lower confidence level	95% upper confidence level	Pr > |t|
Overall, post vs. pre	1.48	1.25	1.76	<0.001
A	1.60	1.33	1.94	<0.001
B	1.13	0.88	1.45	0.293
C	1.39	1.08	1.79	0.016
D	1.85	1.53	2.24	<0.001
E	1.76	1.32	2.36	0.002
F	1.71	1.38	2.11	<0.001
G	1.23	0.96	1.57	0.089
H	1.37	1.12	1.67	0.007
I	1.46	1.30	1.63	<0.001

Table 4. Individual physician compliance with treatment protocol pre-CDSS implementation and post-CDSS implementation, count and percent of patients pre and post, difference in percent post versus pre, and odds ratio for difference, post versus pre-implementation.

Physician	Pre: Count	Pre rate, %	Post, Count	Post Rate, %	Difference in Percent	*P* value	Odds Ratio	95% LCL	95% UCL
All						<.0001	1.4792	1.3624	1.606
1	11	63.636	18	88.889	25.253	0.1681	1.9778	0.7493	5.2205
2	27	66.667	36	86.111	19.444	0.1009	2.006	0.8729	4.61
3	21	33.333	24	50	16.667	0.2957	1.5536	0.6796	3.5514
4	24	87.5	42	83.333	-4.167	0.7393	1.1604	0.4825	2.7908
5	23	95.652	30	93.333	-2.319	0.6284	1.2747	0.4762	3.4118
6	21	57.143	10	70	12.857	0.2604	1.7056	0.6723	4.3272
7	22	77.273	30	93.333	16.06	0.1744	1.8986	0.752	4.7929
8	20	95	31	87.097	-7.903	0.9734	1.0163	0.392	2.6347
9	36	36.111	45	48.889	12.778	0.167	1.6432	0.8119	3.3257
10	46	71.739	79	79.747	8.008	0.3697	1.3691	0.6885	2.7224
11	43	86.047	55	81.818	-4.229	0.978	0.9891	0.4524	2.1625
12	6	83.333	6	50	-33.333	0.8705	1.0905	0.384	3.0972
13	9	77.778	7	100	22.222	0.2835	1.7763	0.6208	5.0825
14	8	62.5	6	50	-12.5	0.7063	1.2148	0.4408	3.3474
15	39	56.41	55	61.818	5.408	0.4619	1.2913	0.6529	2.5539
16	14	78.571	5	80	1.429	0.47	1.4628	0.5205	4.111
17	9	66.667	22	95.455	28.788	0.1154	2.2261	0.8216	6.0316
18	6	100	16	100	0	0.3804	1.6127	0.5535	4.6985
19	31	90.323	14	100	9.677	0.296	1.7083	0.625	4.669
20	32	84.375	40	80	-4.375	0.9973	1.0014	0.4362	2.2993
21	9	88.889	14	92.857	3.968	0.4236	1.5229	0.5427	4.2735

22	22	95.455	35	91.429	-4.026	0.6748	1.2289	0.4684	3.2245
23	35	82.857	48	83.333	0.476	0.7006	1.1725	0.5204	2.6416
24	6	83.333	12	91.667	8.334	0.3823	1.5976	0.5577	4.5763
25	16	81.25	19	78.947	-2.303	0.6429	1.2493	0.4867	3.207
26	49	89.796	36	94.444	4.648	0.336	1.562	0.6289	3.8796
27	18	100	24	100	0	0.4884	1.448	0.5073	4.1331
28	23	78.261	34	88.235	9.974	0.2364	1.7106	0.7027	4.1639
29	17	41.176	41	75.61	34.434	0.072	2.1293	0.9345	4.8519
30	23	95.652	25	92	-3.652	0.5692	1.331	0.4965	3.5683
31	21	100	20	90	-10	0.9161	1.0556	0.3856	2.8898
32	7	42.857	4	50	7.143	0.4688	1.4625	0.5221	4.097
33	29	82.759	36	97.222	14.463	0.1129	2.1221	0.8365	5.3835
34	27	85.185	8	87.5	2.315	0.5538	1.3514	0.4979	3.6678
35	24	79.167	33	84.848	5.681	0.4511	1.4005	0.5825	3.3675
36	30	83.333	46	78.261	-5.072	0.8637	1.0735	0.4768	2.4169
37	57	89.474	36	94.444	4.97	0.3114	1.5874	0.6481	3.888
38	21	76.19	20	85	8.81	0.3291	1.5819	0.629	3.9782
39	34	70.588	31	74.194	3.606	0.6144	1.2296	0.5495	2.7511
40	30	83.333	26	69.231	-14.102	0.8616	0.9279	0.3998	2.1539
41	5	80	7	100	20	0.3422	1.6874	0.5725	4.974
42	38	57.895	47	76.596	18.701	0.0806	1.9141	0.9238	3.9661
43	24	91.667	25	96	4.333	0.4175	1.5032	0.5603	4.0329
44	10	40	23	73.913	33.913	0.1636	1.9272	0.7651	4.8543
45	30	6.667	32	21.875	15.208	0.186	1.7671	0.7594	4.1121
46	9	100	16	75	-25	0.9554	1.0291	0.3755	2.8208
47	17	100	16	81.25	-18.75	0.8903	0.9321	0.3422	2.5383
48	32	96.875	46	91.304	-5.571	0.922	1.0476	0.4121	2.6633
49	20	45	25	60	15	0.2263	1.6595	0.73	3.7726

