QUALITY IMPROVEMENT AND INFORMATICS TECHNIQUES IN WORKFLOW ANALYSIS USING HEART FAILURE EMEASURE AS AN EXEMPLAR

by

Megha Kalsy

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STATEMENT OF DISSERTATION APPROVAL

The dissertation of Megha Kalsy has been approved by the following supervisory committee members:

Jennifer Garvin	Chair	08/07/2015 Date Approved
Bruce Bray	Member	08/07/2015 Date Approved
Katherine Sward	Member	08/07/2015 Date Approved
Karen Eilbeck	Member	08/07/2015 Date Approved
Andrew Redd	Member	08/07/2015 Date Approved

and by Wendy W. Chapman, Chair of the Department of Biomedical Informatics
and by David B. Kieda, Dean of The Graduate School.

ABSTRACT

Health information technology (HIT) in conjunction with quality improvement (QI) methodologies can promote higher quality care at lower costs. Unfortunately, most inpatient hospital settings have been slow to adopt HIT and QI methodologies. Successful adoption requires close attention to workflow. Workflow is the sequence of tasks, processes, and the set of people or resources needed for those tasks that are necessary to accomplish a given goal. Assessing the impact on workflow is an important component of determining whether a HIT implementation will be successful, but little research has been conducted on the impact of eMeasure (electronic performance measure) implementation on workflow.

One solution to addressing implementation challenges such as the lack of attention to workflow is an *implementation toolkit*. An implementation toolkit is an assembly of instruments such as checklists, forms, and planning documents. We developed an initial eMeasure Implementation Toolkit for the heart failure (HF) eMeasure to allow QI and information technology (IT) professionals and their team to assess the impact of implementation on workflow.

During the development phase of the toolkit, we undertook a literature review to determine the components of the toolkit. We conducted stakeholder interviews with HIT and QI key informants and subject matter experts (SMEs) at the US Department of Veteran Affairs (VA). Key informants provided a broad understanding about the context

of workflow during eMeasure implementation. Based on snowball sampling, we also interviewed other SMEs based on the recommendations of the key informants who suggested tools and provided information essential to the toolkit development.

The second phase involved evaluation of the toolkit for relevance and clarity, by experts in non-VA settings. The experts evaluated the sections of the toolkit that contained the tools, via a survey.

The final toolkit provides a distinct set of resources and tools, which were iteratively developed during the research and available to users in a single source document. The research methodology provided a strong unified overarching implementation framework in the form of the Promoting Action on Research Implementation in Health Services (PARIHS) model in combination with a socio-technical model of HIT that strengthened the overall design of the study.

This dissertation is dedicated to my parents.
For their endless love, support, and encouragement

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DEFINITION OF TERMS

The following definitions are taken from Health Information: Management of a Strategic Resource (Abdelhak, Grostick, Hanken, and Jacobs, 2001); the National Quality Forum (2013); and Health Information Management: Concepts, Principles and Practice (LaTour and Eichenwald-Maki, 2006) unless otherwise noted.

The Agency for Health Research and Quality (AHRQ) is a United States government agency that functions as a part of the Department of Health and Human Services (HHS) to support research to improve the quality of healthcare.

The American College of Surgeons (ACS) is an educational association of surgeons created in 1913.

The American Medical Association (AMA), founded in 1847 and incorporated in 1897, is the largest association of physicians and medical students in the United States.

The Centers of Medicare and Medicaid Services (CMS) is an agency within the United States Department of Health and Human Services responsible for the administration of several key federal healthcare programs.

Clinical Laboratory Improvement Amendments (CLIA) of 1988 are United States federal regulatory standards that apply to all clinical laboratory testing performed on humans in the United States, except clinical trials and basic research.

Det Norske Veritas (DNV) Healthcare is a leading accreditor of United States hospitals integrating ISO 9001 quality compliance with the Medicare conditions of participation.

Electronic Health Records (EHRs) is an evolving concept defined as a systematic collection of electronic health information about individual patients or populations.

eMeasures Electronic measures or eMeasures are standardized performance measures in an electronic format. eMeasures can promote greater consistency in measure development and in measuring and comparing performance results. They also can provide more exact requirements about where information should be collected, and drive greater standardization across the measures and greater confidence in comparing outcomes and provider performance.

Focus group is a form of qualitative research in which a group of interacting individuals having some common interests or characteristics, brought together by a moderator, who uses the group and its interactions as a way to gain information about a specific or focused issue.

Health Information Technology (HIT) is the area of Information Technology (IT) that involves the design, development, creation, use, and maintenance of information systems for the healthcare industry.

The Health Information Technology for Economic and Clinical Health Act (HITECH) was passed by Congress in 2009 to stimulate the adoption of electronic health records (EHR) and supporting technology in the United States. HITECH is part of the American Recovery and Reinvestment Act (ARRA) of 2009.

The Health Insurance Portability and Accountability Act (HIPAA) is an act of congress, passed in 1996, that affords certain protections to persons covered by healthcare plans, including continuity of coverage when changing jobs, standards for electronic healthcare transactions, and privacy safeguards for individually identifiable patient information.

Information Technology (IT) is the use of computers and telecommunications equipment to store, retrieve, transmit, and manipulate data.

Institute of Medicine (IOM) is a nonprofit organization established in 1970 as a component of the United States National Academy of Sciences that works outside the framework of government to provide evidence-based research and recommendations for public health and science policy.

The Joint Commission (TJC) is an independent, not-for-profit organization that evaluates and accredits many healthcare organizations and programs in the United States.

The Leapfrog Group is a consortia of public and private organizations that provide healthcare benefits, which work with medical experts in the United States to identify problems and propose solutions that it believes will improve hospital systems that could break down and harm patients.

Meaningful Use (MU) is using certified electronic health record (EHR) technology to improve quality, safety, and efficiency, and reduce health disparities; and to engage patients and family, improve care coordination, and population and public health. Demonstrating Meaningful Use is a requirement of the HITECH act and is a national goal. CMS grants an incentive payment to professionals and hospitals who can demonstrate that they have engaged in efforts to adopt, implement, or upgrade certified EHR technology. In order to encourage widespread EHR adoption, promote innovation, and to avoid imposing excessive burden on healthcare providers, Meaningful Use was implemented as a phased approach, divided into three stages that span 2011 (data capture and sharing), 2013 (advanced clinical processes) and 2015 (improved outcomes).

The National Committee for Quality Assurance (NCQA) is an independent nonprofit organization in the United States created to improve patient care quality and health plan performance in partnership with managed care plans, purchasers, consumers, and the public sector.

National Quality Forum (NQF) is a nonprofit organization based in Washington, D.C., that is dedicated to improving the quality of healthcare in the United States.

Performance measures include the specific representation of a capacity, process, or outcome deemed relevant to the assessment of performance. A performance measure is quantifiable and therefore can be documented.

Performance measurement is the process of collecting, analyzing, and/or reporting information regarding the performance of an individual, group, organization, system, or component.

Quality is the degree to which physicians and healthcare institutions fulfill their care obligations to individual patients and the degree to which patients, physicians, trained healthcare staff, and healthcare institutions enable these obligations to be fulfilled fairly across the population.

Quality assurance is the maintenance of a desired level of quality in product or service. The term has largely been replaced by "quality improvement".

Quality Improvement (QI) is the combined efforts of everyone—healthcare professionals, patients and their families, researchers, payers, planners, and educators—to make the changes that will lead to better patient outcomes (health), better system performance (care), and better professional development (learning).

Continuous quality improvement is a structured process to improve all aspects of care and service continually; ongoing study to improve performance.

Semistructured interview is a flexible interview in which the interviewer does not follow a formalized list of questions. Instead, there is a list of general topics called an interview guide.

Six sigma is a management philosophy developed by Motorola that emphasizes setting extremely high objectives, collecting data, and analyzing results to a fine degree as a way to reduce defects in products and services. This approach is now widely used in many industrial settings and businesses.

Thematic analysis is a method of qualitative analysis based on participants' conceptions of actual communication episodes; a theme is identified based on recurrence and repetition of statements that reflect a common pattern or 'theme'.

Workflow is the set of tasks—grouped chronologically into processes—and the set of

people or resources needed for those tasks that are necessary to accomplish a given goal. An organization's workflow is comprised of the set of processes it needs to accomplish, the set of people or other resources available to perform those processes, and the interactions among them.

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CHAPTER 1

THE PROBLEM AND ITS SETTING

Healthcare quality and quality improvement are increasingly important areas of Biomedical Informatics research that address urgent national concerns about measurement, assessment, and improvement of healthcare at private and public healthcare establishments [1]. In the healthcare industry, quality of care is seen as essential to patients' well-being and financial survival [2]. Ironically, although the United States spends far more money on healthcare than any other country, its health outcomes, i.e., the quality of its care, are not as good as those of other industrialized nations [3]. To bridge this gap and provide high value care, the United States needs to provide high-quality, safe, and reliable care at a reasonable cost [3].

Health information technology (HIT) in conjunction with quality improvement (QI) methodologies can promote higher quality care at lower costs and with increased patient and clinician satisfaction [4]. Unfortunately, most inpatient practice settings (i.e., hospitals) have been slow to adopt HIT and QI products and services [5]. Successful adoption requires close attention to workflow. Workflow is the sequence of tasks, processes, and the set of people or resources needed for those tasks that are necessary to accomplish a given goal. Workflow includes how tasks are organized and resources utilized [6].

HIT and QI initiatives are implemented through strategic planning, strong

leadership, change management, process reengineering, and customized information technology (IT) systems that support workflows [7]. Implementing QI using HIT has been a prominent national initiative [5]. Some quality measures are limited to reporting internally within an organization, and other measures need to be reported to external regulatory or oversight organizations such as the Centers for Medicare and Medicaid (CMS) or the National Quality Forum (NQF). Automated quality measurement reporting, with HIT supporting data extraction, analysis and report preparation, and electronic transmission of the report to regulatory agencies, is increasingly being required by policy initiatives. Implementing QI using HIT is also expected to benefit the use and management of QI data within a given organization. While HIT-supported QI appears logical to improve efficiency, the transition from manual data collection to automated data collection can have unintended negative consequences for clinical and operational workflow [8].

1.1 Statement of the Problem

The impact on workflow is an important component in determining whether an HIT implementation will be successful. Workflow is, unfortunately, a concept that is often ignored when implementing HIT and the literature about workflow in domains of quality improvement, system implementation, and process improvement has not been adequate. HIT is not always designed to fit the workflow of a given organization, making it difficult to truly assess HIT impact on outcomes or processes [9]. The literature demonstrates inadequate sophistication in studies regarding the role of workflow in the adoption of HIT in the domain of QI, due to the absence of formal workflow design and methodologies, lack of comprehensive knowledge about the system, and a lack of interest

by the quality improvement staff towards the use of the new technology [9].

One solution to addressing implementation challenges such as the lack of attention to workflow is an *implementation toolkit*. An implementation toolkit is an assembly of instruments such as checklists, forms, and planning documents. Implementation toolkits are intended to provide guidance or assistance; they may provide a template or blueprint for what to do, when to do it, and how to do it. Users can apply an implementation toolkit in its entirety, or only apply certain portions that are informative for their needs.

To ensure that HIT successfully integrates with workflow, it is essential to understand the current system before implementing the new technology [10, 11]. Therefore, an implementation toolkit that supports workflow evaluation for HIT-enabled QI efforts needs to include evaluation of both the current workflow, and the potential impact of the new system on workflow.

1.2 Purpose/Aims

The purpose of this study was to establish a generalizable toolkit to assess the impact of implementing electronic Quality Improvement (QI) reporting on the workflow of quality improvement professionals and their team, in the inpatient (hospital) setting. The toolkit was a compilation of resources such as checklists, forms, and planning documents that provide a template for workflow analysis. The toolkit information was designed to support decision making on the implementation approaches related to workflow analysis.

The National Quality Forum (NQF) 0081 eMeasure was used as an exemplar. It is defined as the quality metric for use of Angiotensin converting enzyme (ACE) inhibitor

or Angiotensin Receptor Blocker (ARB) Therapy for Left Ventricular Systolic Dysfunction (LVSD) [12]. Electronic measures or eMeasures are standardized performance measures in an electronic format. Meaningful Use requires the hospitals to report their performance measures electronically, and VA is making efforts to become Meaningful Use certified by 2015. Standardized performance measures define a denominator, which is the number of people in the population of interest, in the organization; and a numerator, which is the number of people who received the intervention. The measure is represented as a ratio or percent. For NQF 0081, the measure includes the percentage of patients aged 18 years and older with a diagnosis of Heart Failure (HF) and LVSD (Left Ventricular Ejection Fraction (LVEF) <40% (the denominator) who were prescribed ACE inhibitor or ARB therapy. The specific aims were:

Aim 1. To explore and document the current workflow for National Quality Forum (NQF) 0081 (inpatient heart failure) eMeasure and to assess the impact on workflow of implementing this as an eMeasure in the US Department of Veterans Affairs.

Aim 2. To develop an implementation toolkit for workflow analysis, for the U.S. Department of Veterans Affairs, based on the results of Aim 1.

Aim 3. To assess potential generalizability by evaluating the relevance and clarity of the toolkit for stakeholders in a non-VA setting.

Aim 1 was approached as a qualitative study based on semistructured interviews with Quality Improvement stakeholders. Aim 2 was a development process. Aim 3 was approached using a web-based survey.

1.3 Theoretical Framework

The study was guided by the Promoting Action on Research Implementation in Health Services (PARIHS) model as a unified overarching research framework [13]. This framework, which was developed in 1998 to explain the process of implementing research into practice, has helped explain the variable success of many types of implementation projects. The framework suggests that three elements (evidence, context, and facilitation) exist on a continuum from weak to strong in terms of the extent to which each supports successful implementation. *Evidence* examines the science behind the innovation to be implemented, *context* examines the environment in which the implementation will occur, and *facilitation* examines barriers and suggests strategies to support implementation. The PARIHS model has been used to guide implementation projects in VA settings. The PARIHS model was supplemented by concepts from a Socio-Technical Model for Studying Health IT [14] containing eight dimensions: 1) hardware and software, 2) clinical content, 3) human-computer interface, 4) people, 5) workflow and communication, 6) internal organizational factors, 7) external rules, and 8) measuring and monitoring. For the purpose of the research, we combined the PARIHS and socio-technical approaches to target the areas that were most useful in guiding this study. This study focused on context and facilitation, from the PARIHS model, and five of the socio-technical model dimensions: hardware and software, clinical content, workflow and communication, people, and internal organizational features.

1.4 Study Rationale

Technology is rapidly transforming healthcare by enabling the sharing of real-time health information across institutions to support patient care, administration, and

research. HIT tools are being used as a component of interventions to improve the quality of care and to reduce costs. For example, these tools reduce medication errors and improve medication management [15]. Given their capacity to reduce costs, informatics methods are integral to healthcare quality metric assessment and reporting. QI activities (e.g., data gathering) from sources such as electronic health records (EHRs), data warehouses, and decision support facilitate the evaluation of quality metrics. Consequently, QI is an emerging subspecialty (focus area) within Biomedical Informatics. Although HIT support for QI activities is increasing, little research has been done on the workflow involved in the automation of quality metric assessment and reporting. The lack of attention to workflow could be a barrier to successful implementation of information systems intended to support QI activities. This barrier to implementation of an automated system can potentially be overcome by the design, or redesign, of clinical and operational workflow coupled with Biomedical Informatics techniques to provide a solid framework for the development and implementation of an automated system for quality improvement [9].

Conducting a comprehensive workflow analysis is a critical step in HIT implementation. Workflow analysis allows health centers to critically analyze the work environment. Workflow is loosely defined as a set of tasks that can be grouped chronologically into processes, and the set of people or resources needed for those tasks in order to accomplish an end goal [9]. In this research, the workflow is comprised of a set of processes that are needed to transition from a manual approach of data collection to an automated one, the set of people or resources that are available to perform this transition, and the human-technology interactions between them.

The automated approach to healthcare quality measurement and improvement follows a series of steps beginning with a decision of what to measure, appropriate tools that can be used for the measurement, the identification of data sources for data extraction, analysis and aggregation of data, understanding, and dissemination of the results [16]. This human-technology interactive approach can be dynamic and often complex, and it could be simplified by using Biomedical Informatics coupled with QI techniques to support the implementation of a new system at a healthcare setting [17].

1.5 Significance

1.5.1 Significance for Biomedical Informatics

Biomedical Informatics (BMI) is the interdisciplinary field that studies the use of biomedical data, information, and knowledge to support efforts to improve human health [18]. BMI spans molecular to population levels of health and biomedicine, and is both a basic/theoretical and an applied science. BMI encompasses all aspects of understanding and promoting the effective organization, analysis, management, and use of information in healthcare, including the human and socio-technical context [18, 19, 20].

Much essential informatics work draws upon human-centric fields such as cognitive psychology, organizational theory, change management, linguistics, or other areas [18, 19, 20] including implementation science. The process of implementation is complex, and gaps can occur between what is intended, and what is actually implemented. Implementation science helps to understand the complexity of this process. Implementation science methods promote the integration of research findings and evidence into healthcare policy and practice. Implementation scientists seek to understand the behavior of healthcare professionals, organizational staff, and other

stakeholders as a key influence on the sustainable uptake, adoption, and use of evidence-based interventions [21]. Strategic planning and organizational theory provides context for understanding the QI workflow at an inpatient setting, and aid in understanding the allocation of resources and to measuring results [22]. Change management is about handling the complexity of the processes. In a healthcare setting, it is about evaluating, planning, and implementing operations, tactics, and strategies, to improve the quality of healthcare [23]. As a newly emerging field, the definition of implementation science and the type of research it encompasses may vary according to setting and sponsor [21]. However, the intent of implementation science and related research is to investigate and address major bottlenecks (e.g. social, behavioral, economic, management) that impede effective implementation, and test new approaches to improve healthcare quality [24]. Understanding methods to promote successful implementation is considered a core competency for graduate education in the discipline of BMI [18].

1.5.2 Clinical Significance

The toolkit is intended to serve as an implementation guide for assessing the potential impact of implementing electronic Quality Improvement (QI) reporting on the workflow of quality improvement teams in the inpatient hospital setting. The outcome of this study will provide tools and processes that address key knowledge gaps in the domain of HIT-enabled QI, with regards to formal workflow evaluation and design, and comprehensive knowledge about workflow within the system.

CHAPTER 2

THE REVIEW OF RELATED LITERATURE

2.1 Introduction: International Standardization Organizations

The literature review is designed to serve the following purposes. First, it provides a historical overview and explains the various organizations associated with healthcare quality in the 20th century. Second, it explains the transition of the major quality initiatives and organizations in the 21st century with background information on the Health Information Technology for Economic and Clinical Health (HITECH) Act, Meaningful Use (MU), and Medicare reimbursement policy. Third, this literature review examines the toolkits related to healthcare and QI assessment that provide a background for developing our QI toolkit to assess the impact of implementing eMeasures on quality improvement and information technology professionals' and their team in the inpatient hospital setting. Finally, this review describes research methods such as semistructured interviews, thematic analysis, workflow observation, and simple surveys for the proposed toolkit development in Chapter 3.

2.2 A Historical Overview

The majority of the historical overview section was derived from the book *Health Information Management: Concepts, Principles, and Practice* [10]. Figure 2.1 shows a timeline for significant healthcare quality organizations and selected quality initiatives.

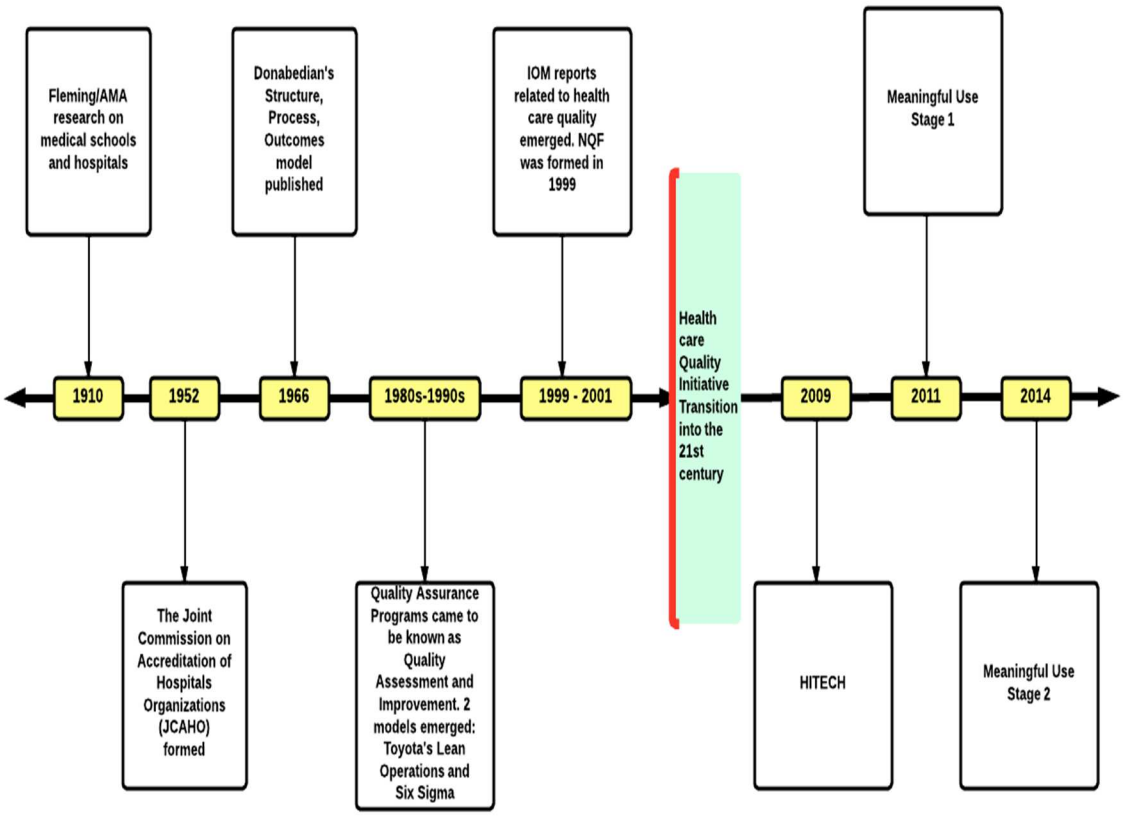

Figure 2.1 Timeline for healthcare quality organizations.

The quality of healthcare in the United States was first addressed in the 20th century when the American Medical Association found medicine in America to be disorganized and of poor quality. In response to this concern, in 1910 the American Medical Association encouraged Alexander Fleming to research and report on the condition of the nation's medical schools and hospitals. That same year, Ernest Codman of Boston's Massachusetts General Hospital also saw the need to improve hospital conditions and to track the recovery of patients discharged from the hospital. In 1917, Codman's efforts led to the American College of Surgeons (ACS) establishing its Hospital Standardization Program, which came to be known as minimum standards that focused on care within hospitals. Shortly after the introduction of these standards, the

ACS began surveying healthcare organizations to determine whether they met the standards needed for hospital accreditation [26].

By 1952, the American College of Physicians, the American Hospital Association, the American Medical Association, and the Canadian Medical Association joined the ACS to form the Joint Commission on Accreditation of Hospitals, which later changed its name to the Joint Commission (TJC) [27]. Although TJC used the ACS minimum standards for many years, in 1966, it began incorporating Donabedian's classic structure-process-outcome model [28]. Avedis Donabedian was a physician who studied healthcare quality and medical outcomes. In his 1966 paper "Evaluating the Quality of Medical Care," he described the need to examine healthcare quality, and in later papers, he suggested that the evaluation of care could be conceptualized into three categories: structure, process, and outcome. He transformed how people thought about health systems, and his model remains the paradigm for evaluating healthcare quality [29, 30]. For Donabedian, "structure" refers to the organizational aspects that create the context of the care environment, "process" to the actions performed to improve or stabilize the patients' health status, and "outcomes" to the results associated with patients' well being. Together the components of the structure-process-outcome model identify the unique relationships among for quality assessment, improvement, and measurement [31].

For countless years, the ACS and TJC audited medical records to assess the quality of healthcare organizations. In the 1970s, their findings led to standardized outcome-oriented surveys that provided credentials for physicians. In 1979, TJC dropped some audit requirements and replaced them with hospital-wide quality assurance programs that later came to be known as quality assessment and improvement [32].

Since Donabedian's initial description of quality evaluation in healthcare, oversight organizations have encouraged and enforced improvements in the quality of healthcare. In the early 1970s, an organization called Professional Standards Review Organization was developed to ensure that physicians were adhering to standards of medical care for Medicare beneficiaries throughout the nation. These efforts were not effective because they focused on cost containment rather than on quality improvement during medical audits. In the 1980s, this problem was recognized and there was a shift from Professional Standards Review Organizations to peer review organizations, in which physician-inclusive organizations referred appropriate assignments such as readmission, complication, and death rates, to Diagnosis Related Groups, [33]. These groups were given the ability to deny payment to services and punish incompetence and fraud.

Initially, TJC concentrated on acute general hospital care. Over time, its mission has expanded to include other care settings—long-term care in 1965, community mental health in 1973, ambulatory care in 1975, and hospices in 1983. Due to its expanding role in healthcare, in 1987 it changed its name from The Joint Commission on Accreditation of Healthcare Organizations to The Joint Commission (TJC) [34]. In 1988, it advocated an approach called Continuous Quality Improvement**,** which was designed to improve performance of an entire group rather than to identify poor performers.

Between the mid-1980s and the 1990s, quality assurance evolved into quality assessment and improvement. The zero defects approach to QI initiated by William Edwards Deming and Philip Crosby [35] set the stage for two other models during this time: Toyota's Lean Operations and Six Sigma. Toyota's lean operations introduced

standardized work processes to avoid wasting resources, time, and money. Six Sigma, which Motorola developed in the late 1980s, also strived to improve quality in the process stage. The process stages involve defining the problem, mapping out the current process, analyzing the cause of the problem, implementing and verifying the solution, and maintaining the solution. Six Sigma is a statistical measure of variation that assesses defects per million opportunities. The process aims for fewer than 3.4 defective parts per million opportunities [36].

Until 1987, healthcare quality concepts were used within accreditation processes; however, in 1990, the Institute of Medicine (IOM) formulated a robust and widely cited publications related to healthcare quality. According to the IOM, "quality" is the degree to which physicians and healthcare institutions fulfill their care obligations to individual patients and the degree to which patients, physicians, trained healthcare staff, and healthcare institutions enable these obligations to be fulfilled equitably across the population [37]. The IOM conducted a study that found that many health services were inadequate. In response, several QI initiatives were launched by various quality organizations throughout the United States. However, it was the publication of the IOM reports in 1999 and 2001 that finally fixed the nation's attention on the critical need for QI in healthcare. The first report, *To Err is Human: Building a Safer Health System* (1999), pointed out the safety gaps in U.S. healthcare, noting that as many as 98,000 people die yearly in hospitals due to preventable medical errors. The second report, *Crossing the Quality Chasm: A New Health System for the 21st Century* (2001), further indicted the country's entire healthcare delivery system for failing to provide consistent, high-quality medical care to all people. Echoing the philosophies of Deming, Juran, and

Crosby, the IOM reports focused on the healthcare system, instead of individuals, as the cause of widespread errors [36].

In the 1990s, TJC broadened the scope of quality assessment and improvement (formerly called quality assurance) programs with an emphasis on performance measurement. TJC, in conjunction with the Centers for Medicare and Medicaid services (CMS), initiated programs to penalize hospitals that did not report the same data to both organizations simultaneously. Initially, the collection and reporting of these data were not uniform from all hospitals, but in 2009, the hospitals achieved consistent rates of reporting performance measures [38], which is part of a strategic process, used to assess accomplishment of goals and objectives. Data about the processes of interest serve as a feedback loop to inform achievement of goals and objectives.

Despite the efforts from organizations involved in QI activities, greater efforts are required to advance emerging best practices, research findings, and comprehensive recommendations in the development of long-term goals for quality improvement. NQF was established to review and endorse consensus-based standards and performance measures for a variety of sectors of healthcare. Since its inception in 1999, this organization has led the effort to automate quality measurement [39, 40]. NQF—a voluntary, consensus-based organization established to standardize healthcare quality improvement, measurement, and reporting through dynamic and automated approaches—does not develop standards; rather, its purpose is to harmonize existing ones. This forum acts as an umbrella organization of hospitals, professional medical societies, teaching institutions, health insurers, pharmaceutical companies, and consumer advocacy groups. It engages many different stakeholders, such as TJC, and pools ideas for operationalizing

automation of performance measures by promulgating electronic quality measures, referred to as eMeasures. [41].

2.3 Overview of the Quality Improvement Organizations

The national quality measurement initiatives [42] consist of a wide variety of organizations that can include public or private, federal or state, as well as business leaders, consumers, purchasers, healthcare systems, and hospitals. Over the last decade, considerable attention has been given to the deficiencies associated with healthcare quality and patient safety performance in the United States. Despite this national attention, the rate at which the quality in patient outcomes and patient safety has improved needs to accelerate [42–46]. One reason that improvements in healthcare quality have received inadequate priority is partly because there is a lack of a uniform national quality measurement and quality outcomes reporting system. Another reason that quality improvement activities have been slow to be adopted is because the various healthcare organizations do not have the necessary skilled staff or the resources to facilitate nationwide QI efforts with a standardized approach that is accepted by all the healthcare organizations throughout the country.

Recognizing that progress in improving quality and patient safety hinges on the availability of robust measures, many stakeholders have developed and disseminated a variety of quality measurement and reporting mechanisms. Unfortunately, efforts to improve the efficiency, effectiveness, equity, timeliness, safety, and patient-centeredness of healthcare delivery services have been hindered by the lack of nationally accepted measures. Nevertheless, many organizations related to quality have arisen.

2.3.1 The National Quality Forum

The National Quality Forum is a not-for-profit membership organization created in 1999 by a coalition of public and private sector leaders in response to the recommendation of the Advisory Commission on Consumer Protection and Quality in the Healthcare Industry to develop and implement a national strategy for healthcare quality measurement and reporting. Figure 2.2 shows the NQF as an umbrella organization that hosts quality improvement efforts from other national initiatives. This organization and its initiatives play an increasingly important role in the efforts to improve the efficiency, effectiveness, equity, timeliness, safety, and patient-centeredness of healthcare delivery services that have been hindered by the lack of universally accepted quality measurement and reporting mechanisms [47–50]. Established as a public-private partnership, NQF has broad participation from all parts of the healthcare system, including national, state, regional, and local groups representing consumers, public and private purchasers, employers, healthcare professionals, provider organizations, health plans, accrediting bodies, labor unions, supporting industries, and organizations involved in healthcare research or QI. Its goal is to promote a common approach to measuring healthcare quality and to foster system-wide capacity for QI [51, 52]. NQF does not develop measures; rather, it is a neutral body that endorses them [53]. Other groups, such as the National Committee for Quality Assurance (NCQA), or the American Medical Association/Physician Consortium for Performance Improvement (PCPI), develop the performance measures.

The National Quality Forum's mandate to find "one-size-fits-all" measures may not be the best approach. For example, certain hospitals found that they could not

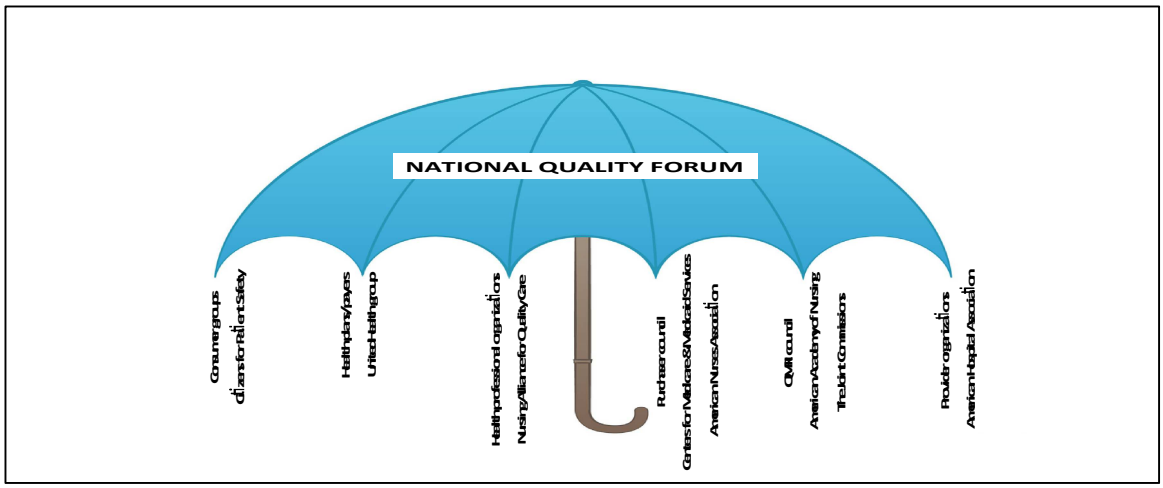

Figure 2.2 National Quality Forum as an umbrella organization

implement some of the NQF-endorsed quality measures because of resource barriers such as small hospital size, rural location, staffing shortages, and lack of financial resources—constraints that may be ameliorated by economies of scale or certain models of health system management/ownership [54].

Although most stakeholders have agreed to hospital quality measures, the current proliferation of other measures of quality and safety has convinced the Agency for Health Research and Quality (AHRQ), NCQA, CMS, TJC, and NQF to remedy the lack of coordinated quality performance measures. NQF asserts that the harmony and the alignment of metrics with other QI organizations help bridge the gap between quality measurement/reporting and effective improvement. Although work needs to be done, over time, better-aligned and harmonized metrics can be envisioned as tools to facilitate successful QI efforts at healthcare organizations nationwide. In the 21st century, the NQF has successfully established a leadership role as a key organization focused on improving quality and patient safety in healthcare. Continued success is likely to depend on widespread agreement among healthcare organizations on NQF-endorsed measures that

represent a single source of quality metrics for public reporting and pay-for-performance programs. In turn, the ability of NQF to achieve this trusted agent position will depend on how efficiently and effectively it evaluates candidate measures through the lenses of expert consensus and scientific evidence [55, 56].

2.3.2 The Joint Commission

The Joint Commission is an independent, not-for-profit organization that accredits and certifies more than 19,000 healthcare organizations and programs in the United States. Accreditation and certification done by TJC are recognized nationwide as symbols of quality that reflect an organization's commitment to meeting certain performance standards. Founded in 1951, TJC is the nation's oldest and largest standards setting and accrediting body in healthcare [34]. In collaboration with its stakeholders, TJC seeks to continuously improve healthcare for the public by evaluating healthcare organizations and inspiring them to excel in providing safe, effective care of the highest quality and value. The Specifications Manual for National Hospital Inpatient Quality Measures [57] is the result of the collaborative efforts of CMS and TJC to publish a uniform set of national hospital quality measures. The aligned specifications manual represents a unified approach among common national hospital performance measures and shares a single set of common documentation among institutions.

The Joint Commission consists of individuals from the private medical sector that develop and maintain standards of quality in medical facilities in the United States. TJC publishes a large body of literature designed not only to improve the quality of health services but also to help in the accreditation process for healthcare facilities. Although completing the TJC accreditation process is not mandatory for a healthcare organization,

doing so indicates that a facility has successfully implemented guaranteed quality control standards, a process that increases consumers' confidence in a facility's credibility.

2.3.3 Det Norske Veritas Healthcare

Det Norske Veritas (DNV) Healthcare, established in 1964 in Oslo, Norway, has essentially taken the place of TJC, which, after enjoying a monopoly status in healthcare quality control for nearly half a century, started to lose its focus as well as its support from health organizations [58]. On September 26, 2008, DNV was granted authority from CMS to accredit acute care hospitals in the United States. DNV is a relative newcomer to the healthcare industry. Its parent company—Det Norske Veritas, a nongovernmental foundation based in a suburb of Oslo, Norway—first started in 1864 as a classification society to rate the seaworthiness of ships.

Meeting Medicare's conditions is the first part of meeting DNV's standards. Its accreditation process also helps hospitals receive International Organization for Standardization (ISO) 9001 certification, a process known in industries such as auto manufacturing as a quality management system with a heavy emphasis on leadership and accountability. According to DNV, hospitals that establish quality management systems are better equipped to reduce costs, manage workflow, and improve health outcomes [59].