50	6	16.667	4	50	33.333	0.323	1.6896	0.5963	4.7871
51	18	83.333	35	85.714	2.381	0.4198	1.4535	0.5852	3.6103
52	9	88.889	16	87.5	-1.389	0.4912	1.4316	0.5146	3.983
53	23	69.565	45	91.111	21.546	0.0752	2.1976	0.9228	5.2337
54	46	86.957	59	88.136	1.179	0.5423	1.2866	0.5713	2.8976
55	47	82.979	35	82.857	-0.122	0.7262	1.1582	0.5085	2.6377
56	29	96.552	41	97.561	1.009	0.4255	1.4955	0.555	4.0301
57	24	45.833	2	100	54.167	0.2109	1.9305	0.6881	5.416
58	8	62.5	5	80	17.5	0.3747	1.5913	0.5697	4.4447
59	48	79.167	56	98.214	19.047	0.0096	3.0839	1.3161	7.2263
60	9	44.444	7	57.143	12.699	0.4154	1.5066	0.5611	4.045
61	9	55.556	18	77.778	22.222	0.3084	1.6426	0.6314	4.2731
62	16	56.25	18	88.889	32.639	0.082	2.2898	0.8998	5.8269
63	19	57.895	27	77.778	19.883	0.247	1.6585	0.7036	3.9091
64	63	49.206	77	67.532	18.326	0.0367	1.8898	1.0402	3.4331
65	12	66.667	9	88.889	22.222	0.3247	1.6535	0.607	4.5048
66	12	58.333	6	100	41.667	0.1502	2.1177	0.7614	5.8902
67	23	91.304	17	64.706	-26.598	0.6482	0.8067	0.3201	2.0328
68	10	80	16	93.75	13.75	0.2368	1.8512	0.6666	5.1412
69	35	74.286	41	92.683	18.397	0.053	2.3092	0.9893	5.3899
70	29	86.207	95	85.263	-0.944	0.6837	1.1818	0.5284	2.6429
71	25	84	21	57.143	-26.857	0.4402	0.7123	0.3005	1.6881
72	13	53.846	21	95.238	41.392	0.0407	2.6976	1.0432	6.9758
73	25	92	54	77.778	-14.222	0.5922	0.7938	0.3404	1.8506
74	7	42.857	5	80	37.143	0.2537	1.8267	0.6483	5.1469
75	13	53.846	12	75	21.154	0.3057	1.6418	0.635	4.2449
76	32	96.875	60	95	-1.875	0.6507	1.2433	0.4837	3.1955
77	15	80	21	71.429	-8.571	0.8653	1.0826	0.4321	2.7124

78	9	77.778	10	70	-7.778	0.6823	1.2286	0.4577	3.2976
79	7	71.429	31	87.097	15.668	0.4532	1.4522	0.547	3.8552
80	3	66.667	3	66.667	0	0.4835	1.4713	0.4988	4.3403
81	5	60	1	100	40	0.419	1.5711	0.5244	4.7068
82	20	90	22	86.364	-3.636	0.6706	1.2321	0.4701	3.2291
83	3	33.333	10	60	26.667	0.3732	1.5957	0.5698	4.4689
84	33	100	46	100	0	0.4895	1.436	0.5138	4.0131
85	51	96.078	76	96.053	-0.025	0.491	1.3762	0.5539	3.4196
86	35	97.143	35	97.143	0	0.564	1.3371	0.4976	3.593
87	35	82.857	56	96.429	13.572	0.0763	2.2172	0.9191	5.3489
88	29	79.31	51	66.667	-12.643	0.6503	0.8376	0.3888	1.8044
89	27	48.148	24	62.5	14.352	0.2446	1.611	0.7209	3.6
90	2	100	11	81.818	-18.182	0.6014	1.3287	0.4567	3.8662
91	27	70.37	19	94.737	24.367	0.0998	2.1791	0.8615	5.5116
92	17	47.059	25	60	12.941	0.3264	1.5267	0.6551	3.558
93	57	52.632	56	64.286	11.654	0.262	1.4414	0.7604	2.7321
94	11	81.818	21	90.476	8.658	0.4265	1.496	0.5535	4.0435
95	20	80	18	100	20	0.1614	2.036	0.7521	5.5118
96	28	89.286	23	86.957	-2.329	0.7206	1.1874	0.4626	3.0473
97	2	50	1	100	50	0.3951	1.6182	0.5328	4.9146
98	39	79.487	31	74.194	-5.293	0.8692	1.0702	0.4767	2.4024
99	14	92.857	11	90.909	-1.948	0.6215	1.2905	0.4681	3.5574
100	34	82.353	30	90	7.647	0.3441	1.5356	0.6308	3.7381
101	29	75.862	19	57.895	-17.967	0.719	0.8558	0.3659	2.0017
102	34	97.059	44	79.545	-17.514	0.3672	0.6687	0.2784	1.6057
103	19	89.474	20	90	0.526	0.5817	1.3164	0.4943	3.5063
104	1	0	1	0	0	0.5359	1.4209	0.4665	4.3281
105	13	69.231	18	83.333	14.102	0.3021	1.6473	0.6376	4.2563

106	10	70	7	85.714	15.714	0.3742	1.5908	0.5706	4.4352
107	46	56.522	64	92.188	35.666	0.0006	3.6515	1.7409	7.6589
108	15	73.333	18	83.333	10	0.348	1.5717	0.6105	4.0459
109	18	83.333	14	71.429	-11.904	0.8295	1.1101	0.4283	2.8768
110	3	0	2	50	50	0.3071	1.7589	0.5943	5.2055
111	16	93.75	22	95.455	1.705	0.4698	1.4543	0.5259	4.0215
112	6	83.333	2	100	16.667	0.4206	1.5702	0.5229	4.7149
113	10	70	20	75	5	0.4778	1.408	0.5466	3.6269
114	36	69.444	42	90.476	21.032	0.1974	1.7483	0.747	4.0919
115	14	50	27	77.778	27.778	0.0381	2.3757	1.049	5.3804
116	46	82.609	50	98	15.391	0.1226	2.0025	0.8289	4.8374
117	30	53.333	27	74.074	20.741	0.0334	2.5843	1.0776	6.1976
118	36	94.444	30	96.667	2.223	0.1235	1.8847	0.841	4.2237
119	22	81.818	35	91.429	9.611	0.5031	1.3954	0.5255	3.705
120	13	76.923	20	95	18.077	0.2548	1.7002	0.6813	4.243
121	23	56.522	18	72.222	15.7	0.3352	1.5361	0.6409	3.6814
122	33	75.758	33	93.939	18.181	0.1867	1.6675	0.7801	3.5646
123	41	82.927	51	84.314	1.387	0.1791	1.9653	0.7329	5.2706
124	18	83.333	15	66.667	-16.666	0.0817	2.1895	0.9058	5.2926
125	30	60	46	76.087	16.087	0.4757	1.3346	0.6031	2.9533
126	9	77.778	11	90.909	13.131	0.9645	0.979	0.3841	2.4949
127	23	86.957	25	76	-10.957	0.3636	1.6036	0.5781	4.4484
128	35	88.571	42	64.286	-24.285	0.9478	0.9705	0.3959	2.3793
129	46	73.913	72	87.5	13.587	0.1205	0.5369	0.2447	1.1779
130	11	63.636	9	66.667	3.031	0.5067	1.3922	0.5235	3.7023
131	13	69.231	25	88	18.769	0.0027	3.7368	1.582	8.8271
132	33	81.818	34	91.176	9.358	0.0664	1.994	0.9541	4.1671
133	1	100	4	100	0	0.1763	1.913	0.7464	4.9029

134	33	45.455	25	96	50.545	0.2127	1.7501	0.7251	4.224
135	15	93.333	23	91.304	-2.029	0.4033	1.5988	0.5311	4.813
136	6	66.667	5	80	13.333	0.5597	1.348	0.4934	3.683
137	55	87.273	49	93.878	6.605	0.4182	1.5365	0.5424	4.3531
138	35	88.571	40	82.5	-6.071	0.9206	1.0439	0.4475	2.4351
139	41	78.049	42	69.048	-9.001	0.9784	1.0105	0.4751	2.1492
140	17	94.118	30	100	5.882	0.3211	1.68	0.6021	4.6873
141	66	95.455	51	100	4.545	0.2515	1.7537	0.6706	4.5859
142	16	75	34	88.235	13.235	0.147	1.9653	0.7881	4.9011
143	43	100	42	80.952	-19.048	0.192	0.5531	0.227	1.3475
144	14	21.429	3	33.333	11.904	0.3057	1.7067	0.6129	4.7521
145	2	0	1	100	100	0.2536	1.9034	0.6296	5.7541
146	21	90.476	27	74.074	-16.402	0.7189	0.8475	0.3437	2.0897
147	16	93.75	8	100	6.25	0.5126	1.423	0.4942	4.0981
148	30	76.667	66	86.364	9.697	0.2076	1.6652	0.7528	3.6836
149	39	87.179	25	96	8.821	0.1852	1.8858	0.7371	4.8244
150	1	100	4	50	-50	0.7516	1.1927	0.3998	3.5578
151	24	75	46	84.783	9.783	0.2563	1.6228	0.7028	3.7473
152	27	96.296	59	93.22	-3.076	0.6738	1.2221	0.4795	3.1152
153	6	33.333	6	50	16.667	0.3828	1.5725	0.5682	4.3516
154	31	67.742	64	59.375	-8.367	0.9064	0.9583	0.4704	1.9521
155	22	50	26	50	0	0.7637	1.1324	0.5028	2.5501
156	9	66.667	29	72.414	5.747	0.5907	1.2903	0.5089	3.2713
157	22	81.818	23	91.304	9.486	0.3252	1.6111	0.6222	4.1717
158	7	28.571	7	71.429	42.858	0.1731	2.0055	0.7362	5.4636
159	13	84.615	19	84.211	-0.404	0.5434	1.3516	0.5107	3.5772
160	30	90	34	76.471	-13.529	0.6918	0.8404	0.3553	1.9878
161	27	59.259	25	92	32.741	0.0409	2.4981	1.0388	6.0077

162	27	96.296	38	89.474	-6.822	0.9032	1.06	0.414	2.7138
163	16	93.75	38	100	6.25	0.2269	1.8802	0.6745	5.2411
164	13	92.308	8	75	-17.308	0.9373	1.0422	0.3718	2.9216
165	1	100	2	100	0	0.4697	1.5073	0.4948	4.592
166	9	66.667	11	100	33.333	0.1546	2.1065	0.7546	5.8805
167	7	28.571	6	66.667	38.096	0.1897	1.9707	0.7143	5.4371
168	14	92.857	21	85.714	-7.143	0.7444	1.1775	0.4402	3.1498
169	16	81.25	25	84	2.75	0.4921	1.3888	0.5433	3.5499
170	29	86.207	35	85.714	-0.493	0.5648	1.2956	0.5357	3.1335
171	27	66.667	30	90	23.333	0.0489	2.3804	1.0042	5.6427
172	2	50	3	33.333	-16.667	0.6365	1.2979	0.4394	3.8339
173	6	83.333	6	66.667	-16.666	0.7067	1.2228	0.4281	3.4922
174	11	36.364	17	88.235	51.871	0.0313	2.8084	1.0976	7.1855
175	37	70.27	26	76.923	6.653	0.5886	1.2545	0.551	2.8564
176	40	90	35	100	10	0.1591	1.9952	0.7622	5.2229
177	47	82.979	53	75.472	-7.507	0.6922	0.861	0.41	1.8082
178	31	67.742	44	68.182	0.44	0.5781	1.239	0.5816	2.6395
179	32	96.875	39	87.179	-9.696	0.807	0.8918	0.3553	2.2382
180	47	80.851	45	93.333	12.482	0.1071	1.9999	0.8603	4.6494
181	5	80	14	85.714	5.714	0.4652	1.4702	0.5218	4.1422
182	33	93.939	44	93.182	-0.757	0.552	1.3273	0.5214	3.3787
183	30	56.667	43	79.07	22.403	0.0888	1.9527	0.9032	4.2216
184	14	78.571	18	94.444	15.873	0.2108	1.8741	0.6999	5.018
185	57	40.351	75	58.667	18.316	0.07	1.7531	0.9551	3.2178
186	17	64.706	15	86.667	21.961	0.183	1.8984	0.7382	4.8816
187	30	60	23	60.87	0.87	0.7349	1.1504	0.5104	2.5929
188	31	35.484	27	62.963	27.479	0.102	1.9338	0.8769	4.2645
189	13	84.615	10	70	-14.615	0.7011	1.2141	0.4501	3.2748

190	24	58.333	15	100	41.667	0.0265	2.9023	1.1326	7.437
191	20	15	12	41.667	26.667	0.0868	2.2253	0.8904	5.5615
192	20	65	31	77.419	12.419	0.2056	1.7314	0.7394	4.054
193	34	85.294	46	89.13	3.836	0.3439	1.5107	0.6422	3.5538
194	25	56	24	75	19	0.0979	2.02	0.8781	4.647
195	29	82.759	25	92	9.241	0.2329	1.7488	0.6974	4.3855
196	42	85.714	59	93.22	7.506	0.2219	1.6987	0.7252	3.9789
197	33	78.788	36	63.889	-14.899	0.5432	0.7859	0.361	1.7109
198	7	71.429	19	84.211	12.782	0.455	1.4619	0.5391	3.9638
199	18	66.667	5	80	13.333	0.3331	1.6406	0.6013	4.4765
200	31	80.645	33	66.667	-13.978	0.6156	0.8134	0.3628	1.8238
201	10	100	17	88.235	-11.765	0.8349	1.1151	0.3996	3.1122
202	21	33.333	32	50	16.667	0.2778	1.5565	0.6994	3.464
203	2	0	1	0	0	0.4306	1.5563	0.5173	4.6821
204	17	88.235	12	100	11.765	0.3659	1.6089	0.5731	4.5173
205	19	42.105	19	73.684	31.579	0.0713	2.2088	0.9333	5.2274
206	44	95.455	49	95.918	0.463	0.5566	1.3258	0.517	3.4003
207	44	70.455	50	80	9.545	0.2361	1.5607	0.7467	3.2621
208	9	66.667	26	92.308	25.641	0.1397	2.0968	0.7843	5.6058
209	19	78.947	13	84.615	5.668	0.4042	1.5062	0.5746	3.948
210	13	30.769	5	60	29.231	0.1695	2.0061	0.7423	5.4211
211	83	78.313	98	86.735	8.422	0.0818	1.7792	0.9296	3.4051
212	11	36.364	9	100	63.636	0.036	2.8846	1.0716	7.7647
213	24	100	17	94.118	-5.882	0.8024	1.1415	0.4043	3.2224
214	24	87.5	25	80	-7.5	0.8924	1.0647	0.4286	2.6452
215	18	66.667	22	77.273	10.606	0.2946	1.6138	0.6587	3.9536
216	6	100	8	75	-25	0.7758	1.166	0.4044	3.3619
217	12	25	8	75	50	0.1181	2.1787	0.82	5.789