2.3.4 The Centers for Medicare and Medicaid Services

The Centers for Medicare and Medicaid Services is an agency within the U.S. Department of Health & Human Services responsible for the administration of several key federal healthcare programs. In addition to Medicare (the federal health insurance

program for seniors) and Medicaid (the federal needs-based program), CMS oversees the Children's Health Insurance Program, the Health Insurance Portability and Accountability Act (HIPAA), and the Clinical Laboratory Improvement Amendments, among other services.

With the passage of the HITECH Act on February 17, 2009, the CMS has been charged with several key tasks for advancing HIT, including implementation of EHR incentive programs, a part of the Meaningful Use (MU) of certified EHR technology; standards for the certification of EHR technology; and HIPAA's health information privacy and security regulations. Much of this work is being done in conjunction with the Office of the National Coordinator for Health Information Technology [60]. The ONC is a staff division within the U.S. Department of Health and Human Services that is focused on implementing an interoperable, private and secure, nationwide health information system and supporting the widespread Meaningful Use of EHR technology. ONC was created in 2004 through an executive order by President George W. Bush, and was legislatively mandated in the Health Information Technology for Economic and Clinical Health Act (HITECH) of 2009 [61].

2.3.5 The Physician Consortium for Performance Improvement

The Physician Consortium for Performance Improvement (PCPI) is a national physician-led initiative that is dedicated to improving patient care and safety by identifying and developing evidence-based clinical performance measures and measurement resources that enhance the quality of patient care and foster accountability. The PCPI is nationally recognized for measure development, specification and testing of measures, and enabling use of measures in electronic health records (EHRs). The PCPI's

measure development resources include a measure testing protocol, a position statement on the evidence base required for measure development, a composite framework, specification and categorization of measure exceptions, and an outcomes measure framework [62].

The NCQA is a private, nonprofit organization that is committed to improving healthcare quality, and it began accrediting in 1991. NCQA develops quality standards and performance measures for a broad range of healthcare entities. The NCQA accredits carriers using a comprehensive review of approximately 60 standards [63].

The American Medical Association's Physicians Consortium for Performance Improvement (PCPI) and the National Committee for Quality Assurance (NCQA) are the entities primarily responsible for developing performance measures. This coordination eliminates redundant measures. Although some specialty societies and payers have developed their own performance measures, many specialty societies want all measures to come through the American Medical Association's Physicians Consortium for Performance Improvement and the National Committee for Quality Assurance as they follow a 3-step rigorous accreditation process. The 3-step accreditation process consists of first, feedback to the NCQA based on the Interactive survey system (ISS) for performing readiness evaluations; second, a 2-day review by trained NCQA reviewers that includes interviews with carrier staff, file review, and document review; third, NCQA’s review oversight committee, a national panel of physicians analyzes the survey teams findings to determine accreditation status as excellent, commendable, accredited, and provisional [64, 65].

2.3.6 The Agency for Healthcare Research and Quality

The Agency for Health Research and Quality (AHRQ), formerly known as the Agency for Healthcare Policy and Research, was established in 1989. Its mission is to improve the quality, safety, efficiency, and effectiveness of healthcare for the nation's healthcare system. With a congressional mandate to produce an annual report to the nation on healthcare quality, it provides evidence-based information on healthcare outcomes and quality of care and helps the NQF to improve the safety, quality, affordability, and accessibility of healthcare through its research programs [66].

The National Quality Strategy to improve the delivery of healthcare services, patient health outcomes, and population health was guided by AHRQ's first report the National Healthcare Quality Report, which was submitted to Congress in 2003. A central goal of the National Quality Strategy is to build a consensus on how to measure quality so that stakeholders can align their efforts for maximum results. The strategy itself serves as a framework for quality measurement, measure development, and healthcare quality analysis.

The National Healthcare Quality Report is set to include a series of performance measures that monitor the nation's progress towards healthcare quality improvement. The purpose of the report is to demonstrate the validity of concerns about healthcare quality; to document ascent, stability, or decline of healthcare quality; and to provide national benchmarks against which healthcare quality comparisons can be made [67].

2.3.7 The Leapfrog Group

Formulated in 2000, the Leapfrog Group is a consortium of Fortune 500 companies as well as other large private and public healthcare purchasers that work

together to drive improvements in patient quality and safety, customer care, and affordability of healthcare in the United States. The mission of the Leapfrog Group is to have immediate positive impact on employees, hospitals, and health plans. Leapfrog encourages the organizations it works with to be transparent and offer easy access to healthcare information; it also offers rewards for hospitals that have a proven record of high-quality care [68]. Endorsed by NQF, the Leapfrog Group recognizes computer physician order entry, evidence-based hospital referral, and intensive care unit staffing by physicians experienced in critical care medicine. Leapfrog also measures a hospital's performance with its own assessment called the Leapfrog Safe Practice Survey. The more points a hospital earns out of the possible 737, the higher the ranking it receives. [69].

2.4 The HITECH Act and Healthcare Reimbursement Policies

The HITECH Act, part of the American Recovery and Reinvestment Act of 2009, includes Medicare incentives for adoption and MU of certified EHR technology. To be eligible for incentive payments, hospitals and physicians must effectively use EHRs, exchange electronic health information to improve the quality of care, and report on clinical quality. The HITECH Act authorizes incentive payments through Medicare and Medicaid to clinicians and hospitals when they privately and securely use EHRs to achieve specified improvements in care delivery. HITECH's goal is not only for a hospital to the adopt EHR technology but to use it in a way that achieves significant improvements in care [70].

Through HITECH, the federal government has given unprecedented financial support for EHRs. In 2010, it made available incentive payments totaling up to $27 billion over 10 years, or as much as $44,000 (through Medicare) and $63,750 (through

Medicaid) per clinician. This funding provides important support for the creation of a nationwide system of EHRs [71]. The most recent data available, which are from February 2012, are that 12,365 physicians and other eligible professionals received $222.6 million in Medicare MU incentives, compared with 84 hospitals receiving $129.9 million. Doctors qualifying for Medicare MU incentives in stages over five years can earn up to $44,000 per physician [72]. These statistics show that more physicians and eligible professionals have been collecting Medicaid MU bonuses at a smaller number than the hospitals have.

Success in improving care with EHRs may be related to which types of EHRs are used, where they are implemented, and which incentives are put in place. To maximize the likelihood that improvement will occur through the HITECH Act, EHR certification is required to qualify for the EHR Incentive Program and to fulfill the requirements of MU. These regulations have clearly affected both vendors and healthcare organizations as they scramble to meet tight timelines to ensure that their EHRs meet a long list of requirements. The MU requirements are as follows: improve quality, safety, efficiency, care coordination; reduce the number of patient deaths in the hospital; engage patients and families in their healthcare; and maintain privacy and security of healthcare data. Nearly half of all health institutions (49%) ranked MU as their leading IT priority for 2011 [71]. This rise in the number of organizations that value HIT has increased organizations' interest in speeding up the implementations of EHRs to achieve MU incentives.

2.4.1 Stages of Meaningful Use

Meaningful Use will intended to be phased over three stages, allowing providers to gradually increase their EHR use. Providers follow the rules of Stage 1 for two years before being required to meet the increasingly stringent requirements of Stage 2, and ultimately Stage 3, to qualify for successive incentives. As part of Meaningful Use, electronic reporting of quality measures (eMeasures) are increasingly required.

Stage 1 (2011, 2012) criteria for MU include an array of requirements ranging from systems for computerized physician order entry to decision support. The MU criteria for eligible professionals requires the collection of specific quality measures; in particular, 15 inpatient and 6 outpatient quality measures have to be collected and reported to meet the criteria of MU. Hospitals must complete 14 core objectives and 5 out of 10 objective from a menu set, as well as 15 clinical quality measures.

Stage 2 (2014) encourages providers to begin improving the process of MU-advanced clinical processes and is characterized by increased interoperability and the exchange of data between providers and with patient. During this stage, providers must report all 17 core measures and must meet three of 6 menu measures. Providers also report on 9 clinical quality measures selected from a set of 64.

Stage 3 (2016) focuses on improving clinical outcomes that support new models of care (e.g., team-based, outcomes-oriented, population management); address national health priorities; have broad applicability to various providers' specialties, patients' needs and areas of the country; promote advancement; are achievable; and reflect reasonableness/feasibility of products or organizational capacity. Vendors and hospitals have already identified major challenges in collecting, calculating, and reporting even the

first 15, inpatient quality measures. Accordingly, attention to the m stages has increased the number of people and work hours required to achieve positive outcomes [73].

2.4.2 Healthcare Reimbursement Issues

Government health agencies continue to develop and advance payment methods in the United States. Healthcare professionals need to monitor the continuing evolution of healthcare reimbursement methodologies to comply with the HITECH Act [71, 74]. About one-third of the population is covered by Medicare and Medicaid, and the CMS is the single largest payer for healthcare in the United States [71]. Since Medicare and Medicaid have a higher proportion of coverage, than other government health agencies, clinicians and hospitals that did not follow the HITECH Act set by CMS for reimbursement will not qualify for reimbursement and physicians will not be financially covered to treat the patients. These discrepancies may contribute to the uneven coverage and reimbursement policies that can become significant barriers to quality healthcare. [75–80].

Established in 2009, the $19.2 billion HITECH Act will likely have a dramatic and lasting effects on the adoption of EHRs in the United States. The bulk of funds in the Act are spent on incentives for hospitals and healthcare professionals to encourage the widespread adoption of EHRs. The emphasis is on reimbursement for ambulatory physicians participating in Medicare. Because Medicare is a federal program, the provisions for reimbursement are the most straightforward. The Medicaid program and related reimbursement policies are managed by each state; however, a state's guidelines must be aligned with those of Medicare.

In order to qualify for incentive payments, Medicare physicians must use a

certified EHR. The HITECH Act does not specify the details of certification or who will provide it. However, it does specify that to be qualified as a certified EHR, the technology must (1) protect the privacy of health information, (2) ensure the comprehensive collection of patient demographic and clinical data, (3) include patient demographic and clinical health information, and (4) have the capacity to provide clinical decision and physician order entry.

Healthcare professionals with Medicare patients who meet the requirements for MU of a certified EHR are eligible to receive up to 75% of the Medicare allowable incentive payment. In addition to providing incentives to medical practices to adopt an EHR, the HITECH Act also creates penalties and disincentives for practices that fail to utilize an EHR. If eligible professionals have not become meaningful users of EHRs by 2015, their Medicare payments to the professionals will be reduced by 1% for physicians who do not meet this requirement [74, 81]. In addition, healthcare professionals and organizations must demonstrate MU of certified EHR technology to avoid being subjected to reduced physician fees and schedule fees.

2.5 Toolkit Development in Healthcare Settings

The purpose of this study was to develop a generalizable toolkit to assess the impact of implementation on the workflow of Quality Improvement (QI) and information technology professionals' and their team in the inpatient hospital setting. The toolkit was a compilation of resources including checklists, forms, and planning documents that provided a template for workflow analysis. The toolkit was designed to support and provide guidance on developing and implementing plans for achieving optimal workflow at any acute inpatient setting. The QI toolkit was an assembly of instruments that could

assist with implementing a project or initiative and was designed to support decision making on the implementation approaches related to workflow analysis.

2.5.1 Workflow Analysis

Workflow analysis, also known as process analysis, involves identifying, prioritizing, and ordering the tasks and information needed to achieve the intended result of a clinical or business process. Inattention to workflow has been associated with poor acceptance and unforeseen effects of use. Though workflow analysis mitigates the risks and increases the chances for success of QI analysis and HIT implementation, it is frequently omitted or overlooked when identifying and selecting new HIT needs [82].

Workflow analysis involves applying a set of techniques that identify and address environmental factors and information needs in the early stages of a system's selection and implementation. These techniques are useful in identifying the boundaries of a process; establishing a common understanding of its triggers, steps, and results among stakeholders; analyzing how the current process functions; understanding where it can be streamlined and otherwise improved; and developing use cases that will guide the design, development, and support of the new system that automates the process [83]. The methods used to understand the current and future state of workflow and processes usually include interviews with stakeholders, simple observation, and the use of tools such as checklists and activity logs. Information about the process is captured through a wide variety of tools such as process data flow diagrams and workflow diagrams.

The new emphasis on workflow analysis has increased the need for assessment toolkits. Assessment serves multiple important purposes. First, a continuous evaluation process guides a project. Second, by carefully documenting the barriers encountered and

the lessons learned, other organizations can better understand how to best approach their own HIT projects.

2.5.2 Toolkit Development

The toolkit in this study was developed to guide users through the process of devising a realistic and achievable evaluation plan to assess workflow related to implementing eMeasures. We examined other implementation toolkits and guides to understand the general methodology for developing the eMeasure Implementation Toolkit. The steps for creating a toolkit outlined in the Health Information Exchange Evaluation Toolkit [84], Implementation toolkit developed by Berkeley [85], Workflow Assessment for Health IT Toolkit [86], and Rapid Cycle Patient Safety and Quality Improvement Toolkit [87] guided the toolkit development process. These implementation toolkits contained information for developing the eMeasure Implementation Toolkit, and provided evidence in terms of: 1) review and assessment of the current state of workflow during an HIT implementation, 2) a definition of future state requirements and workforce strategies, 3) a summary of benefits and operational savings, and 4) an implementation roadmap. In addition, we examined the evidence from the stakeholder interviews derived from the results of Aim 1, as well as a peer review of scientific literature.

Another important set of guidelines to consider while discussing methods for toolkit development and implementation is the Health Level Seven (HL7) [88], a nationally recognized standard for electronic data exchange between systems housing healthcare data. The HL7 standard supports this two-way exchange of information because it defines a syntax for formulating the messages that carry this information. The implementation guide for HL7 not only defines the vocabulary used in these messages

but also specifies a standard for electronic submission of Healthcare Associated Infection Reports to the National Healthcare Safety Network of the Centers for Disease Control and Prevention [89]. The implementation guide is directly related to the initial set of standards and certification criteria interim final rule issued earlier this year by the Department of Health and Human Services.

2.5.3 Implementation Guide

Implementation guides provide step-by-step resources in the form of checklists, forms, and planning documents that provided a template for facilitating implementation projects. They offer a roadmap to implementation through the following steps: providing background information, identifying gaps in the science, setting objectives, and implementation. For the purpose of our research, we examined implementation guides to understand the requirements for creating the eMeasure Implementation Toolkit. We examined the Electronic Laboratory Reporting to Public Health, Release 1, also called Implementation Guide 2.5.1, which meets the needs and requirements of implementation guidance in public health entities, contains the necessary specifications for laboratory results reporting to local, state, territorial, and federal health agencies. In particular, it addresses the messaging content and dynamics related to the transmission of Laboratory Reportable Result Messages/Electronic Laboratory Reporting. Electronic Laboratory Reporting allows hospitals and laboratories to report test results for reportable infectious diseases through an automated and secure process.

Each state and county has requirements for what laboratories need to report to health officials. In the past, these reports were written by hand on forms provided by health departments and then mailed to the appropriate offices. With the computerization

of laboratories, it has become possible for laboratories to send reportable data to health departments electronically.

HL7 Version 2.5.1, the standard for implementation guides, has been selected, along with other HL7 standards, by the Office of the National Coordinator for HIT in the U.S. Department of Health and Human Services to support Stage 1 of MU in its interim final rule for the initial set of standards, implementation specifications, and certification criteria adopted in Stage 1. All of these established the capabilities that certified EHR technology would need to include to, at a minimum, support eligible professionals' and eligible hospitals' efforts to achieve what had been proposed for Stage 1 under the proposed Medicare and Medicaid EHR Incentive Programs.

In addition to being selected to support Stage 1 of MU, several of HL7's standards are key to overcoming four major challenges of adopting HIT data identified by The Office of the National Coordinator for HIT in the U.S. Department of Health and Human Services. HL7 has developed and is continuing to develop standards that address challenges such as security of HIT, patient-centered cognitive support, healthcare applications, network platform architectures, and secondary uses of EHR data [90]. HL7 frequently publishes implementation guides that provide assistance with implementing standards.

This study was guided by the methodologies and examples demonstrated in HL7 and other implementation guides, which were used for the development of the eMeasure Implementation Toolkit. The toolkit was designed as an implementation guide to address the challenges associated with the lack of attention to workflow during the automation of performance measures. The toolkit provides a distinct set of resources and tools, such as

checklists, forms, and planning documents, which were available to the users in a single source document. The toolkit was focused on workflow.

2.6 Methods Used for Workflow Analysis and Data Collection

2.6.1 Semistructured Interviews

The concept of quality in healthcare is multidimensional and complex and some of the questions pertaining to quality cannot be answered through quantitative analysis. The use of qualitative data involves the systematic collection, organization, and analysis of textual material derived from talk or observation. Qualitative methods for collecting data include interviews, observations, and analysis of documents. In certain cases, a single method or a combination of methods can be applied to qualitative analysis of data [91].

This study used techniques described by Steinar Kvale in *Doing Interviews* [92] to conduct semistructured interviews. They follow a fairly open framework that allows for focused, conversational, two-way communication. Unlike the questionnaire framework, in which detailed questions are formulated ahead of time, semistructured interviewing starts with more general questions or topics that can be further developed on the basis of responses from the interviewee. These steps parallel the steps of conducting semistructured interviews mentioned in the article "Training Manual: Data Collection Methods: Semistructured Interviews and Focus Groups" [93]. An overview of the important aspects of semistructured interviews includes a number of steps. First, it is important to limit the number of interviews because semistructured interviews are time consuming to conduct and analyze. The aim is not to get a random sample of the various categories of informants but to gather a substantial body of representative information

from them. Usually only 3–5 people from each of the identified groups are required. Second, it is important to explain the purpose of the interview to the interviewees. Third, the informant being interviewed should be asked for verbal consent, and the method of interview documentation should be explained. Finally, when conducting semistructured interviews, the interviewer needs to be prepared with a list of open-ended questions and topics. The flow of the interview depends on the direction of the discussion; it is best to start with a topic that is important but not challenging to the respondent. The researcher acts as a moderator, guiding the respondent from one topic to another. Before ending the conversation, the interviewer needs to thank the interviewee for his/her time and to check whether all the questions from the interview guide have been covered [94].