218	26	57.692	28	64.286	6.594	0.3728	1.4384	0.6459	3.2033
219	44	75	32	62.5	-12.5	0.7783	0.8974	0.4219	1.9091
220	18	88.889	23	91.304	2.415	0.4108	1.5047	0.5675	3.9896
221	14	85.714	14	85.714	0	0.6007	1.304	0.4818	3.5289
222	25	60	10	80	20	0.146	2.002	0.7847	5.1074
223	33	81.818	43	95.349	13.531	0.0678	2.2843	0.9412	5.5441
224	27	55.556	25	84	28.444	0.0802	2.1394	0.9124	5.0166
225	82	63.415	91	96.703	33.288	<.0001	5.9779	2.9472	12.1253
226	12	66.667	16	93.75	27.083	0.1336	2.1404	0.7913	5.7895
227	17	76.471	20	80	3.529	0.5604	1.3155	0.522	3.3152
228	29	68.966	40	80	11.034	0.1854	1.72	0.7703	3.8407
229	26	92.308	36	86.111	-6.197	0.8945	1.0634	0.4282	2.6407
230	23	91.304	37	83.784	-7.52	0.9633	1.0214	0.414	2.5197
231	12	58.333	5	60	1.667	0.4414	1.4873	0.5406	4.0922
232	43	20.93	79	62.025	41.095	0.003	2.7539	1.4132	5.3664
233	11	72.727	16	93.75	21.023	0.2007	1.9229	0.7057	5.2398
234	2	100	5	80	-20	0.571	1.3667	0.4629	4.0348
235	16	75	9	100	25	0.2196	1.8967	0.6819	5.2759
236	47	89.362	48	95.833	6.471	0.2068	1.7838	0.7257	4.3846
237	48	75	53	75.472	0.472	0.7781	1.1081	0.5419	2.266
238	61	88.525	61	96.721	8.196	0.0861	2.1294	0.8979	5.0501
239	41	78.049	35	88.571	10.522	0.155	1.838	0.7938	4.2559
240	23	82.609	31	96.774	14.165	0.1557	1.9875	0.7694	5.1342
241	30	80	50	66	-14	0.5433	0.789	0.3671	1.696
242	22	86.364	43	90.698	4.334	0.4088	1.4689	0.5891	3.6624
243	24	87.5	27	96.296	8.796	0.2601	1.744	0.6617	4.5969
244	44	77.273	26	92.308	15.035	0.1321	1.966	0.8151	4.7422
245	22	40.909	33	66.667	25.758	0.1898	1.7122	0.7657	3.8285

246	33	69.697	43	79.07	9.373	0.398	1.3999	0.641	3.0571
247	24	87.5	44	90.909	3.409	0.4204	1.451	0.586	3.5933
248	48	16.667	48	25	8.333	0.4063	1.3632	0.6554	2.8354
249	17	64.706	22	54.545	-10.161	0.8655	1.0779	0.4517	2.5723
250	12	83.333	15	73.333	-10	0.7533	1.1685	0.4417	3.0915
251	29	62.069	19	63.158	1.089	0.5794	1.2681	0.5469	2.9403
252	66	98.485	57	98.246	-0.239	0.6215	1.2774	0.4826	3.3811
253	60	78.333	68	79.412	1.079	0.4914	1.2739	0.6385	2.5417
254	43	69.767	33	84.848	15.081	0.1032	1.951	0.8728	4.361
255	47	87.234	50	92	4.766	0.3515	1.4983	0.6393	3.5111
256	22	9.091	29	44.828	35.737	0.0538	2.2924	0.9864	5.3278
257	12	100	19	94.737	-5.263	0.5989	1.3252	0.4634	3.7893
258	35	91.429	41	87.805	-3.624	0.8075	1.1154	0.4626	2.6893
259	26	65.385	29	72.414	7.029	0.3913	1.4298	0.6306	3.2421
260	13	92.308	14	71.429	-20.879	0.9132	0.9479	0.3613	2.487
261	91	87.912	107	90.654	2.742	0.3801	1.3704	0.6774	2.7723
262	31	100	31	100	0	0.5258	1.3961	0.4972	3.9198
263	26	92.308	22	95.455	3.147	0.4342	1.4815	0.5524	3.9732
264	17	70.588	15	86.667	16.079	0.2437	1.7636	0.6787	4.5831
265	29	79.31	40	95	15.69	0.0855	2.1777	0.8966	5.2894
266	6	83.333	5	100	16.667	0.3906	1.5917	0.55	4.6062
267	6	66.667	3	100	33.333	0.2934	1.7748	0.6079	5.1818
268	31	48.387	40	67.5	19.113	0.1629	1.6956	0.8072	3.5619
269	41	70.732	53	90.566	19.834	0.0183	2.5782	1.1743	5.6605
270	29	100	22	81.818	-18.182	0.5695	0.7559	0.2876	1.9862
271	5	80	1	0	-80	0.6787	1.2597	0.4217	3.7629
272	62	95.161	46	84.783	-10.378	0.4766	0.7352	0.3147	1.7172
273	9	88.889	3	100	11.111	0.481	1.4732	0.5007	4.3348

274	32	56.25	32	87.5	31.25	0.0246	2.5671	1.1285	5.8397
275	12	50	21	38.095	-11.905	0.7053	0.8424	0.3457	2.0526
276	20	65	19	84.211	19.211	0.1581	1.9184	0.7757	4.7443
277	33	78.788	40	77.5	-1.288	0.6799	1.184	0.5301	2.6445
278	33	72.727	38	78.947	6.22	0.261	1.578	0.7117	3.4986
279	13	38.462	40	90	51.538	0.0072	3.3784	1.3917	8.2009
280	47	74.468	51	80.392	5.924	0.3973	1.3764	0.6562	2.8871
281	41	95.122	34	85.294	-9.828	0.6598	0.8171	0.3318	2.0118
282	69	86.957	62	93.548	6.591	0.1885	1.7227	0.7653	3.8777
283	41	68.293	38	89.474	21.181	0.021	2.5696	1.1538	5.7227
284	18	83.333	23	56.522	-26.811	0.581	0.7837	0.3294	1.8648
285	51	25.49	32	37.5	12.01	0.3444	1.4215	0.685	2.9501
286	15	66.667	11	81.818	15.151	0.3081	1.6498	0.6292	4.326
287	21	90.476	30	90	-0.476	0.6129	1.2768	0.4947	3.2956
288	34	64.706	46	76.087	11.381	0.1053	1.8611	0.8772	3.9484
289	33	90.909	29	79.31	-11.599	0.9183	0.9548	0.3939	2.3145
290	14	85.714	12	100	14.286	0.2647	1.7767	0.6464	4.8839
291	51	82.353	46	78.261	-4.092	0.8836	0.945	0.4423	2.0189
292	25	76	16	81.25	5.25	0.3138	1.6026	0.6394	4.0167
293	27	92.593	21	95.238	2.645	0.4443	1.4725	0.5455	3.9752
294	21	61.905	32	84.375	22.47	0.08	2.1418	0.9127	5.0257
295	14	42.857	15	66.667	23.81	0.2013	1.813	0.7273	4.5198
296	16	100	11	0	-100	0.0123	0.3036	0.1195	0.7715
297	6	50	3	0	-50	0.7741	1.1665	0.4069	3.3439
298	79	96.203	81	96.296	0.093	0.6076	1.2624	0.5181	3.0757
299	45	64.444	61	75.41	10.966	0.3024	1.4352	0.7216	2.8543
300	20	60	27	62.963	2.963	0.7091	1.172	0.5084	2.7017
301	29	65.517	27	96.296	30.779	0.015	3.0069	1.2389	7.298

302	12	58.333	17	70.588	12.255	0.3704	1.5262	0.6043	3.8545
303	31	61.29	35	71.429	10.139	0.3265	1.4739	0.6785	3.2018
304	19	100	39	94.872	-5.128	0.6973	1.2191	0.4485	3.3135
305	55	94.545	76	98.684	4.139	0.2161	1.7933	0.7101	4.5291
306	24	95.833	16	100	4.167	0.4288	1.5196	0.5382	4.2899
307	16	93.75	19	94.737	0.987	0.4639	1.4605	0.5292	4.0309
308	28	78.571	45	91.111	12.54	0.1008	2.0639	0.8682	4.9063
309	54	74.074	51	76.471	2.397	0.462	1.3062	0.6404	2.664
310	28	75	36	75	0	0.6149	1.2323	0.5455	2.7839
311	75	85.333	69	86.957	1.624	0.3786	1.3888	0.6678	2.888
312	1	100	3	100	0	0.4496	1.5348	0.5047	4.6673
313	8	50	7	100	50	0.1195	2.2432	0.8107	6.2066
314	21	90.476	11	90.909	0.433	0.5571	1.3532	0.4923	3.72
315	12	58.333	13	61.538	3.205	0.4772	1.4003	0.5526	3.5481
316	32	78.125	27	81.481	3.356	0.5024	1.3386	0.5701	3.1427
317	7	57.143	3	100	42.857	0.2665	1.8173	0.6328	5.2189
318	28	89.286	29	72.414	-16.872	0.6545	0.821	0.3456	1.9503
319	2	0	1	100	100	0.2725	1.8522	0.6152	5.5765
320	40	75	52	94.231	19.231	0.0395	2.4024	1.0432	5.5329
321	21	85.714	12	100	14.286	0.2952	1.726	0.6205	4.8012
322	21	66.667	17	88.235	21.568	0.1381	2.0098	0.7983	5.0602
323	6	66.667	17	88.235	21.568	0.233	1.8372	0.6754	4.9972
324	38	76.316	27	55.556	-20.76	0.3365	0.6808	0.3105	1.4927
325	8	87.5	18	83.333	-4.167	0.5997	1.3088	0.4783	3.581
326	1	100	28	96.429	-3.571	0.317	1.7414	0.5867	5.1684
327	22	100	45	95.556	-4.444	0.6414	1.2669	0.4674	3.4345
328	34	97.059	43	83.721	-13.338	0.5751	0.776	0.3192	1.8863
329	35	91.429	25	100	8.571	0.2225	1.8459	0.6887	4.9476

330	46	78.261	66	95.455	17.194	0.0064	3.103	1.3772	6.9916
331	11	63.636	14	64.286	0.65	0.7067	1.1992	0.4648	3.0942
332	16	43.75	9	55.556	11.806	0.3837	1.5183	0.5926	3.8901
333	4	100	7	85.714	-14.286	0.5977	1.3309	0.4595	3.8548
334	30	16.667	25	48	31.333	0.0803	2.0657	0.9159	4.6589
335	45	77.778	56	82.143	4.365	0.4213	1.3573	0.6439	2.8608
336	27	74.074	11	63.636	-10.438	0.9359	1.0388	0.4108	2.6269
337	23	43.478	19	63.158	19.68	0.2947	1.5716	0.6739	3.6651
338	98	89.796	107	90.654	0.858	0.5602	1.2339	0.6078	2.505
339	12	66.667	15	60	-6.667	0.7386	1.172	0.4606	2.982
340	25	80	31	80.645	0.645	0.4814	1.3631	0.5747	3.2332
341	42	61.905	45	80	18.095	0.0859	1.9083	0.9125	3.9908
342	49	63.265	6	83.333	20.068	0.1687	1.9657	0.7501	5.1512
343	46	93.478	37	94.595	1.117	0.4769	1.3998	0.5534	3.541
344	21	85.714	47	72.34	-13.374	0.5884	0.7941	0.3442	1.8325
345	31	87.097	18	88.889	1.792	0.5511	1.3351	0.5155	3.4575
346	36	80.556	65	83.077	2.521	0.5757	1.2491	0.5724	2.7257
347	15	100	18	94.444	-5.556	0.6473	1.2711	0.4541	3.5579
348	19	84.211	33	72.727	-11.484	0.8984	0.9448	0.3947	2.2618
349	3	100	1	100	0	0.5375	1.4176	0.4667	4.3065
350	42	78.571	29	65.517	-13.054	0.6541	0.8363	0.3821	1.8303
351	6	66.667	11	100	33.333	0.1633	2.1048	0.7386	5.9978
352	7	42.857	13	53.846	10.989	0.4595	1.438	0.5484	3.7706
353	30	96.667	30	93.333	-3.334	0.7781	1.1504	0.4335	3.0529
354	26	26.923	29	48.276	21.353	0.2624	1.5781	0.7099	3.5081
355	36	100	41	90.244	-9.756	0.7547	0.86	0.3332	2.2193
356	58	51.724	72	63.889	12.165	0.0957	1.679	0.9124	3.0896
357	24	54.167	28	60.714	6.547	0.0308	1.823	1.0573	3.1431