2.6.2 Thematic Analysis

Analysis of the semistructured interviews was conducted using applied thematic analysis [95], a method for identifying, analysing, and reporting patterns (i.e., themes) within data. Thematic analysis focuses on identifiable themes that become the categories for analysis [96]. According to the report, the steps of conducting a thematic analysis involves the following, the first of which is to audio record and transcribe interviews [97]. From the transcriptions, patterns of experiences can be identified by collecting direct quotes or paraphrasing recurring ideas.

The next task is to identify all data that relate to the already classified patterns. The third task is to combine and catalogue related patterns into subthemes. Themes are defined as units derived from patterns such as conversation topics, vocabulary, recurring activities, and meanings [98]. Themes are identified by combining components or fragments of ideas or experiences that are often meaningless when viewed alone [99].

Themes that emerge from the information collected during interviews are pieced together to form a comprehensive idea of the interview. The coherence of ideas are linked together by an analyst to make the analysis more meaningful. When gathering subthemes to obtain a comprehensive view of the information, it is easy to see a pattern emerging. When patterns emerge, it is best to obtain feedback from the informants about them. This can be done while the interview is taking place or by later asking the informants to give feedback from the transcribed conversations [100].

The final task is to build a valid argument for choosing the themes. This is done by reading the related literature to find information that helps the researcher make sound inferences from the interview. Once the themes have been collected and the literature has been studied, the researcher formulates theme statements to develop a summary of findings that helps the reader of the study comprehend the process and understand of the interviews on which the thematic analysis was carried out [101].

2.6.3 Simple Surveys

We have used the steps involved in constructing simple surveys as described by Lu Ann Aday in *Designing and Conducting Health Surveys* [102]. Surveys are consistently used to measure quality in healthcare and Likert scales are a common ratings format for surveys. Likert scales ask respondents to indicate how much they agree or disagree, approve or disapprove, or believe a variety of questions to be true or false. The survey will be designed to measure relevance and clarity of data. This Likert scale is intended to provide a unified scaling methodology to help survey developers' critically understand the implications of the decisions for the quality and usefulness of the data for relevance and clarity [103].

CHAPTER 3

METHODOLOGY

3.1 Aim 1

Aim 1 of this study was to explore and document the current workflow for National Quality Forum (NQF) 0081 (inpatient heart failure) eMeasure [12] and to assess the impact on workflow of implementing this as an eMeasure in the U.S. Department of Veterans Affairs. This aim included 2 objectives: 1) to describe the NQF 0081 eMeasure's impact on workflow in the U.S. Department of Veterans Affairs, and 2) to analyze key aspects of workflow in order to understand the current manual system and the anticipated automated system.

3.1.1 Research Design

This was a qualitative study to explore and document the current workflow for the National Quality Forum (NQF) 0081 (inpatient heart failure) eMeasure [12]. The National Quality Forum (NQF) 0081 eMeasure was used as an exemplar. It is defined as the quality metric for use of Angiotensin converting enzyme (ACE) inhibitor or Angiotensin Receptor Blocker (ARB) Therapy for Left Ventricular Systolic Dysfunction (LVSD). Electronic measures or eMeasures are standardized performance measures in an electronic format. Meaningful Use requires the hospitals to report their performance measures electronically, and VA is making efforts to become Meaningful Use certified

by 2015. Standardized performance measures define a denominator, which is the number of people in the population of interest, in the organization; and a numerator, which is the number of people who received the intervention. The measure is represented as a ratio or percent. For NQF 0081, the measure includes the percentage of patients aged 18 years and older with a diagnosis of Heart Failure (HF) and LVSD (Left Ventricular Ejection Fraction (LVEF) <40% (the denominator) who were prescribed ACE inhibitor or ARB therapy. We evaluated the processes and tools used to implement this as an eMeasure in the U.S. Department of Veteran Affairs. We assessed the potential barriers and facilitators that impact the adoption and uptake of a new system for the automation of the inpatient HF performance measure, as well as the potential impact of the new system on workflow.

We used a combination of the PARIHS [13] and socio-technical approaches as a theoretic framework to guide our research, as seen in Figure 3.1. The PARIHS implementation framework includes three important areas—evidence, context, and facilitation—all of which work together to implement evidence-based guidelines into clinical practice. In the scientific literature, HIT [104] has been recognized as a facilitator of evidence-based medicine in inpatient medical settings. We focused on 5 of the 8 dimensions of the socio-technical model [14]: (a) hardware and software, (b) clinical content, (c) workflow and communication, (d) internal organizational factors, and (e) people.

Combining the PARIHS and socio-technical approaches allowed us to target the areas needed to develop a sound implementation strategy, which would result in the successful adoption and uptake of the new system.

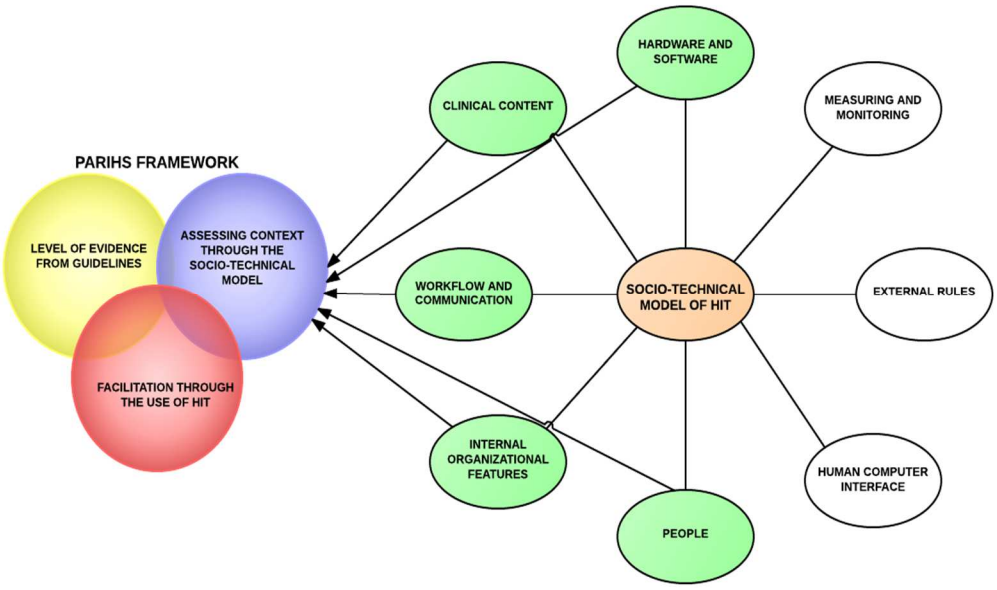

Figure 3.1: Combination of PARIHS and socio-technical model

3.1.2 Setting

Participants for this aim were recruited from the U.S. Department of Veterans Affairs, Salt Lake City, Utah. Analysis was conducted at the investigator's office and the University of Utah.

3.1.3 Methods

We used snowball sampling methods. We identified key informants to begin the process of interviewing stakeholders to initiate our snowball sampling process whereby during each interview, we asked each participant whether they could recommend another acquaintance or colleague for an interview. We then interviewed others who were recommended to us.

We conducted 15 stakeholder interviews with Quality Management (QM) and Quality Improvement (QI) key informants and subject matter experts (SMEs) at the U.S. Department of Veteran Affairs (VA) [92-94]. Key informants [105] provided a broad

understanding about the context of workflow during eMeasure implementation. We interviewed 4 key informants with the following job categories: directors or associate directors of quality management, geriatrics, epidemiology, and pharmacy executives. We then interviewed 11 SMEs [106] based on the recommendations of the key informants. The SMEs suggested tools and provided information essential to the toolkit development. Subject matter experts were quality management specialists, information system specialists, data support specialists, quality measurement experts, pharmacists, and clinician providers (physicians, advanced practice nurses, and physician assistants).

The study was approved by the University of Utah Institutional Review Board (IRB). This is also the IRB for the Salt Lake Veteran's Administration.

3.1.3.1 Interviewee Characteristic Definitions

This research used the sociology definition of healthcare professional to identify the hierarchy of the individuals who have served as key informants and subject matter experts. The key informants referred to individuals with whom an interview about a particular organization, social program, problem or interest group is conducted. Key informant interviews are in-depth interviews of a select (nonrandom) group of experts who are most knowledgeable of the organization or issues [105]. Similarly, subject matter experts (SMEs) were individuals who exhibited the highest level of expertise in performing specialized jobs, tasks, or skills within their organization [106].

3.1.3.2 Inclusion Criteria

The QI, HIT, and measure automation key informants and subject matter experts (SMEs) participated in 15 semistructured interviews, and discussions. Key informants

were Quality Management (QM) and Quality Improvement (QI) experts who had national leadership and technical roles at the U.S. Department of Veteran Affairs. Key informants [105] provided a broad understanding about the context of workflow during eMeasure implementation. We interviewed 4 key informants with the following job categories: directors or associate directors of quality management, geriatrics, epidemiology, and pharmacy executives. Based on the key informants' recommendations, 11 subject matter experts [106] were interviewed. SMEs recommended tools and provided information essential to the toolkit development. Subject matter experts were quality management specialists, information system specialists, data support specialists, quality measurement experts, pharmacists, and clinician providers (physicians, advanced practice nurses, and physician assistants).

3.1.3.3 Semistructured Interview Guide

We developed semistructured interview guides with relevant stakeholder engagement questions for all interviews. We focused on high-level strategic and informatics infrastructure questions with key Informant Interviews. We focused SME questions on the specific area of expertise of the interviewee. The interview guide contained demographic questions as well as questions related to the dimensions of the socio-technical model for our research.

3.1.3.4 Stakeholder Engagement Interview Process

We engaged stakeholders individually, in person over the phone with virtual meeting software (LiveMeeting and Lync), and conducted open-ended, semistructured interviews. Two independent note takers listened on the call, and populated the interview

guide independently. The two transcripts were summarized, and then combined into a single summary through a consensus process. The final single summary was then sent to each interviewee for review and editing (a validation process also called *member checks*). We used the collective set of validated summaries to generate themes to answer our research questions.

3.1.4 Analysis

Thematic analysis, a method for identifying, analysing, and reporting patterns (i.e., themes), was applied to the information retrieved from the semistructured interviews [97-101]. We used applied thematic analysis [95-96], which involved the following: We used the collected set of validated summaries to document the current workflow related to the HF performance measure, and to identify the tools and process that affected the workflow during implementation. Iterative rounds of analysis were based on the dimensions of the socio-technical model, and the PARIHS framework.

We created figures to describe most of the themes. We documented the findings from this research study in a qualitative research report, which described the current workflow of how the VA is trying to automate the inpatient HF performance measure. We created data flow diagrams and figures to support themes that arose from the analysis. We augmented the themes with supporting evidence, through the peer review of scientific literature. We examined themes and supporting information to understand the context of implementation at the national, VISN, and local levels in terms of hardware and software, clinical content, workflow and communication, internal organizational features, and people. Next, we identified factors that would enable us to overcome eMeasure implementation barriers at the national, VISN, and local levels.

3.2 Aim 2

Aim 2 of this study was to develop an implementation toolkit for workflow analysis, for the U.S. Department of Veterans Affairs, based on the results of Aim 1. The toolkit was developed as a comprehensive document. A website was created to allow immediate access to subsections of the toolkit.

3.2.1 Methods

3.2.1.1 eMeasure Implementation Toolkit Development

We examined other implementation toolkits and guides to understand the general methodology for developing the eMeasure Implementation Toolkit. We based the toolkit development procedures on the detailed methodology in the Health Information Exchange Evaluation Toolkit [84], Implementation toolkit developed by Berkeley [85], Workflow Assessment for Health IT Toolkit [86], and Rapid Cycle Patient Safety and Quality Improvement Toolkit [87]. These implementation toolkits contained information for developing the eMeasure Implementation Toolkit, and provided evidence in terms of: 1) review and assessment of the current state of workflow during an HIT implementation, 2) a definition of future state requirements and workforce strategies, 3) a summary of benefits and operational savings, and 4) an implementation roadmap. In addition, we examined the evidence from the stakeholder interviews derived from the results of Aim 1, as well as a peer review of scientific literature.

The initial toolkit was predominantly focused on evaluating workflow during the automation of performance measures. The toolkit was a compilation of resources such as checklists, forms, and planning documents that provided a template for workflow analysis. The implementation toolkit was intended to provide guidance or assistance; and

provide a template or blueprint for what to do, when to do it, and how to do it. The heart failure (HF) eMeasure implementation at the VA provided the exemplar for the tools in the toolkit.

During the development of the toolkit, we applied a set of techniques required in the early stages of selecting and implementing a system. These techniques helped identify the boundaries of the research; establish a common understanding of its triggers, steps, and results among QM, QI experts, and IT professionals; analyze the current functions of the process; understand potential improvements; and develop use cases that guided the design, development, and support of the new system. Users could apply the toolkit in its entirety, or only apply certain portions that were informative for their needs.

3.2.1.2 Website Development

We developed a website to host the eMeasure Implementation Toolkit using HTML tools such as Bluefish [107] and BlueGriffon [108]. We used a secure CHPC (Center for High Performance Computing) server at the University of Utah to host the website. We tested the functionality of the website, ability to access the website from outside of the University firewalls, and ensured that the content of the website matched precisely to the content of the full toolkit document.

3.3 Aim 3

Aim 3 was to assess the toolkit based on expert review by stakeholders in a non-VA setting. This aim included 2 objectives: 1) to assess the potential generalizability of the eMeasure Implementation Toolkit in a non-VA setting, and 2) to undertake a detailed evaluation of the toolkit for relevance and clarity.

3.3.1 Research Design

This was a descriptive study. A web-based survey was used to evaluate stakeholder perceptions about relevance and clarity of specific toolkit items, to assess for missing or unnecessary information, and perceptions about potential generalizability of the toolkit.

3.3.2 Setting

Participants were recruited from non-VA settings. These settings included federal and state healthcare institutions, private nonprofit healthcare organizations, academic institutions, and academic healthcare institutions.

3.3.3 Methods

This was a single point in time, web-based survey. It was distributed using REDCap, a secure, web-based application for building and managing online surveys and databases. The study was approved by the University of Utah Institutional Review Board (IRB).

3.3.3.1 Inclusion Criteria

We included 10 Quality Measurement (QM), HIT, and measure automation experts who had national leadership and technical roles and who had knowledge of quality performance measurement within a non-VA setting. The experts reviewed the toolkit online and participated in the online survey. The stakeholders had the following types of job categories:

1. Directors or associate directors of healthcare quality and safety
2. Primary care providers

3. Clinical Quality Program Specialists (QI team members)
4. Informatics professionals or HIT team professionals

3.3.3.2 Evaluation of the Assessment Toolkit

The QI, HIT, and measure automation experts were asked to review the eMeasure Implementation Toolkit online and to provide their viewpoint about the toolkit. The link to the survey was embedded in the Toolkit website; and hyperlinks in the survey allowed the participants to go back and review sections of the Toolkit. The survey contained demographic information and questions that represented toolkit elements. The experts were asked to rate each item in the toolkit for relevance and clarity and add additional comments at the end of the survey.

The total time of participation was approximately 20-30 minutes, approximately 10-15 minutes to review the toolkit and 10-15 minutes to complete the questionnaire. Participation in this study was voluntary and the experts could choose not to take part in the research. The experts could also omit any question they preferred not to answer without penalty or loss of benefits. We provided the URLs for the eMeasure Implementation Toolkit and the REDCap survey at the end of the questionnaire cover letter.

3.3.3.3 Generalizability of the Assessment Toolkit

The survey was developed using participants who worked at the VA. We assessed the generalizability of the eMeasure Implementation Toolkit by surveying a different set of subject matter experts from VA and non-VA settings. We asked the experts to evaluate the toolkit for relevance and clarity. The 10 subject matter experts were QI, HIT, and

measure automation experts from 3 healthcare quality sectors including: the governmental sector at the federal level via the Department of Veterans Affairs, and at the state level, via the Utah Department of Health (UDOH), as well as from the academic medical center healthcare sector via the University of Utah Medical Center and Health Sciences, and Partners Healthcare.

3.3.4 Analysis

3.3.4.1 Descriptive Statistics

We obtained survey data from experts to evaluate the eMeasure Implementation Toolkit. We used descriptive statistics to summarize the results from the survey, for items rating relevance and clarity.

3.3.4.2 Content Validity

Evidence for content validity was supported by having QI, HIT, and measure automation experts review the content of the toolkit. Each item was rated for relevance to the underlying constructs (a scale of 1–5 will be used, with 1 being “very relevant”) and for clarity (a scale of 1–5 with 1 being “very clear”). A correlation of the assessment toolkit was measured via similarities in answers between the various non-VA settings. A qualitative research report documented the findings from this analysis.

CHAPTER 4

RESULTS

4.1 Aim 1

Aim 1 was a qualitative study to explore and document the current workflow for National Quality Forum (NQF) 0081 (inpatient heart failure) eMeasure [12] and to assess the impact on workflow of implementing this as an eMeasure in the U.S. Department of Veterans Affairs. National Quality Forum (NQF) 0081 inpatient Heart Failure eMeasure evaluates Angiotensin Converting Enzyme (ACE) inhibitor or Angiotensin Receptor Blocker (ARB) therapy for Left Ventricular Systolic Dysfunction (LVSD).

4.1.1 Stakeholders Who Participated in the Study

We interviewed 15 stakeholders with the respondent characteristics described in Table 4.1. We began with 4 key informants who were Quality Measurement (QM) experts with national leadership and technical roles, and who had VA-wide knowledge about inpatient Heart Failure (HF) quality measurement. Key informants were directors or associate directors of quality management, geriatrics, epidemiology, and pharmacy executives.

Key informants recommended 11 subject matter experts who were responsible for receiving and interpreting quality monitoring data. Subject matter experts were quality management specialists, information system specialists, data support specialists, quality

Table 4.1: Stakeholder characteristics

Participant Category	VA experience (years)	Quality management experience (years)	Total Number
Key informants	5.5-33	20-33	4
Subject matter experts	3-26	0-16	11

measurement experts, pharmacists, and clinician providers (physicians, advanced practice nurses, and physician assistants).

4.1.2 Resulting Themes

We identified themes related to the dimensions of the socio-technical model of HIT [14], which informs the implementation of eMeasures. For each dimension, we generated a summary statement of findings for the dimension, then listed themes with supporting examples. The detailed qualitative summary report containing the themes and supporting information to understand the context of implementation at the national, VISN, and local levels in terms of hardware and software, clinical content, workflow and communication, internal organizational features, and people, as well as the factors that would enable us to overcome eMeasure implementation barriers, can be found in Appendix A.

Sittig, in describing the socio-technical framework, noted that health-IT systems are complex adaptive systems and therefore, the model dimensions have multiple inter-dependencies [14]. We found this in the themes as reflected in Table 4.2. For example, storing heterogeneous data on multiple servers leads naturally to the need for multiple systems for extracting and analyzing the data, for the eMeasure.

Table 4.2: Overview of themes

Socio-technical model dimension	**Summary of context at the VA**	**Highlights of the major themes**
Computing Infrastructure (Hardware/Software)	VA has a robust and reliable, but evolving, hardware and software infrastructure and architecture that makes eMeasurement possible	Hardware includes multiple servers and databases including servers for structured data, text notes, lab, and echo. EHR (VistA) and multiple data warehouses are part of overall architecture Software includes a large variety of general database management and analytic software, along with multiple types of reporting and display software, and a few custom eMeasure tools. Additional software applications include: • The core information technology system (VistA) is built on MUMPS platform • The data warehouse can be queried with SQL. NLP tools are also used
Clinical Content	VA has the availability of appropriate clinical content in the form of structured, unstructured, and semistructured data, located in multiple electronic medical databases that can be extracted by informatics and text processing techniques for eMeasurement if needed	Structured clinical data within VA's EHR is aggregated within specialized databases Data are extracted from clinical and administrative systems. Standard clinical terminologies are used in many of the databases. Information extraction (IE) and Natural Language processing (NLP) techniques extract unstructured data from clinical notes; NLP techniques transform semistructured data into structured data that are stored in data warehouses Some heart failure eMeasure data, such as LV function or the specific ejection fraction, continue to be challenging to abstract at times

Table 4.2 continued.

Socio-technical model dimension	**Summary of context at the VA**	**Highlights of the major themes**
Workflow and communication	VA manually abstracts data for performance measures	A significant portion of the clinical content for eMeasures is available in electronic format VA currently has a manual abstraction process for the abstraction of performance measure data that is contracted through the EPRP VA is making efforts to promote automated data extraction for performance measurement
Internal organizational features	VA has a culture of continuous quality improvement, which is enhanced by its internal organizational factors	VA is making efforts to achieve Meaningful Use certification by 2015. VA uses Health Information Technology as a facilitator for quality improvement VA is routinely using quality control reporting as a feedback loop
People	VA has informed research staff that is engaged at various levels of automation of performance measures to facilitate eMeasurement	Key informants for example, directors, and executives provide overall comprehensive knowledge about the efforts that are being made to comply with Meaningful Use at the VA. Subject matter experts (department administrators, patient care managers, data analysts, informatics and information technology professionals) and quality improvement and management staff provide a high level of expertise in performing specialized tasks to support eMeasurement

4.1.3 Workflow Assessment for the Implementation of eMeasures

We described the high level workflow for implementing eMeasures via a swimlane diagram, as seen in Figure 4.1. The diagram represented a simple roadmap to show the steps involved in eMeasure implementation from start to finish. The diagram provided us with information about the role of various quality improvement and information technology professionals, who were part of the 'people' dimension of the socio-technical model, and the tasks that they undertook. For example, the information technology subject matter experts were responsible for assessing and evaluating the hardware and software and data requirement, which represented the interdependencies between the 'people', 'hardware and software', and the clinical content dimensions of the socio-technical model.

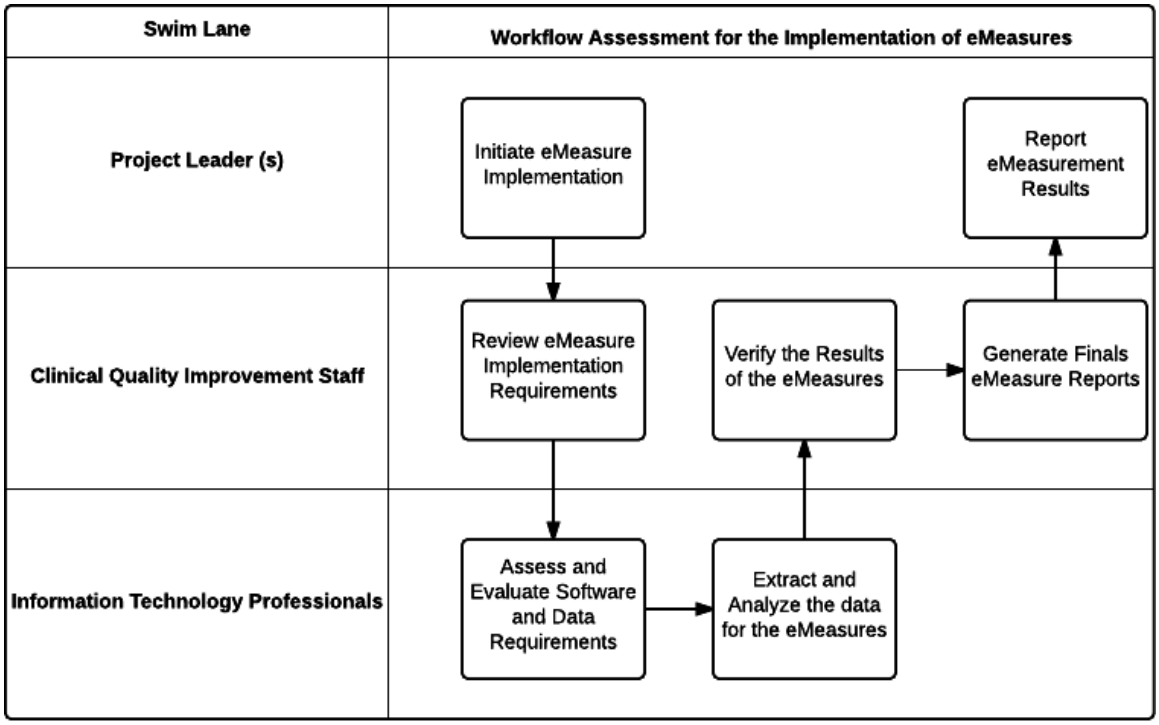

Figure 4.1: Swimlane diagram for workflow assessment

4.1.4 Aim 1 findings summary

The goal of our stakeholder engagement process was to understand the context of implementation of the National Quality Forum (NQF) 0081 inpatient Heart Failure eMeasure, which evaluates Angiotensin Converting Enzyme (ACE) inhibitor or Angiotensin Receptor Blocker (ARB) therapy for Left Ventricular Systolic Dysfunction (LVSD). Facilitating factors identified through stakeholder engagement included use of evidence-based care, a culture of continuous quality improvement, routine use of quality control reporting as a feedback loop, multiple informatics tools for clinical care, and extensive supporting informatics infrastructure. We also identified barriers to implementation including, lack of available structured data, and desired clinical features to better use informatics tools to support eMeasurement. Our work demonstrated that the stakeholder engagement process facilitated the development of themes that were then effectively used to develop the eMeasure Implementation Toolkit.

4.2 Aim 2

Aim 2 was a development process, in which an initial eMeasure Implementation Toolkit was developed based on the results of Aim 1, peer review of scientific literature and the information gathered from the review of other similar implementation toolkits. The goal of the eMeasure Implementation Toolkit was to support and provide guidance to quality improvement and information technology professionals' and their team for achieving optimal workflow at any acute inpatient healthcare setting during the implementation of an eMeasure. The toolkit was a compilation of resources such as checklists, forms, and planning documents that provided a template for workflow analysis.

Users could apply the toolkit in its entirety, or only apply certain portions that were informative for their needs. However, for the purpose of evaluation, the participants were asked to evaluate the entire toolkit. The toolkit was implemented as a text-based document (Word and PDF), and as a website that allowed direct access to individual components. The detailed eMeasure Implementation Toolkit can be found in Appendix B. A screen shot of the website can be seen in Figure 4.2. The website was posted at: http://home.chpc.utah.edu/~u0059963/tableofcontents_table_01.html.

4.2.1 Source of Information for Toolkit Development

We examined other implementation toolkits and guides to understand the general methodology for developing a Toolkit. For our research, we examined the detailed methodology in the Health Information Exchange Evaluation Toolkit [84], Implementation toolkit developed by Berkeley [85], Workflow Assessment for Health IT Toolkit [86], and Rapid Cycle Patient Safety and Quality Improvement Toolkit [87], which contained information for developing the toolkit, and provided information in terms of: 1) review and assessment of the current state of workflow during an HIT implementation, 2) a definition of future state requirements and workforce strategies, 3) a summary of benefits and operational savings, and 4) an implementation roadmap.

In addition, we examined the evidence from the stakeholder interviews derived from the results of Aim 1, and information obtained in the peer review of scientific literature. The source of information for each toolkit element is summarized in Table 4.3. The source of information for each toolkit section was distributed between other toolkits (Table 4.3 column A), stakeholder interviews (Table 4.3 column B), and published literature (Table 4.3 column C).

Biomedical Informatics

Click Here to Access the REDCap Survey

eMeasure Implementation Toolkit for the Evaluation of Workflow during the Automation of a Performance Measure
IRB# 00065529

Section	Topic	Tools
Section A	Background and Introduction	• Introduction • Background about workflow • Introduction to eMeasures
Section B	Determine Pre-implementation Requirements	• Tool 1: Pre-implementation planning checklist • Tool 2: Stakeholder interviews for understanding the eMeasure implementation requirements • Tool 3: Flowcharts for identifying key process during the implementation of eMeasures
Section C	Tools for Implementing a single eMeasure	• Tool 1: Tools for analyzing the eMeasure XML document • Tool 2: Tools for Identifying standard terminology and data sources for implementing an eMeasure • Tool 3: Tools for extracting structured data for an eMeasure • Tool 4: Tools for extracting free text from clinical notes
Section D	Tools for Managing multiple eMeasures	• Tool 1: Tools for version control • Tool 2: Tools for the project evaluation plan • Tool 3: Templates (meeting agenda, budget, project timeline)
Section E	Tools for Determining Post-implementation Requirements	• Tool 1: Post implementation assessment of barriers and facilitators • Tool 2: Post implementation assessment of process improvement requirements • Tool 3: Post implementation assessment to finalize workflows
Section F	Appendix	Detailed PDF version of the eMeasure Implementation toolkit
Section G	Additional Resources	Link to additional tools for understanding the workflow during the implementation of eMeasures
Section H	Acknowledgements	
Section I	About the Author	

Figure 4.2: Website for the eMeasure Implementation Toolkit

Table 4.3: Source of information for toolkit development

Toolkit element	A	B	C
Section A: Determine Preimplementation Requirements			
Preimplementation planning checklist	X		
Stakeholder interviews for understanding the eMeasure implementation requirements		X	X
Flowcharts for key process for the automation of eMeasures	X	X	X
Section B: Tools for Implementing a Single eMeasure			
Analyzing the eMeasure document			X
Identifying standard terminology and data sources for implementing an eMeasure		X	X
Identifying Structured Query Language (SQL) tools for extracting structured data for an eMeasure		X	X
Identifying Natural Language Programming (NLP) tools for extracting free text from clinical notes		X	X
Section C: Tools for Managing Team Activity			
Identifying tools for version control			X
Identify tools for project evaluation	X		X
Identify templates for planning tools	X		X
Section D: Determine Postimplementation Requirements			
Postimplementation assessment of barriers and facilitators	X	X	
Postimplementation assessment of process improvement requirements	X	X	
Postimplementation assessment to finalize workflows	X	X	

* Column A: Information from other implementation toolkits; * Column B: Evidence from the stakeholder interviews (Aim 1); * Column C: Peer review of scientific literature

We used several sources of information for the development of the toolkit. Figure 4.3 shows the distribution of the type of information sources that were used for the development of the toolkit. A slight majority of the information was obtained from the peer review of scientific literature, which amounted to 38% of the total information used. Evidence from stakeholder interviews contributed 33% of the information, and the information from other implementation toolkits provided 29% of the information.

4.2.2 Aim 2 Findings Summary

To develop the toolkit, we examined the detailed methodology in the Health Information Exchange Evaluation Toolkit [84], Implementation toolkit developed by Berkeley [85], Workflow Assessment for Health IT Toolkit [86], and Rapid Cycle Patient

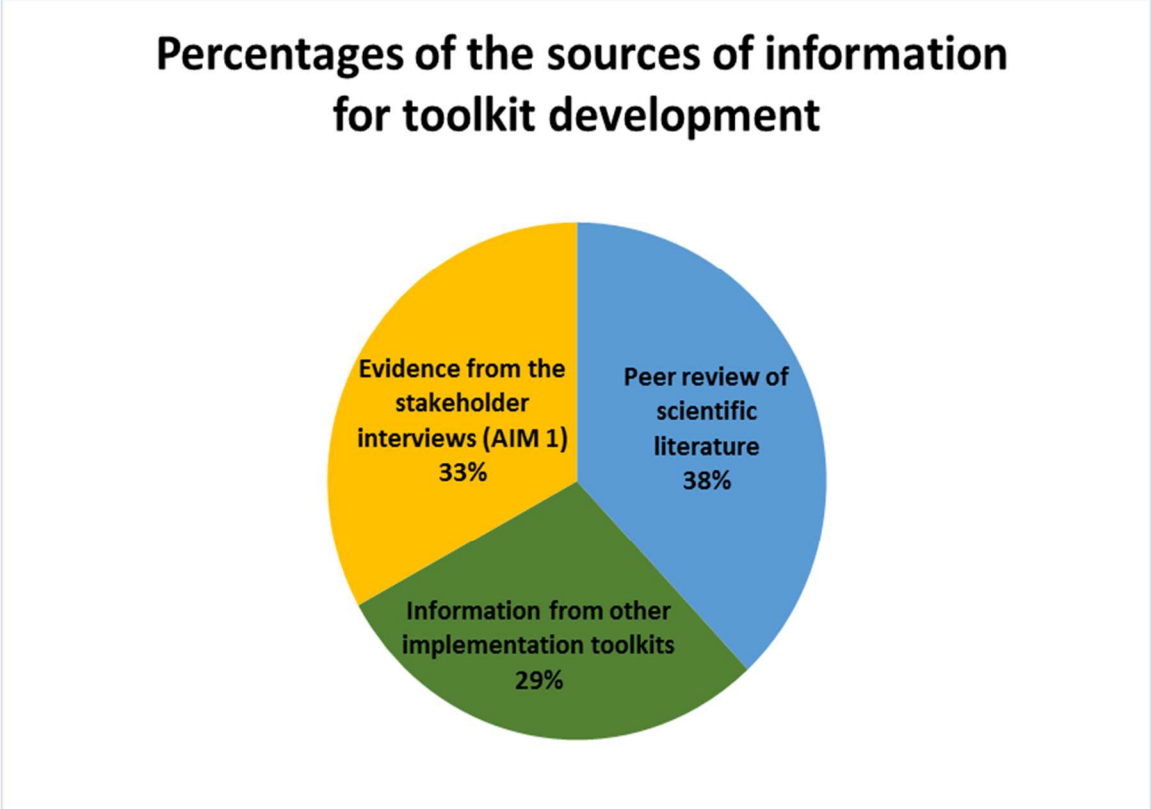

Figure 4.3: Percentages of the sources of information for toolkit development

Safety and Quality Improvement Toolkit [87], which contained a methodology for developing a toolkit and provided information regarding: 1) review and assessment of the current state of workflow during an HIT implementation, 2) a definition of future state requirements and workforce strategies, 3) a summary of benefits and operational savings, and 4) an implementation roadmap. In addition, we examined the evidence from the stakeholder interviews derived from the results of Aim 1, and the peer review of scientific literature.

4.3 Aim 3

Aim 3 involved the evaluation of the eMeasure Implementation Toolkit. We conducted the research using a survey in REDCap. The non-VA subject matter experts evaluated the eMeasure Implementation Toolkit for relevance and clarity. The PDF of the REDCap survey can be found in Appendix C. The link for the survey was posted at: https://redcap01.brisc.utah.edu/ccts/redcap/surveys/?s=jzJhsWJUNf .

The subject matter experts predominantly evaluated the sections of the toolkit that contained the tools for evaluating the workflow during eMeasure implementation. The total time of participation in the evaluation phase was approximately 20-30 minutes, approximately 10-15 minutes to review the toolkit and 10-15 minutes to complete the questionnaire. Table 4.4 lists the tools under each section of the eMeasure Implementation Toolkit that were evaluated by the non-VA subject matter experts.

4.3.1 Non-VA Stakeholders Who Participated in the Study

We included non-VA Quality Measurement (QM), Health Information Technology (HIT), and measure automation experts who had national leadership and

Table 4.4: List of tools evaluated by the non –VA subject matter experts

Toolkit sections	List of tools
Section A: Determine Preimplementation Requirements	• Preimplementation planning checklist • Stakeholder interviews for understanding the eMeasure implementation requirements • Flowcharts for key process for the automation of eMeasures
Section B: Tools for Implementing a Single eMeasure	• Analyzing the eMeasure document • Identifying standard terminology and data sources for implementing an eMeasure • Identifying Structured Query Language (SQL) tools for extracting structured data for an eMeasure • Identifying Natural Language Programming (NLP) tools for extracting free text from clinical notes for eMeasurement
Section C: Tools for Managing Team Activity	• Identifying tools for version control • Identify tools for project evaluation • Identify templates for planning tools
Section D: Determine Postimplementation Requirements	• Postimplementation assessment of barriers and facilitators • Postimplementation assessment of process improvement requirements • Postimplementation assessment to finalize workflows

technical roles and who had knowledge of healthcare quality performance measurement within a non-VA setting. The QM, HIT, and measure automation experts reviewed the toolkit online and participated in the online survey, to evaluate the eMeasure Implementation Toolkit for relevance and clarity.