358	30	63.333	22	68.182	4.849	0.4886	1.3275	0.5947	2.9633
359	42	95.238	50	94	-1.238	0.4864	1.336	0.5902	3.0239
360	42	64.286	32	81.25	16.964	0.6037	1.2768	0.5068	3.2165
361	2	0	9	11.111	11.111	0.1193	1.8693	0.8504	4.1092
362	42	92.857	55	90.909	-1.948	0.7954	1.1497	0.3999	3.3049
363	8	87.5	17	94.118	6.618	0.587	1.275	0.5299	3.0681
364	28	50	16	68.75	18.75	0.3732	1.5954	0.5699	4.4661
365	46	86.957	30	83.333	-3.624	0.1326	1.9331	0.8183	4.5667
366	83	60.241	110	74.545	14.304	0.7938	1.1214	0.4742	2.6516
367	35	85.714	34	82.353	-3.361	0.7358	1.1576	0.494	2.7123
368	30	93.333	40	90	-3.333	0.7535	1.1586	0.4615	2.9084
369	30	43.333	45	80	36.667	0.0048	2.9694	1.396	6.3162
370	41	65.854	49	91.837	25.983	0.0054	3.0619	1.3931	6.7297
371	38	78.947	40	97.5	18.553	0.0322	2.6353	1.0863	6.3933
372	29	75.862	33	81.818	5.956	0.339	1.5063	0.6498	3.4921
373	38	97.368	38	97.368	0	0.5244	1.3753	0.5147	3.6748
374	19	100	24	95.833	-4.167	0.6707	1.2485	0.4481	3.4787
375	49	93.878	46	95.652	1.774	0.4393	1.4449	0.5678	3.6766
376	50	72	39	97.436	25.436	0.0121	2.9969	1.2722	7.0595
377	28	82.143	27	77.778	-4.365	0.8008	1.117	0.4722	2.6426
378	6	50	4	25	-25	0.7167	1.2105	0.4305	3.4036
379	6	50	8	100	50	0.1562	2.1321	0.7481	6.0764
380	28	64.286	42	78.571	14.285	0.165	1.7502	0.7937	3.8592
381	13	92.308	16	100	7.692	0.3636	1.6201	0.5713	4.5948
382	6	66.667	7	85.714	19.047	0.2806	1.7756	0.6249	5.0452
383	28	78.571	33	75.758	-2.813	0.678	1.1929	0.5182	2.746
384	53	86.792	37	86.486	-0.306	0.6729	1.1964	0.5198	2.7536
385	33	96.97	36	83.333	-13.637	0.6326	0.8008	0.3217	1.9934

386	21	52.381	29	72.414	20.033	0.1487	1.8372	0.8042	4.197
387	7	28.571	1	100	71.429	0.1898	2.0523	0.6999	6.0185
388	32	93.75	22	95.455	1.705	0.517	1.3911	0.5118	3.7806
389	26	100	12	0	-100	0.0037	0.2592	0.1042	0.6446
390	26	61.538	27	51.852	-9.686	0.9912	0.9955	0.4489	2.2079
391	29	82.759	34	100	17.241	0.068	2.4267	0.9364	6.2888
392	54	87.037	45	93.333	6.296	0.2496	1.6535	0.7017	3.896
393	7	42.857	10	90	47.143	0.141	2.1206	0.7789	5.7735
394	13	53.846	14	100	46.154	0.0479	2.6812	1.0091	7.1237
395	41	75.61	38	86.842	11.232	0.1869	1.7297	0.7661	3.9053
396	16	75	28	96.429	21.429	0.0994	2.2389	0.858	5.8422
397	28	96.429	18	100	3.571	0.4854	1.4444	0.5134	4.064
398	25	80	21	95.238	15.238	0.1588	1.9815	0.7648	5.134
399	26	23.077	36	66.667	43.59	0.0109	2.769	1.2651	6.0605
400	41	68.293	48	83.333	15.04	0.0596	2.0676	0.971	4.4029
401	26	88.462	42	97.619	9.157	0.1586	1.9858	0.7646	5.1575
402	60	91.667	68	95.588	3.921	0.2447	1.6686	0.7036	3.9572
403	28	96.429	38	89.474	-6.955	0.8902	1.0682	0.4176	2.7323
404	4	50	2	0	-50	0.7613	1.1811	0.4028	3.4636
405	7	28.571	8	62.5	33.929	0.2187	1.8707	0.6889	5.0801
406	21	76.19	29	96.552	20.362	0.1219	2.1059	0.8191	5.4143
407	45	97.778	37	83.784	-13.994	0.4819	0.7244	0.2945	1.7815
408	28	32.143	18	88.889	56.746	0.0022	3.8258	1.6227	9.0199
409	38	50	45	80	30	0.0111	2.589	1.2436	5.3899
410	41	78.049	51	80.392	2.343	0.5324	1.2741	0.5949	2.7286
411	43	86.047	48	89.583	3.536	0.4388	1.3919	0.6019	3.2187
412	23	60.87	21	76.19	15.32	0.3342	1.5326	0.6436	3.6494
413	16	93.75	20	90	-3.75	0.6537	1.2589	0.4596	3.4483

414	26	88.462	39	97.436	8.974	0.2092	1.8417	0.7094	4.7817
415	28	75	26	76.923	1.923	0.683	1.1946	0.5082	2.8081
416	22	77.273	28	89.286	12.013	0.2091	1.7895	0.721	4.4415
417	4	75	3	100	25	0.3808	1.6268	0.5471	4.8369
418	14	100	20	100	0	0.4902	1.4502	0.5037	4.1753
419	36	75	45	86.667	11.667	0.1375	1.8429	0.822	4.1316
420	10	50	20	60	10	0.3192	1.5936	0.6363	3.9909
421	33	57.576	21	61.905	4.329	0.4037	1.4103	0.6286	3.1639
422	29	79.31	19	73.684	-5.626	0.6543	1.2234	0.5055	2.9606
423	28	100	20	95	-5	0.8145	1.1308	0.4041	3.1641
424	16	25	9	77.778	52.778	0.0467	2.598	1.0139	6.657
425	22	100	24	83.333	-16.667	0.7532	0.8566	0.326	2.2512
426	32	81.25	42	100	18.75	0.0295	2.8283	1.1095	7.2095
427	12	33.333	24	70.833	37.5	0.1127	2.0636	0.8426	5.0538
428	57	64.912	47	68.085	3.173	0.485	1.2742	0.6448	2.5179
429	14	85.714	32	84.375	-1.339	0.6698	1.2264	0.4793	3.1379
430	15	73.333	41	90.244	16.911	0.1075	2.1149	0.849	5.2682
431	16	62.5	14	71.429	8.929	0.4315	1.4496	0.574	3.6607
432	12	66.667	31	90.323	23.656	0.149	1.9939	0.7804	5.0947
433	18	55.556	14	50	-5.556	0.7179	1.1768	0.4859	2.8501
434	38	86.842	72	93.056	6.214	0.1652	1.8162	0.7814	4.2212
435	21	100	35	91.429	-8.571	0.9843	1.0099	0.378	2.6979
436	18	77.778	20	90	12.222	0.2547	1.7394	0.6703	4.5139
437	13	53.846	20	70	16.154	0.3491	1.5405	0.6228	3.8102
438	8	87.5	17	76.471	-11.029	0.7798	1.1527	0.425	3.1268
439	35	82.857	27	77.778	-5.079	0.8909	1.0612	0.4532	2.4851
440	4	75	2	100	25	0.3887	1.6204	0.5399	4.8633
441	27	77.778	44	70.455	-7.323	0.7988	0.9025	0.4095	1.9888