The first section of the survey contained demographic information. A total of 10 non-VA subject matter experts participated in the online survey. The expert evaluators consisted of non-VA subject matter experts with job categories such as: directors or associate directors of quality and safety, information technology or quality improvement professionals, clinical quality program specialists, primary care providers, and health information coders. The subject matter experts were employed by various types of healthcare organizations, Figure 4.4 depicts the percentages of the expert evaluators by the type of organization where they were employed. The largest percentage of expert evaluators belonged to academic healthcare system, which amounted to 30% of the total participants who evaluated the toolkit for relevance and clarity. Evaluators from academic institutions amounted to 20% of the total participants who took the survey. Federal government and state government each formed 20% of the total percentage of expert evaluators, while nonprofit organizations formed 10% of the total percentage of evaluators who took the survey.

The non-VA stakeholder respondent characteristics have been described in Table 4.5. Table 4.5 describes the demographic information of the expert evaluators by their respective type of organizations. In addition, the table contains information regarding the percentage of expert evaluators who belonged to that organizations, the range for the number of years of work experience at their respective institution, their position title, the range of the number of years of work experience in quality improvement, and the range

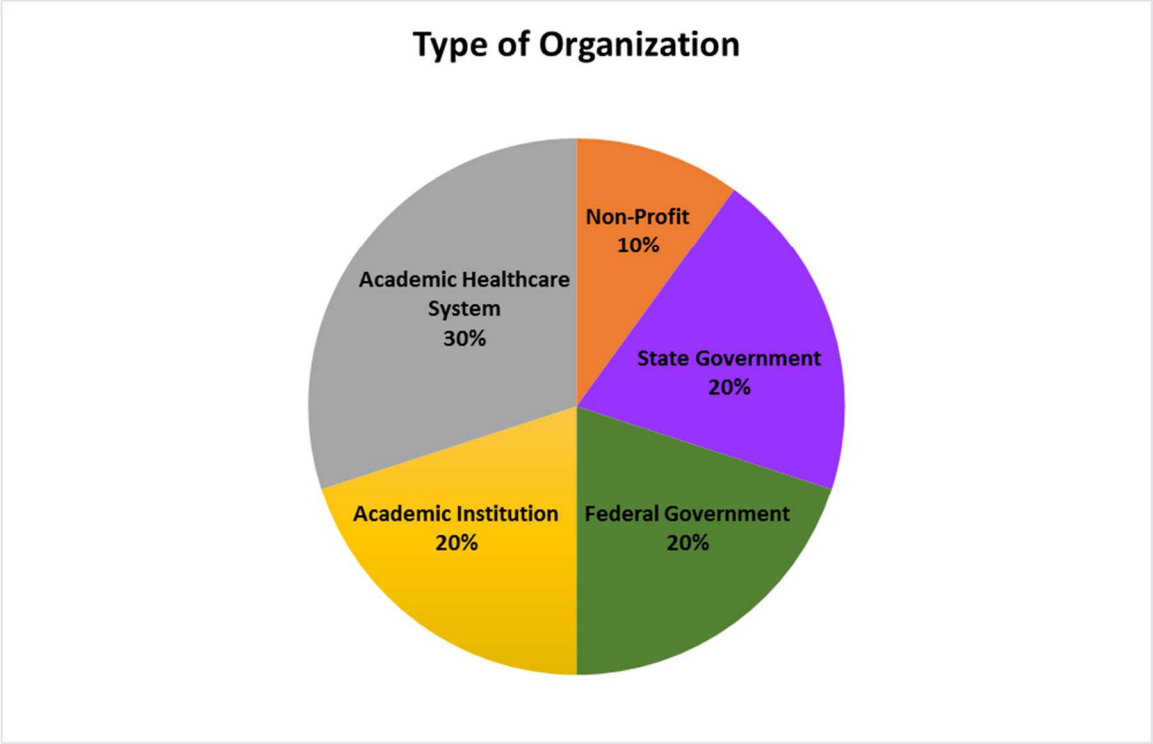

Figure 4.4: Percentages of the expert evaluators by the type of organization

Table 4.5: Demographic information of the expert evaluators by the type of organization

Type of Organization	Percentage of validators who belonged to the respective organization	Range of the number of years of work experience at the respective organization	Position titles of the validators	Range of the number of years of work experience in QI	Range of the number of years of work experience in HIT
Academic healthcare system	30%	11-20	Medical Director for IT Services, Core measure abstractor	6-20	0-26+
Academic institution	20%	0 - 10	Informatics/IT team	0 – 26+	0 – 26+
Federal government	20%	0 - 5	Primary care providers	0 – 10	0 – 5
State government	20%	0 - 20	Informatics/IT team	0 – 5	0 – 20
Non-profit	10%	6 - 10	Director or associate director of quality/safety	6 – 10	11 – 15

of the number of years of work experience in health information technology. The respondends encompassed a broad range of work experience. Diverse key stakeholder types were represented ranging from clinicians, to IT professionals, to QI specialists.

4.3.2 Summary of the Descriptive Statistics Results of the Survey

The expert evaluators were asked to review the tools in the eMeasure Implementation Toolkit, and provide their perspectives about the tools. The experts were asked to rate each item in the toolkit for relevance and clarity and add additional comments at the end of the survey. Each item was rated on a 1 to 5 scale, with 1 representing “very relevant” (or very clear) and 5 representing not at all relevant (or not at all clear). For each tool, the correlation between tool relevance and clarity was also assessed.

4.3.2.1 Section A: Determine Preimplementation Requirements

Table 4.6 shows results for preimplementation requirements. This section of the toolkit featured three tools: the planning checklist, a template for stakeholder interviews, and flowcharts. Each of the tools in this section was rated moderately relevant and moderately clear. There appears to be a strong correlation between relevance and clarity ratings for each tool. Completeness of the toolkit could be a concern, as comments included “Preimplementation planning checklist - concerning the jobs lists diary knowing how busy the floor staff can be I'm not sure they would take the time to fill out the form in total”. Other comments included “I was a little unclear how I would use the planning checklist. A few more details or links to instructions would be valuable”.

Table 4.6: Preimplementation requirements

Tools	Relevance							Clarity							
	1*	2	3	4	5+	Mean	SD	1*	2	3	4	5+	Mean	SD	Cor
Planning checklist	4	3	1	2	0	2.10	1.20	2	4	3	1	0	2.30	0.95	0.85
Stakeholder interviews for requirements	4	2	1	3	0	2.30	1.34	4	2	2	2	0	2.20	1.23	0.97
Flowchart of key processes	5	1	2	1	1	2.20	1.48	4	1	3	2	0	2.30	1.25	0.81
Average across all tools composing section.						2.20							2.27		

* Very Relevant
\+ Not at all relevant

4.3.2.2 Section B: Tools for Implementing a Single eMeasure

Table 4.7 displays survey findings for four tools for implementing a single eMeasure. The analysis of the eMeasure document, standard terminology and data sources for implementing an eMeasure, structured query language tools, and natural language programming tools were the four tools in the single eMeasure implementation section.

The analysis of the eMeasure document, the standard terminology and data sources, and structured query language tools were each rated moderately for relevance and clarity. The natural language programming tools were rated moderately for relevance. For clarity of the natural language tools, the evaluators took a more neutral stance. There appears to be a strong correlation between relevance and clarity rating for each tool. On average, the tools in this section were seen as moderately relevant and moderately clear. Completeness could be a concern, as comments included “NLP section needs further work as this is an area that may hold the key to capturing data from a large portion of medical records”.

Table 4.7: Tools for implementing a single eMeasure

Tools	Relevance							Clarity							
	1*	2	3	4	5+	Mean	SD	1*	2	3	4	5+	Mean	SD	Cor
Analyzing the eMeasure document	4	2	2	0	1	2.11	1.36	2	3	3	0	1	2.44	1.24	0.93
Identifying standard terminology and data sources for implementing an eMeasure	4	1	3	1	0	2.11	1.17	3	1	4	1	0	2.33	1.12	0.83
Identifying Structured Query Language (SQL) tools for extracting structured data for an eMeasure	4	3	0	0	2	2.22	1.64	1	4	2	1	1	2.67	1.22	0.85
Identifying Natural Language Programming (NLP) tools for extracting free text from clinical notes for eMeasurement	3	1	1	2	1	2.63	1.60	3	0	1	2	3	3.22	1.79	0.86
Average across all tools composing section.						2.27							2.67		

* Very Relevant

\+ Not at all relevant

4.3.2.3 Section C: Tools for Managing Team Activity

Table 4.8 displays results for three tools for determining the implementation of multiple eMeasures. The tools for version control, project evaluation, and templates for planning tools were the three tools in the multiple eMeasure implementation section.

Each of the tools in this section was rated moderately relevant and moderately clear. There appears to be a strong correlation between relevance and clarity rating for each tool. On average, the tools in this section were seen as moderately relevant and moderately clear. Comments included “HIT terminology is unfamiliar to me so clarity is difficult to rate”. Completeness of the tools for managing team activity could be a concern, as other comments suggested that additional tools in each of these tool categories might be helpful. The number of eMeasures being simultaneously implemented, as well as characteristics of the team, could impact eMeasure implementation workflow.

Table 4.8: Tools for implementing multiple eMeasures

Tools	Relevance							Clarity							Cor
	1*	2	3	4	5+	Mean	SD	1*	2	3	4	5+	Mean	SD	
Identifying tools for version control	4	1	2	2	0	2.22	1.30	4	0	3	1	1	2.44	1.51	0.83
Identify tools for project evaluation	4	2	2	0	1	2.11	1.36	3	3	0	2	1	2.44	1.51	0.94
Identify templates for planning tools	3	2	1	3	0	2.44	1.33	4	0	3	1	1	2.44	1.51	0.88
Average across all tools composing section.						2.26							2.44		

* Very Relevant
\+ Not at all relevant

4.3.2.4 Section D: Determine Postimplementation Requirements

Table 4.9 displays results for three tools for postimplementation requirements. The tools for assessment of barriers and facilitators, and process improvement requirements, were rated very relevant and moderately clear. The postimplementation assessment to finalize workflows was rated moderately relevant and moderately clear. There appears to be a strong correlation between relevance and clarity rating for each tool. On average, the tools in this section were seen as very relevant and moderately clear

4.3.2 Aim 3 Findings Summary

In general, the expert evaluators felt the toolkit was a useful collection of tools to assess the workflow during the implementation of eMeasures. Overall, the tools in the toolkit were rated by the reviewers as moderately relevant, and moderately clear. The postimplementation tools were rated highest for relevance. Comments predominantly highlighted areas of the toolkit that needed additional depth or detail in the toolkit, rather than suggesting additional tools.

Table 4.9: Postimplementation requirements

Tools	Relevance							Clarity							
	1*	2	3	4	5+	Mean	SD	1*	2	3	4	5+	Mean	SD	Cor
Postimplementation assessment of barriers and facilitators	5	2	0	2	0	1.89	1.27	4	2	1	1	1	2.22	1.48	0.95
Postimplementation assessment of process improvement	5	2	0	1	0	1.63	1.06	2	4	1	2	0	2.33	1.12	0.87
Postimplementation assessment to finalize workflows	4	2	1	0	2	2.33	1.66	3	1	3	2	0	2.44	1.24	0.89
Average across all tools composing section.						1.95							2.33		

* Very Relevant

+ Not at all relevant

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CHAPTER 5

CONCLUSIONS, DISCUSSION, STRENGTHS, AND LIMITATIONS

5.1 Introduction

In this section, we summarized what was accomplished in this research study and offered conclusions based on the data presented in Chapter 4. Second, we discussed the limitations and strengths of this research and offered recommendations for the potential use of the eMeasure Implementation Toolkit. We concluded Chapter 4 with recommendation of future research.

5.2 Discussion

The impact on workflow is an important component in determining whether an HIT implementation will be successful. Workflow is, unfortunately, a concept that is often ignored when implementing HIT and the literature about workflow in domains of quality improvement, system implementation, and process improvement has not been adequate. HIT is not always designed to fit the workflow of a given organization, making it difficult to truly assess HIT impact on outcomes or processes [9]. The literature demonstrates inadequate sophistication in studies regarding the role of workflow in the adoption of HIT in the domain of QI, due to the absence of formal workflow design and methodologies, lack of comprehensive knowledge about the system, and a lack of interest by the quality improvement staff towards the use of the new technology [9].

One solution to addressing implementation challenges such as the lack of attention to workflow is an *implementation toolkit*. An implementation toolkit is an assembly of instruments such as checklists, forms, and planning documents. Implementation toolkits are intended to provide guidance or assistance; they may provide a template or blueprint for what to do, when to do it, and how to do it. Users can apply an implementation toolkit in its entirety, or only apply certain portions that are informative for their needs.

To ensure that HIT successfully integrates with workflow, it is essential to understand the current system before implementing the new technology [10, 11]. Therefore, an implementation toolkit that supports workflow evaluation for HIT-enabled QI efforts needs to include evaluation of both the current workflow, and the potential impact of the new system on workflow.

The purpose of this study was to establish an initial toolkit, which would be generalizable to assess the impact of implementation on the workflow of quality improvement and information technology professionals' and their team in the inpatient hospital setting. The toolkit, in the form of an implementation guide, is a compilation of resources such as checklists, forms, and planning documents that provided a template for workflow analysis. The toolkit was designed to support and provide guidance on developing and implementing plans for achieving optimal workflow at any acute inpatient setting. The toolkit information was designed to support decision making on the implementation approaches related to workflow analysis.

During the development of the toolkit, we conducted stakeholder interviews with the VA key informants and subject matter experts, who provided valuable information

about the context of the workflow during the implementation of eMeasures. The stakeholder engagement highlighted tools and provided information essential to the toolkit development phase. The areas noted by the stakeholders included the need for a robust hardware and software infrastructure and for information technology architecture that supports the implementation of eMeasures; the availability of required clinical content in the form of structured data in electronic medical databases, as well as unstructured and semistructured text data, that can be processed by text processing techniques; efforts to promote automated calculation of performance measures; and the processes that serve to facilitate overcoming eMeasure implementation barriers.

The final phase involved evaluation of the eMeasure Implementation Toolkit for relevance and clarity by experts in non-VA settings. The non-VA subject matter experts evaluated the sections of the toolkit that contained the tools for evaluating the workflow during eMeasure implementation via a survey. During the evaluation phase of the toolkit, the expert evaluators rated the tools as moderately relevant, and moderately clear. The postimplementation tools were rated highest for relevance. Comments predominantly highlighted areas that needed additional depth or detail in the toolkit, rather than suggesting additional tools.

The toolkit provides a distinct set of resources and tools, which were available to the users in a single consolidated document. The research methodology provided a strong unified overarching implementation framework in the form of the Promoting Action on Research Implementation in Health Services (PARIHS) model in combination with socio-technical model of HIT that strengthened the overall design of the study.

Moreover, this research is clearly situated within the realm of Biomedical

Informatics. The study followed a four-step sequence aligned with creating and evaluating the toolkit as an implementation guide resource: (1) model formulation, (2) toolkit development, (3) toolkit deployment, and (4) toolkit evaluation. The research drew upon sciences contributing to informatics including quality measurement, strategic planning, change management, human - technology interaction, and implementation science [95,106].

5.3 Conclusions

The purpose of this study was to establish a generalizable toolkit to assess the impact of implementing eMeasures on the workflow of quality improvement and information technology professionals' and their team in the inpatient hospital setting. The toolkit developed during this research was guided by a strong unified overarching implementation framework in the form of the Promoting Action on Research Implementation in Health Services (PARIHS) model, in combination with a socio-technical model of HIT that strengthened the overall design of our study. The toolkit provided a useful collection of tools in the form of checklists, forms, and planning documents to enhance the workflow during implementation of eMeasures.

During the development of the toolkit, we conducted stakeholder interviews with the VA key informants and subject matter experts, who provided valuable information about the context of understanding the workflow during the implementation of eMeasures. The information obtained from the stakeholder engagement highlighted areas and tools that were essential to the toolkit development phase.

The final phase involved the evaluation of the eMeasure Implementation Toolkit for relevance and clarity by non-VA experts. The non-VA subject matter experts

predominantly evaluated the sections of the toolkit that contained the tools for evaluating the workflow during eMeasure implementation via a survey. During the evaluation phase of the toolkit, the expert evaluators rated the tools as moderately relevant, and moderately clear. The postimplementation tools were rated highest for relevance. Comments predominantly highlighted areas of the toolkit that needed additional depth or detail in the toolkit, rather than suggesting additional tools.

5.4 Strengths and Limitations

The study had significant strengths. First, although HIT support for QI activities is increasing, little research has been done on the workflow involved in the automation of quality metric assessment and reporting. This lack of attention to workflow is a barrier to successful implementation of information systems intended to support QI activities. This study provided a methodology for identifying information needs, detecting conflicts, and implementing possible workflow solutions; thus, the toolkit could serve as a pragmatically useful implementation guide to assess the workflow pertaining to the quality improvement and information technology professionals' and their team during the implementation of eMeasures at an inpatient hospital setting.

The toolkit also provided a distinct comprehensive set of resources and tools in the form of an implementation guide to assess the workflow during the implementation of eMeasures, which were available to the users in a single document. Finally, the research methodology provided a strong unified overarching implementation framework in the form of the Promoting Action on Research Implementation in Health Services (PARIHS) model in combination with the socio-technical model of HIT that strengthened the overall design of the study.

This research had limitations as well. First, the toolkit may not have complete information so that it can be generalized to all medical centers and healthcare quality organizations, as sampling across systems, medical centers across consortiums, public, and private sectors would need to be included with significant input and time investment by many interested parties. Nevertheless, the toolkit was developed with input from more than 3 healthcare quality sectors including the governmental sector at the federal level via the Department of Veterans Affairs, and at the state level, via the Utah Department of Health (UDOH), as well as from the academic medical center healthcare sector via the University of Utah Medical Center and Health Sciences, and Partners Healthcare. In general, the expert evaluators felt the toolkit was a useful collection of tools to assess the workflow during the implementation of eMeasures. Overall, the evaluators rated the tools in the toolkit as moderately relevant, and moderately clear. The postimplementation tools were rated highest for relevance. Comments predominantly highlighted areas of the toolkit that needed additional depth or detail in the toolkit, rather than suggesting additional tools.

Second, only the VA quality improvement and information technology experts were involved in the development of the toolkit due to time and research limitations. There could have been business needs from other non-VA quality improvement and information technology professionals, which were omitted due to lack of involvement in the toolkit development stage. However, a variety of non-VA professionals, from various job categories and medical centers, were involved in the evaluation stage. This strengthened the toolkits' usability and application for quality measurement and information technology staff from VA, as well as non-VA healthcare settings and

stakeholders. The volunteers included professionals from a wide range of healthcare professionals including directors or associate directors of quality and safety, information technology or quality improvement professionals, clinical quality program specialists, primary care providers, and health information coders. Nevertheless, the toolkit needed to be further tested in other medical facilities as future research work.

Third, the majority of the qualitative analysis was undertaken by only one person and by using an applied thematic analysis, additional results can likely be developed by more in-depth analysis and by including other collaborators.

Fourth, the interviews were not recorded and the summaries may have had more detail for more in-depth analysis. Nevertheless, a summary of the interviews was sent to the VA stakeholders for evaluation, which ensured that most of the information pertinent to the toolkit development was noted.

5.5 Future Directions

There are numerous future directions that may be drawn as a result of this study. Some of these relate to the findings of the study, while others deal with the potential applications and use of the developed eMeasure Implementation Toolkit. Each is enumerated in detail below.

Future direction one: This eMeasure Implementation Toolkit should continue to be refined. The toolkit should undergo further evaluation with a variety of subject matter experts from various job categories and medical centers. Further evaluation of the eMeasure Implementation Toolkit may result in newer tools being recognized.

Future direction two: Further research should be done to develop a specialized toolkit for beginners. There are different levels of cognition and diverse use cases

involved in the implementation of eMeasures. The toolkit should be tailored to the level of cognition of each user, while focusing on the syntax used to describe the sections of the toolkit. A toolkit map could be created to point to the relevant use cases for each category of users to simplify the steps involved in assessing the workflow during eMeasurement. In addition, it would be important to provide extra links to beginners about the background information to understand the details about the eMeasurement process.

Future direction three: The eMeasure Implementation Toolkit could be implemented in an actual healthcare setting to determine the usefulness. It would be essential to have quality improvement and information technology professionals use the toolkit and then determine if additional modifications are needed.

Future direction four: The toolkit could be developed for other quality measures such as stroke, diabetes, pneumonia, etc., based on the research methodology used in the development of the existing toolkit.

APPENDIX A

DETAILED QUALITATIVE SUMMARY REPORT

Hardware and Software

The hardware and software-computing infrastructure includes the centralized (network-attached) data storage devices and all networking equipment required to allow applications or devices to retrieve and store patient data and software at both the operating system and application levels (Sittig and Singh, 2010). Understanding the hardware and software needs was useful to develop the component of the toolkit that included the tools for extracting the structured data in electronic medical databases, as well as unstructured and semistructured text data.

Research Question (1 a): What is the context of implementation at the national, VISN, and local level in terms of hardware and software?

Summary Statement: VA has an overall hardware and software infrastructure and architecture that makes eMeasurement possible.

Theme 1: Hardware – VA has a rapidly evolving and reliable hardware infrastructure for supporting eMeasurement.

Servers:

1. *Servers within VINCI*: For hardware, they have a server on their end and they have a SQL database. [Interviewee number 10: Chief of Ambulatory Care]
2. *Cardiology lab servers:* We have been extracting EF from text notes and structured databases and potentially the cardiology lab/echocardiology labs server so you may know there is a variety of ways that EF is stored in the VA. [Interviewee number 10: Chief of Ambulatory Care]

Theme 2: Software – VA has comprehensive software capabilities

Microsoft SQL Server Management Studio:

We're using SQL server management studios for the querying and creation of tables and for use in looking at the more targeted information. [Interviewee number 15: Pharmacy Benefits Management Data Manager]. Specific functions within the studio were:

1. *SQL Server Reporting Services (SSRS)*: Form there, for most of the reports we have gone from Management Studios into SQL server reporting services to display in repots and show our scorecards, and our patient level reports. [Interviewee number 15: Pharmacy Benefits Management Data Manager]
2. *SQL Server Analysis Services (SSAS)*: We also have some older dashboards and some of our pharmacy dashboards goes through SQL server analysis services to make cubes and those are surfaced to the end user using Performance Point. [Interviewee number 15: Pharmacy Benefits Management Data Manager]
3. *SQL Server Integration Services (SSIS)*: We also use SQL Server Integration Services for the automated running of the data each night so that every morning we have up to date data. [Interviewee number 15: Pharmacy Benefits Management Data Manager]

Reporting and Displaying Software:

1. *Dashboards*: We have a dashboard for several of the HEDIS metrics for diabetes and hypertension so we do a population survey, we don't do any manual chart review. [Interviewee number 12: Clinical Pharmacy Specialist]
2. *Online reports*: Sometimes data is not always captured in the data warehouse so it

makes it difficult using that method to make an e-metric or do the performance measure through online reports or dashboards. [Interviewee number 14: Pharmacoeconomist]

3. *Sharepoint Sites*: All our dashboards and reports are accessed through the business intelligence service line group's Sharepoint Sites. [Interviewee number 15: Pharmacy Benefits Management Data Manager]
4. *Performance Point*: The HF performance measure is an electronic metric being pulled from central warehouse. It is on a SharePoint for us to review and it is reported to us about monthly from an external peer reviewer who also pulls data and looks at it. [Interviewee number 5: Associate director for quality and safety]
5. *Smart forms*: Project using health informatics (Smart form), trying to attach code to the data so we can then query CDW and come up with the outcome. [Interviewee number 1: Clinical Quality Specialist]

eMeasure Tools:

1. *eMeasure validation tool*: It goes back to what I initially said, and after we develop any kind of e-measure validation tool, we validate through a cohort database so that what we are looking at is correct and it will then run the e-measure. [Interviewee number 7: Health Systems Specialist]
2. *Electronic Quality Measurement product (eQM)*: We have a customized product that has been deployed. Its being updated periodically as we add new measures. We call it our eQM or electronic Quality Measures Product. [Interviewee number 11: Management and program analyst]

Programming Languages:

1. *MUMPS*: In the VA, VistA system is built on a MUMPS platform so they are re-engineering in another platform. [Interviewee number 12: Clinical Pharmacy Specialist]
2. *Structured Query Language (SQL)*: I write the SQL code to pull out data from the corporate data warehouse to develop the scores at the VISN levels and some at the national level in the mental health arena to pull data on a population level as opposed to the manual process that has been used in the past. [Interviewee number 15: Pharmacy Benefits Management Data Manager]

Natural Language Processing (NLP):

Currently they are using Natural Language Processing (NLP) to read the data, to extract that data so my suggestion is to create a data field within the medicine package of Vista for a data field that would capture the current ejection fractions and any other pieces of data related to CHF. [Interviewee number 7: Health Systems Specialist]

Veterans Health Information Systems and Technology Architecture (VistA):

VistA, and the VistA data is transformed by a national IT team into a SQL data mart. [Interviewee number 12: Clinical Pharmacy Specialist]

SQL Server:

We're very Microsoft centric. Microsoft management studios with SQL servers. [Interviewee number 12: Clinical Pharmacy Specialist]

Theme 3: Information systems – The compatible structure and architecture in information systems provides secure housing of data and promotes the culture of electronic performance measurement.

Computing Infrastructure and Architecture:

1. *VINCI (VA Informatics and Computing Infrastructure)*: Then we developed our initial prototype system for heart failure performance measurements to the point where we were able to set the system up and sample data on VINCI, run the system and put the outputs on SQL tables in VINCI. [Interviewee number 4: Director of the Geriatrics Research Education and Clinical Center]
2. *Veterans Health Information Systems and Technology Architecture (VistA):* I talked earlier about HF performance system sitting on VINCI and nothing happened to it in a long time, and over this past year we have done a very different measure on HF CDS in which we have developed a prototype system for integrating directly with CPRS which is the front end of EHR and the data is in VISTA. [Interviewee number 4: Director of the Geriatrics Research Education and Clinical Center]

Data Warehouses:

1. *National Data Warehouse*: There may be a lack of what we want pulled in the Data Warehouse often the Corporate Data Warehouse on the national level, they determine what is pulled in to the data warehouse. [Interviewee number 14: Pharmacoeconomist]
2. *Regional Data Warehouse*: A region level data warehouse can pull in additional information so sometimes supplements are in need but that is one disadvantage. [Interviewee number 14: Pharmacoeconomist]
3. *VISN Data Warehouse*: I use our VISN data warehouse to pull patient data and then I will use VISN or VHA wide memo or initiative to make sure that our data

or calculations are meeting what they expect. [Interviewee number 14: Pharmacoeconomist]

4. *Centralized Data Warehouse*: The analysts do more computer related work such as being involved in CDW database trying to write programs to extract what we want them to extract. [Interviewee number 6: Clinical Quality Specialist]

Data Repositories:

1. *SQL database and data marts*: I use that SQL database to develop dashboards and reports for the VISN for various quality improvement measures. We use the data from the SQL data mart, [Interviewee number 12: Clinical Pharmacy Specialist]
2. *Centralized repositories*: VA has a large network of data into centralized repositories that are called national databases such as the CICSP collecting cardiac data that is being collected and once that data has been collected, it is looked in to from the usage perspective. [Interviewee number 9: Chief Medical Information Officer]

Clinical Decision Support Systems:

1. *Clinical Decision Support (CDS)*: In CDS your focus is not measuring how people are doing, but you are focusing is on how to help them do better. [Interviewee number 4: Director of the Geriatrics Research Education and Clinical Center]
2. *ATHENA Clinical Decision Support System*: We have developed ATHENA clinical decision support in several different domains, in the course of computing for clinical decision support we want to know whether the patient appears to be in and whether or not the patient's treatment is in accord with that scenario.

[Interviewee number 4: Director of the Geriatrics Research Education and Clinical Center]

Electronic Health Record (EHR):

1. *EHR*: We use all the electronic data from the electronic health records (EHR). [Interviewee number 12: Clinical Pharmacy Specialist]
2. *Computerized Physician Record System (CPRS)*: So, being able to structure patient notes in CPRS in a way that the data does get captured in to the data warehouse is one example of having to get around and not having things pulled automatically in to the data warehouse. [Interviewee number 14: Pharmacoeconomist]
3. *EPIC*: I have seen that EPIC does things is a little better than the way that CPRS does in terms of medication changes for example or having a document that states the reason why you are increasing or decreasing a dose, or stopping a medication. [Interviewee number 15: Pharmacy Benefits Management Data Manager]

Other Clinical Systems:

1. *Pharmacy system*: In my group, VISN 21 program managers that work for me, and we have clinical data warehouse managers, clinical application coordinators, and also ad tacks which are pharmacists generally involved with electronic medical records in the pharmacy system. [Interviewee number 13: Pharmacy Executive]
2. *CART-CL (Cardiovascular Assessment Reporting and Tracking System for Cath Lab) package*: VA also started another program called CART initially called CART-CL. [Interviewee number 9: Chief Medical Information Officer]

Summary of findings: In general, we found that VA has a robust and reliable, but evolving, hardware and software infrastructure and architecture that makes eMeasurement possible. Hardware includes multiple servers and databases including servers for structured data, text notes, lab, and echo. The VA EHR (VistA) and multiple data warehouses form a part of the overall architecture.

Software includes a large variety of general database management and analytic software, along with multiple types of reporting and display software, and a few custom eMeasure tools. Additional software applications include the core information technology system (VistA), which is built on a MUMPS platform, the data warehouse that can be queried with SQL, and NLP tools for extracting free text from clinical notes.

Clinical Content

Clinical content includes everything on the data-information-knowledge continuum that is stored in the system (i.e., structured and unstructured textual or numeric data and images that are either captured directly from imaging devices or scanned from paper-based sources) (Sittig and Singh, 2010). Understanding the clinical content was useful to develop the component of the toolkit that included the tools for Identifying standard terminology and data sources for implementing an eMeasure.

Research Question (1 b): What is the context of implementation at the national, VISN, and local level in terms of clinical content?

Summary Statement: VA has the availability of appropriate clinical content in the form of structured, unstructured, and semistructured data, in VA electronic medical databases, that can be extracted by informatics and text processing techniques for eMeasurement.

Examples: Excerpts from stakeholder interviews supporting this theme are as follows:

Structured data (Data that resides in a fixed field within a record or file is called structured data)

Theme 1 – Structured clinical data within VA's Electronic Heath Record (EHR) is aggregated within specialized databases, providing a rich source of electronic data for eMeasurement.

Organizational identifiers:

There are organizational identifier like who is the facility, what is the control number, who is the abstractor, when did the abstractor start, and when did the abstractor end their abstraction. [Interviewee number 1: Clinical Quality Specialist]

a) *Who is the facility*
b) *What is the control number*
c) *Who is the abstractor*
d) *When did the abstractor start*
e) *When did the abstractor end their abstraction*

Demographic identifiers:

There are patient identifiers like social security number, first name, last name, birthday, and sex, marital status, and race. [Interviewee number 1: Clinical Quality Specialist]

a) *Social security number*
b) *First name*
c) *Last name*
d) *Birthday*
e) *Sex*

f) Marital status

g) Race

Patient diagnostic coding:

1. Collect principal diagnosis, procedure code, admit type is it an emergent elective or we just don't know, discharge disposition and a lot of times measures will apply if the patient is going home or to personal care. [Interviewee number 1: Clinical Quality Specialist]

    a) Collect principal diagnosis

    b) Procedure code

    c) Admit type

    d) Discharge disposition

    e) *Questions about weight whether pounds or kilograms*

2. VISN 21 has transformed multiple domains of data, patient prescriptions, ecma for inpatients, labs, patient demographics, vital signs, diagnostics for the discharges, as well as the, outpatient encounters, consults, health factors. [Interviewee number 12: Clinical Pharmacy Specialist]

    a) Diagnostics for discharge

    b) Vital signs

    c) Health factors

Laboratory findings:

1. *Lab name field*: The abstraction will usually identify those elements that cannot be extracted consistently or at all, usually text fields or data fields that have a lot of variation like a lab name field. [Interviewee number 12: Clinical Quality

Specialist]

2. *Patient prescriptions*: VISN 21 has transformed multiple domains of data, patient prescriptions, ecma for inpatients, labs, patient demographics, vital signs, diagnostics for the discharges, as well as the, outpatient encounters, consults, health factors. [Interviewee number 12: Clinical Pharmacy Specialist]
3. *Laboratory findings*: VISN 21 has transformed multiple domains of data, patient prescriptions, ecma for inpatients, labs, patient demographics, vital signs, diagnostics for the discharges, as well as the, outpatient encounters, consults, health factors. [Interviewee number 12: Clinical Pharmacy Specialist]

Heart failure specific identifiers:

1. *VA uses the norm files and pharmacy packages for retrieving the standardized fields such as prescription of ACEI and ARB*: For the standardized fields such as prescription of ACEI and ARB we can get from the norm files and from the pharmacy packages. [Interviewee number 2: Management and Program Analyst]
2. *Beta-blockers use*: One of those is for beta-blockers use, one that we did was for those who have an ejection fraction below 40% at the point that echocardiogram was read. [Interviewee number 8: Director of echocardiography Laboratory at the VA]
3. *One of the measures is the smoking measures counseling, medications offered, and referral to a program to help them quit*: One of the measures we are working on with the contractor is the smoking measures counseling, medications offered, and referral to a program to help them quit. [Interviewee number 2: Management and Program Analyst]

4. *Identifying systolic vs. diastolic dysfunction*: We have trouble identifying systolic vs. diastolic dysfunction and the treatment algorithms for that are different. [Interviewee number 12: Clinical Pharmacy Specialist]

Clinical terminology and standards:

1. *VA uses mandatory SNOMED taxonomy for Meaningful Use since it is the only coding instrument that is allowed*: We use mandatory SNOMED taxonomy for Meaningful Use since it is the only coding instrument that is allowed so we are working toward that with a contractor but hoping to have the certification of the EHR by 2015 and measures in place so we can become Meaningful Use certified. [Interviewee number 2: Management and Program Analyst]
2. *Some of the specifications for these measures allow you to use either ICD 9, ICD 10 or SNOMED*: Some of the specifications for these measures allow you to use either ICD 9, ICD 10 or SNOMED and we can manage with them but those cases where specifications only allow SNOMED, we need to figure out how to take the coding system we use and translate it so it is a match for the SNOMED we are working on. [Interviewee number 2: Management and Program Analyst]
3. *LOINC codes*: Required things from a policy standpoint require the lab to make sure the LOINC codes are always populated or the labs names are standardized. [Interviewee number 15: Pharmacy Benefits Management Data Manager]

Administrative identifiers:

1. *For the purpose of Administrative data the exact question in the database can be used for extraction purposes, for example ARRVDATE which is the arrival date when the patient arrived at the acute care of a VA medical center*: We can use the

exact question in the database by pulling that forward no matter what instrument we use for extraction. Example Question: ARRVDATE, which is the arrival date when the patient arrived at the acute care of a VA medical center. [Interviewee number 1: Clinical Quality Specialist]

2. *Facility size, population type, and services offered*: Sampling takes into consideration facility size, population type and sometimes services offered. [Interviewee number 14: Clinical Quality Specialist]
3. *Patient appointments data*: We use appointments, and a lot of different domains we use. [Interviewee number 15: Pharmacy Benefits Management Data Manager]
4. VISN 21 has transformed multiple domains of data, patient prescriptions, ecma for inpatients, labs, patient demographics, vital signs, diagnostics for the discharges, as well as the, outpatient encounters, consults, health factors. [Interviewee number 12: Clinical Pharmacy Specialist]
    a) *Outpatient encounters*
    b) *Consults*
5. We are using the VISN data warehouse mostly, and from them the domains we are using are lab chem, patients, staff, visits for encounter information, inpatient stays for diagnosis. [Interviewee number 15: Pharmacy Benefits Management Data Manager]
    a) *Inpatient stays*

Unstructured data (Data that has not been organized into a format that makes it easier to access and process is called unstructured data)

Theme 2 – VA is integrating information extraction (IE) techniques and Natural Language processing to extract the unstructured data from clinical notes for eMeasurement.