442	29	79.31	30	80	0.69	0.5842	1.2679	0.5411	2.9709
443	2	100	3	0	-100	0.975	1.0175	0.3442	3.0078
444	10	50	27	70.37	20.37	0.2855	1.6422	0.6601	4.0852
445	4	100	4	100	0	0.4893	1.4721	0.4911	4.4128
446	51	76.471	67	73.134	-3.337	0.9141	1.0381	0.5252	2.0522
447	12	75	17	94.118	19.118	0.1982	1.9147	0.7112	5.1551
448	25	76	37	81.081	5.081	0.4365	1.3971	0.601	3.248
449	11	81.818	22	72.727	-9.091	0.8674	1.0831	0.4237	2.7686
450	21	76.19	23	60.87	-15.32	0.8252	0.9079	0.3847	2.1425
451	1	100	1	100	0	0.4744	1.5006	0.4927	4.5708
452	20	60	22	90.909	30.909	0.0641	2.3588	0.9506	5.8529
453	20	95	14	92.857	-2.143	0.6173	1.2964	0.4676	3.5942
454	4	100	8	75	-25	0.7781	1.1655	0.401	3.3872
455	25	72	20	90	18	0.243	1.7403	0.6859	4.4157
456	11	54.545	17	58.824	4.279	0.5431	1.3306	0.5292	3.3459
457	13	69.231	21	76.19	6.959	0.5064	1.3661	0.5436	3.4329
458	15	73.333	15	80	6.667	0.5233	1.364	0.525	3.5439
459	33	87.879	27	88.889	1.01	0.5664	1.3063	0.5232	3.2613
460	59	89.831	86	94.186	4.355	0.2452	1.6247	0.7159	3.6872
461	21	90.476	20	100	9.524	0.2693	1.7666	0.6429	4.8547
462	26	92.308	17	100	7.692	0.3449	1.6323	0.5897	4.518
463	49	93.878	63	92.063	-1.815	0.7024	1.1835	0.4981	2.8119
464	25	88	40	95	7	0.3378	1.5846	0.6174	4.067
465	17	94.118	22	100	5.882	0.3311	1.6664	0.5943	4.6726
466	26	42.308	41	56.098	13.79	0.2106	1.6203	0.7606	3.4517
467	23	73.913	22	81.818	7.905	0.3674	1.5091	0.616	3.6973
468	36	63.889	36	75	11.111	0.3065	1.492	0.6923	3.2155
469	52	90.385	36	91.667	1.282	0.5608	1.3029	0.5334	3.182

470	9	66.667	13	76.923	10.256	0.4563	1.4559	0.5411	3.917
471	30	76.667	21	71.429	-5.238	0.8412	1.0913	0.4637	2.5683
472	31	80.645	69	88.406	7.761	0.222	1.6548	0.7367	3.7171
473	34	70.588	15	86.667	16.079	0.1785	1.8726	0.7502	4.6743
474	38	57.895	49	87.755	29.86	0.004	3.0662	1.4316	6.5673
475	45	95.556	47	97.872	2.316	0.423	1.481	0.5659	3.8757
476	8	62.5	9	100	37.5	0.1694	2.0667	0.7331	5.8266
477	31	74.194	38	81.579	7.385	0.3808	1.4388	0.6371	3.2496
478	49	71.429	39	64.103	-7.326	0.9858	1.0065	0.4904	2.0657
479	18	61.111	11	81.818	20.707	0.2168	1.8173	0.7036	4.6938
480	2	50	4	100	50	0.2691	1.8418	0.6227	5.4477
481	26	88.462	30	86.667	-1.795	0.6528	1.2336	0.4935	3.0835
482	28	85.714	28	71.429	-14.285	0.8336	0.9127	0.3885	2.1439
483	4	100	11	27.273	-72.727	0.451	0.6774	0.2457	1.8679
484	67	98.507	49	91.837	-6.67	0.7539	0.8634	0.3442	2.1659
485	28	82.143	23	95.652	13.509	0.2318	1.7835	0.6902	4.6089
486	10	50	1	100	50	0.2442	1.8886	0.6469	5.5137
487	11	81.818	5	100	18.182	0.3756	1.6002	0.5649	4.533
488	7	85.714	6	66.667	-19.047	0.7823	1.1562	0.4123	3.2428
489	14	85.714	22	63.636	-22.078	0.6272	0.7978	0.3201	1.9884
490	59	77.966	54	79.63	1.664	0.5434	1.2487	0.6094	2.5588
491	18	55.556	27	51.852	-3.704	0.8584	1.0785	0.4696	2.4772
492	25	92	44	97.727	5.727	0.2367	1.7904	0.6815	4.7036
493	38	94.737	11	81.818	-12.919	0.9121	0.9452	0.347	2.5746
494	20	85	36	52.778	-32.222	0.217	0.5949	0.2606	1.3581
495	24	66.667	38	92.105	25.438	0.0308	2.5953	1.0925	6.1653
496	14	50	12	50	0	0.5654	1.3081	0.5228	3.2726
497	9	77.778	9	100	22.222	0.2239	1.9144	0.6715	5.4578

498	23	78.261	26	69.231	-9.03	0.8937	1.0602	0.449	2.5035
499	26	92.308	33	96.97	4.662	0.3964	1.5272	0.5731	4.0697
500	28	39.286	20	65	25.714	0.0967	2.0099	0.8815	4.5826
501	14	92.857	11	90.909	-1.948	0.6222	1.29	0.4677	3.5577
502	6	100	20	95	-5	0.4774	1.4641	0.5107	4.1976
503	4	25	19	68.421	43.421	0.2584	1.777	0.6549	4.8214
504	27	85.185	35	88.571	3.386	0.4527	1.4105	0.574	3.4658
505	49	44.898	72	52.778	7.88	0.2049	1.4954	0.8023	2.7874
506	13	92.308	30	70	-22.308	0.7372	0.854	0.3392	2.1501
507	7	71.429	5	80	8.571	0.3573	1.6342	0.5735	4.6565
508	14	85.714	22	100	14.286	0.2253	1.8764	0.6777	5.1951
509	5	60	13	92.308	32.308	0.2142	1.9224	0.6847	5.3974
510	46	84.783	37	86.486	1.703	0.5205	1.3163	0.5685	3.0475
511	7	57.143	1	100	42.857	0.2788	1.8234	0.614	5.4154
512	13	84.615	24	83.333	-1.282	0.5612	1.3269	0.5102	3.4507
513	17	70.588	18	88.889	18.301	0.1711	1.9328	0.7516	4.9707
514	48	81.25	40	80	-1.25	0.7022	1.165	0.5318	2.5519
515	2	50	7	57.143	7.143	0.6304	1.2976	0.4484	3.7551
516	16	87.5	14	85.714	-1.786	0.5084	1.3964	0.5184	3.7617
517	11	81.818	15	66.667	-15.151	0.949	1.0317	0.3963	2.6859
518	42	92.857	48	83.333	-9.524	0.6728	0.8348	0.3606	1.9323
519	34	88.235	47	93.617	5.382	0.265	1.6648	0.6787	4.0835
520	13	7.692	2	50	42.308	0.1141	2.3188	0.8164	6.5858
521	25	92	28	85.714	-6.286	0.8671	1.0829	0.4257	2.7545
522	30	80	22	100	20	0.0795	2.3575	0.9036	6.1506
523	27	37.037	40	77.5	40.463	0.0076	2.8685	1.3248	6.211
524	62	61.29	73	57.534	-3.756	0.9078	1.0361	0.568	1.8901
525	29	13.793	18	72.222	58.429	0.0033	3.6064	1.5371	8.461

526	60	80	69	73.913	-6.087	0.756	0.8985	0.4568	1.7673
527	24	95.833	19	89.474	-6.359	0.8221	1.1199	0.4167	3.0097
528	9	100	27	100	0	0.3605	1.6357	0.5689	4.703
529	3	100	6	100	0	0.4407	1.5365	0.5149	4.5854
530	16	81.25	18	88.889	7.639	0.4015	1.5127	0.5743	3.9845
531	15	66.667	25	92	25.333	0.1016	2.1816	0.857	5.5534
532	17	82.353	22	68.182	-14.171	0.9192	1.0479	0.4236	2.5927
533	13	92.308	24	79.167	-13.141	0.8998	1.0637	0.4061	2.7859
534	30	76.667	44	79.545	2.878	0.6342	1.2145	0.5448	2.7073
535	14	78.571	17	76.471	-2.1	0.6961	1.209	0.4657	3.1385
536	1	100	3	66.667	-33.333	0.6269	1.3148	0.4354	3.9701
537	2	100	2	100	0	0.5304	1.4242	0.4711	4.3059
538	30	46.667	34	52.941	6.274	0.5036	1.292	0.6091	2.7405
539	2	50	8	100	50	0.2828	1.8128	0.6114	5.3748
540	5	60	3	66.667	6.667	0.4305	1.5333	0.529	4.4442
541	42	83.333	39	82.051	-1.282	0.7267	1.1553	0.5135	2.5991
542	27	88.889	36	80.556	-8.333	0.9997	1.0002	0.4179	2.3937
543	67	70.149	68	70.588	0.439	0.7595	1.1036	0.5866	2.0761
544	20	90	16	75	-15	0.9473	0.9687	0.376	2.4951
545	12	33.333	6	66.667	33.334	0.1816	1.9518	0.731	5.2111
546	8	25	2	50	25	0.2776	1.7929	0.6241	5.1509
547	3	33.333	7	71.429	38.096	0.4091	1.5591	0.5423	4.4828
548	1	0	3	33.333	33.333	0.6167	1.3229	0.4414	3.9645
549	14	71.429	17	94.118	22.689	0.1265	2.144	0.8056	5.7056
550	58	75.862	31	77.419	1.557	0.3968	1.3979	0.6435	3.0367
551	39	87.179	48	87.5	0.321	0.6499	1.2137	0.5251	2.8054
552	35	85.714	26	92.308	6.594	0.3225	1.5899	0.6338	3.9883
553	14	78.571	14	71.429	-7.142	0.6132	1.2794	0.4914	3.3309

554	38	84.211	43	97.674	13.463	0.0891	2.1949	0.8865	5.4342
555	4	25	3	100	75	0.1726	2.1053	0.7216	6.1428
556	18	61.111	19	57.895	-3.216	0.8384	1.095	0.457	2.6234
557	29	72.414	35	80	7.586	0.3698	1.4559	0.6399	3.3121
558	31	58.065	40	70	11.935	0.3697	1.4135	0.6629	3.0138
559	10	60	18	77.778	17.778	0.4329	1.463	0.5645	3.7918
560	34	85.294	47	78.723	-6.571	0.894	1.0563	0.471	2.3692

APPENDICES

Appendix A: IRB Exemption Approval

Dr. Debra Patt
UT-H - School of Public Health
December 10, 2019
HSC-SPH-19-1043 - *NUDGING QUALITY IMPROVEMENT IN CANCER CARE: FACILITATING QUALITY IMPROVEMENT BY USING A CLINICAL DECISION SUPPORT SYSTEM TO PROMOTE ADHERANCE TO EVIDENCE BASED GUIDELINES BY ALTERING CHOICE ARCHITECTURE*
The above named project is determined to qualify for exempt status according to 45 CFR 46.101(b)
CATEGORY #4 *: Research, involving the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens, if these sources are publicly available or if the information is recorded by the investigator in such a manner that subjects cannot be identified directly or through identifiers linked to the subjects.*
CHANGES: Should you choose to make any changes to the protocol that would involve the inclusion of human subjects or identified data from humans, please submit the change via iRIS to the Committee for the Protection of Human Subjects for review.
INFORMED CONSENT DETERMINATION:
Waiver of Consent Granted
HEALTH INSURANCE PORTABILITY and ACCOUNTABILITY ACT (HIPAA):
Waiver for Retrospective Chart Review granted:
Information to be accessed: medical record
PHI to be retained: none
STUDY CLOSURES: Upon completion of your project, submission of a study closure report is required. The study closure report should be submitted once all data has been collected and analyzed.
Should you have any questions, please contact the Office of Research Support Committees at 713-

500-7943.