Demographic identifiers:

Race: There are patient identifiers like social security number, first name, last name, birthday, and sex, marital status, and race. [Interviewee number 1: Clinical Quality Specialist]

Patient diagnostic coding:

1. *Collect principal diagnosis*: Collect principal diagnosis, procedure code, admit type is it an emergent elective or we just don't know, discharge disposition and a lot of times measures will apply if the patient is going home or to personal care. [Interviewee number 1: Clinical Quality Specialist]
2. *Questions about weight whether pounds or kilograms*: [Interviewee number 1: Clinical Quality Specialist]
3. *Contraindication that are present in a narrative format*: It's the contraindications that are difficult because they are present in a narrative format, which makes it a little difficult to get. [Interviewee number 2: Management and Program Analyst]
4. VISN 21 has transformed multiple domains of data, patient prescriptions, ecma for inpatients, labs, patient demographics, vital signs, diagnostics for the discharges, as well as the, outpatient encounters, consults, health factors. [Interviewee number 12: Clinical Pharmacy Specialist]
    a) *Diagnostics for discharge*
    b) *Vital signs*

c) *Health factors*

Administrative identifiers:

1. Collect principal diagnosis, procedure code, admit type is it an emergent elective or we just don't know, discharge disposition and a lot of times measures will apply if the patient is going home or to personal care. [Interviewee number 1: Clinical Quality Specialist]
    a) *Admit type*
    b) *Discharge disposition*
2. VISN 21 has transformed multiple domains of data, patient prescriptions, ecma for inpatients, labs, patient demographics, vital signs, diagnostics for the discharges, as well as the, outpatient encounters, consults, health factors. [Interviewee number 12: Clinical Pharmacy Specialist]
    a) *Outpatient encounters*
    b) *Consults*
3. We are using the VISN data warehouse mostly, and from them the domains we are using are lab chem, patients, staff, visits for encounter information, inpatient stays for diagnosis. [Interviewee number 15: Pharmacy Benefits Management Data Manager]
    a) *Inpatient stays*
4. We use appointments, and a lot of different domains we use. [Interviewee number 15: Pharmacy Benefits Management Data Manager]
    a) *Patient appointments data*

Heart failure specific identifiers:

1. *The LV function, and dysfunction is difficult to abstract from the narrative notes*: Sometimes the LV function, and dysfunction is difficult to abstract from the narrative notes. [Interviewee number 2: Management and Program Analyst]
2. *VA uses the norm files and pharmacy packages for retrieving the standardized fields such as prescription of ACEI and ARB*: For the standardized fields such as prescription of ACEI and ARB we can get from the norm files and from the pharmacy packages. [Interviewee number 2: Management and Program Analyst]
3. *Beta-blockers use*: One of those is for beta-blockers use, one that we did was for those who have an ejection fraction below 40% at the point that echocardiogram was read. [Interviewee number 8: Director of echocardiography Laboratory at the VA]
4. *Ejection fraction below 40% at the point that echocardiogram was read*: One of those is for beta-blockers use, one that we did was for those who have an ejection fraction below 40% at the point that echocardiogram was read. [Interviewee number 8: Director of echocardiography Laboratory at the VA]
5. *One of the measures is the smoking measures counseling, medications offered, and referral to a program to help them quit*: One of the measures we are working on with the contractor is the smoking measures counseling, medications offered, and referral to a program to help them quit. [Interviewee number 2: Management and Program Analyst]
6. *The ejection fraction being measured by multiple different ECHO, cardiac catheterization, and the data from those reports is in a format that is not readily extractable*: We would had a heart failure one, but the ejection fraction being

measured by multiple different ECHO, cardiac catheterization, and the data from those reports is in a format that is not readily extractable. [Interviewee number 12: Clinical Pharmacy Specialist]

7. *Identifying systolic vs. diastolic dysfunction*: We have trouble identifying systolic vs. diastolic dysfunction and the treatment algorithms for that are different. [Interviewee number 12: Clinical Pharmacy Specialist]

Laboratory findings:

1. *Patient prescriptions*: VISN 21 has transformed multiple domains of data, patient prescriptions, labs, patient demographics, vital signs, diagnostics for the discharges, as well as the, outpatient encounters, consults, health factors. [Interviewee number 12: Clinical Pharmacy Specialist]
2. *Laboratory findings*: VISN 21 has transformed multiple domains of data, patient prescriptions, ecma for inpatients, labs, patient demographics, vital signs, diagnostics for the discharges, as well as the, outpatient encounters, consults, health factors. [Interviewee number 12: Clinical Pharmacy Specialist]

Semistructured data (Data that has not been organized into a specialized repository, such as a database, but that nevertheless has associated information, such as metadata, that makes it more amendable to processing than raw data is called semistructured data)

Theme 3 – VA's capabilities of Natural Language Processing is enabling the transformation of semistructured data into structured data for use in data warehouses to support the Meaningful Use initiative.

Demographic identifiers:

Race: There are patient identifiers like social security number, first name, last

name, birthday, and sex, marital status, and race. [Interviewee number 1: Clinical Quality Specialist]

Patient diagnostic coding:

1. *Collect principal diagnosis*: Collect principal diagnosis, procedure code, admit type is it an emergent elective or we just don't know, discharge disposition and a lot of times measures will apply if the patient is going home or to personal care. [Interviewee number 1: Clinical Quality Specialist]
2. *Questions about weight whether pounds or kilograms*: [Interviewee number 1: Clinical Quality Specialist]
3. VISN 21 has transformed multiple domains of data, patient prescriptions, ecma for inpatients, labs, patient demographics, vital signs, diagnostics for the discharges, as well as the, outpatient encounters, consults, health factors. [Interviewee number 12: Clinical Pharmacy Specialist]
    a) *Diagnostics for discharge*
    b) *Vital signs*
    c) *Health factors*

Administrative identifiers:

1. Collect principal diagnosis, procedure code, admit type is it an emergent elective or we just don't know, discharge disposition and a lot of times measures will apply if the patient is going home or to personal care. [Interviewee number 1: Clinical Quality Specialist]
    a) Admit type
    b) Discharge disposition

2. VISN 21 has transformed multiple domains of data, patient prescriptions, ecma for inpatients, labs, patient demographics, vital signs, diagnostics for the discharges, as well as the, outpatient encounters, consults, health factors. [Interviewee number 12: Clinical Pharmacy Specialist]
    a) *Outpatient encounters*
    b) *Consults*
3. We are using the VISN data warehouse mostly, and from them the domains we are using are lab chem, patients, staff, visits for encounter information, inpatient stays for diagnosis. [Interviewee number 15: Pharmacy Benefits Management Data Manager]
    a) *Inpatient stays*
4. We use appointments, and a lot of different domains we use. [Interviewee number 15: Pharmacy Benefits Management Data Manager]
    a) *Patient appointments data*

<u>*Heart failure specific identifiers*</u>*:*

1. *The LV function, and dysfunction is difficult to abstract from the narrative notes*: Sometimes the LV function, and dysfunction is difficult to abstract from the narrative notes. [Interviewee number 2: Management and Program Analyst]
2. *VA uses the norm files and pharmacy packages for retrieving the standardized fields such as prescription of ACEI and ARB*: For the standardized fields such as prescription of ACEI and ARB we can get from the norm files and from the pharmacy packages. [Interviewee number 2: Management and Program Analyst]
3. *Beta-blockers use*: One of those is for beta-blockers use, one that we did was for

those who have an ejection fraction below 40% at the point that echocardiogram was read. [Interviewee number 8: Director of echocardiography Laboratory at the VA]

4. *Ejection fraction below 40% at the point that echocardiogram was read*: One of those is for beta-blockers use, one that we did was for those who have an ejection fraction below 40% at the point that echocardiogram was read. [Interviewee number 8: Director of echocardiography Laboratory at the VA]
5. *One of the measures is the smoking measures counseling, medications offered, and referral to a program to help them quit*: One of the measures we are working on with the contractor is the smoking measures counseling, medications offered, and referral to a program to help them quit. [Interviewee number 2: Management and Program Analyst]
6. *The ejection fraction being measured by multiple different ECHO, cardiac catheterization, and the data from those reports is in a format that is not readily extractable*: We would had a heart failure one, but the ejection fraction being measured by multiple different ECHO, cardiac catheterization, and the data from those reports is in a format that is not readily extractable. [Interviewee number 12: Clinical Pharmacy Specialist]
7. *Identifying systolic vs. diastolic dysfunction*: We have trouble identifying systolic vs. diastolic dysfunction and the treatment algorithms for that are different. [Interviewee number 12: Clinical Pharmacy Specialist]

Laboratory findings:

1. *Patient prescriptions*: VISN 21 has transformed multiple domains of data, patient

prescriptions, labs, patient demographics, vital signs, diagnostics for the discharges, as well as the, outpatient encounters, consults, health factors. [Interviewee number 12: Clinical Pharmacy Specialist]

2. *Laboratory findings*: VISN 21 has transformed multiple domains of data, patient prescriptions, ecma for inpatients, labs, patient demographics, vital signs, diagnostics for the discharges, as well as the, outpatient encounters, consults, health factors. [Interviewee number 12: Clinical Pharmacy Specialist]

Summary of findings: In general, we found that VA has the availability of appropriate clinical content in the form of structured, unstructured, and semistructured data, located in multiple electronic medical databases that can be extracted by informatics and text processing techniques for eMeasurement if needed. Structured clinical data within VA's EHR is aggregated within specialized databases Data are extracted from clinical and administrative systems. Standard clinical terminologies are used in many of the databases. Information extraction (IE) and Natural Language processing (NLP) techniques extract unstructured data from clinical notes; NLP techniques transform semistructured data into structured data which is stored in data warehouses

Some heart failure eMeasure data, such as LV function or the specific ejection fraction, continue to be challenging to abstract at times

Workflow and Communication

Workflow and communication, the first section of the model, acknowledges that people often need to work cohesively with others in the healthcare system to accomplish patient care, a collaboration requiring significant two-way communication (Sittig and Singh, 2010). Understanding the clinical content was useful to develop the component of

the toolkit that included the tools for assessing the preimplementation requirements. The tools in this section were preimplementation planning checklists, stakeholder interviews for understanding the eMeasure implementation requirements, flowcharts of key processes for the automation of eMeasures.

Research Question (1 b): What is the context of implementation at the national, VISN, and local level in terms of workflow and communication?

Summary Statement: VA manually abstracts data for performance measures that is contracted through the External Peer Review Program (EPRP).

Examples: Excerpts from stakeholder interviews supporting this theme are as follows:

Theme 1 – A significant portion of the clinical content for eMeasures is available in electronic format

The data collection process for standard quality measures includes the following steps:

1. Each month a random sample of cases of both paper and electronic medical records is selected for each Veteran Administration Medical Center (VAMC)for the diagnosis. Core data (i.e., age, sex, admit date, and discharge date) are electronically transmitted to WVMI for processing. The core data are then merged with the database questions. The entire dataset is then placed on a network for uploading to encrypted computers by the abstractors assigned to each VAMC.

2. Registered record administrators, accredited record technicians, or registered nurses assure that the medical record meets coding validation guidelines and that the records are available for abstraction. The abstractors then review patient records onsite using VAMC-assigned encrypted computers and complete the chronic condition database question set. The abstraction format is identical for all abstractors. The chronic condition-

specific database question set for the abstracted cases is then downloaded to WVMI via an electronic network.

3. The abstracted data are then submitted to a computerized screening algorithm, which identifies any deviation in the pattern of care. Monthly reports are then produced showing the number of cases that pass the algorithm by VAMC. This process is summarized as the general process for routine data collection for quality measures (Figure 1).

Screening criteria are classified by validation of diagnosis, appropriate preadmission care, appropriate inpatient care, and occurrences. Those cases that fail the screening algorithm are reviewed monthly by a physician review panel (PRP).

At the initial review, the PRP determines if (1) the care is appropriate, (2) a re-abstraction is necessary before a determination may be made, (3) the complexity of the case requires a full chart review, or (4) the case is considered a pending failure.

Following re-abstraction, receipt of full charts, and responses regarding pending failures, the cases are reviewed again. The PRP then determines if the care is appropriate or is a pending failure. The pending failure determination (1) becomes final because of an agreement with the VAMC, (2) becomes final even though it is not agreed to by the VAMC, or (3) becomes final because of a lack of appropriate feedback by the VAMC within the designated 15-day period. [Interviewee number 1: Clinical Quality Specialist]

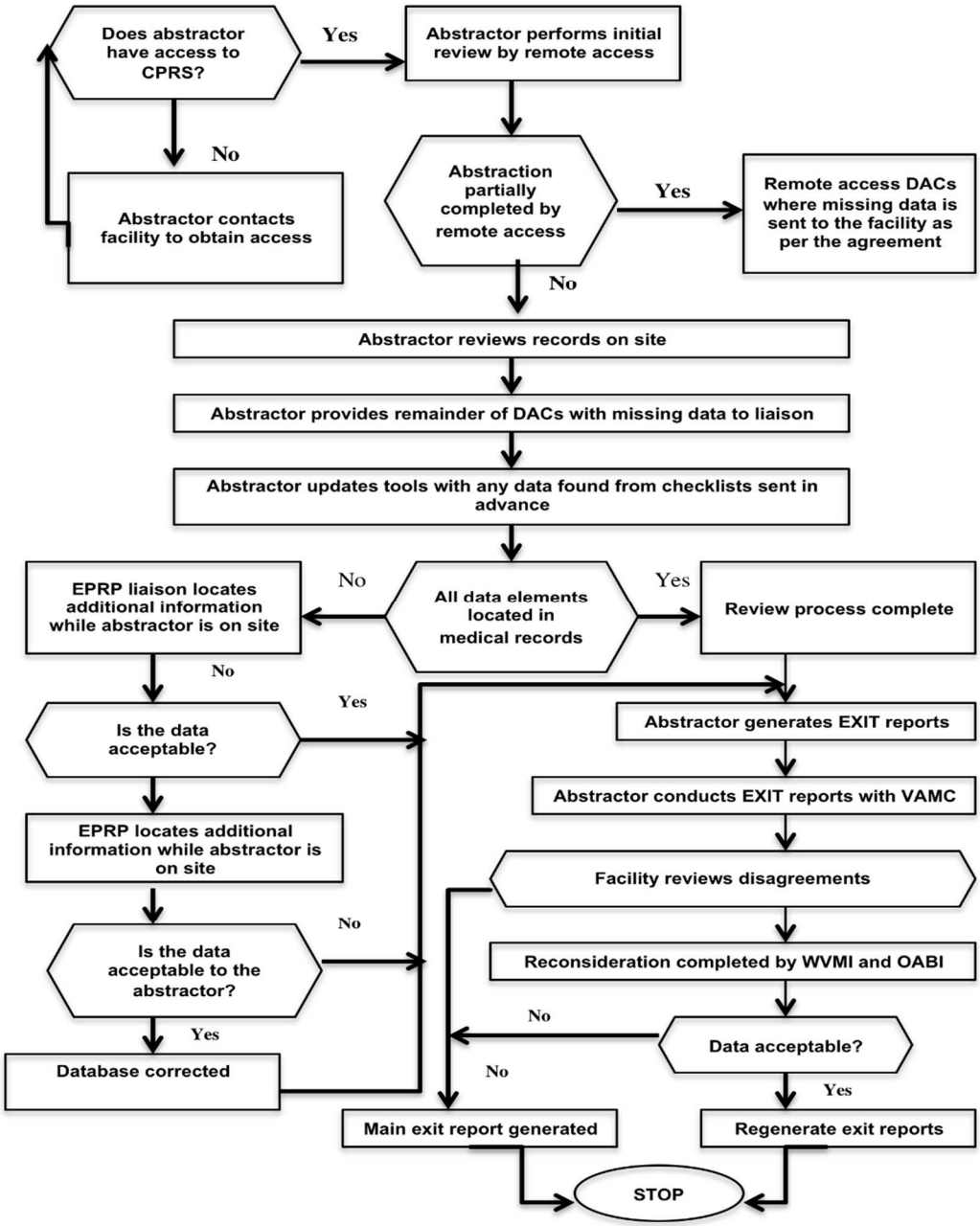

Figure 1. The general process for manual data collection for quality measures by the EPRP.

Theme 2 – VA currently has a manual abstraction process for the abstraction of performance measure data that is contracted through the EPRP. (This theme reflects both workflow and organizational features).

1. *Process of manual abstraction is currently being used*: The abstractors do a lot of manual chart review remotely at computer and then do exit conferences in the facility or remotely. The abstractors look for the abstraction of information, answering the data based questions that correlate with the measure they are looking at and each data based question is embedded in an algorithm that is used in scoring the measure. [Interviewee number 1: Clinical Quality Specialist]
2. *External Abstractors are contracted through the EPRP for quality measurement at the VA*: This data is collected right now by EPRP (Electronic Peer Review Process) abstractors. The abstractors are contracted to us from the West Virginia Medical Institute (WVMI) and they have 50 to 75 abstractors and there has been an increase because of the amount of data needing collected. [Interviewee number 1: Clinical Quality Specialist]
3. *Inpatient heart failure data is currently available through abstraction*: We continue to pull the inpatient heart failure data though abstraction. This is the information that continues to be sent to the joint commission and that is considered our gold source at this point. [Interviewee number 2: Management and Program Analyst]

Theme 3 – VA is making efforts to promote automated data extraction for performance measurement. (This theme reflects both workflow and organizational features).

1. *There are high performance levels on performance measures where data elements*

are more readily available electronically: On the other hand, if you are functioning in a healthcare system such as the VA where a lot has already been done and the performance levels on the simple performance measures are quite high the remaining patients who fail the measure are usually quite complex patients and it may be worthwhile to have more complex measures for them. [Interviewee number 4: Director of the Geriatrics Research Education and Clinical Center]

2. *Increase measure extraction and reduce measure abstraction*: Goal is to reduce the number of measures abstracted and increase the number of measures extracted with the goal of doing it consistently and accurately. We understand that not all measures are good candidates for extraction and that there will always be some abstraction needed. [Interviewee number 6: Clinical Quality Specialist]
3. *Usage of centralized repository data at the national level*: VA has a large network of data into centralized repositories that are called national databases. Once that data has been collected it is looked in to from the usage perspective at the national and reporting levels. [Interviewee number 9: Chief Medical Information Officer]
4. *Capturing and refreshing outpatient medications within VistA*: VA within the VistA system did develop a list for their outside medications and it started, the problem is that there is no way to refresh that data. [Interviewee number 12: Clinical Pharmacy Specialist]
5. *Reporting abstracted data to the corporate data warehouse*: Once that data has been collected it is looked in to from the usage perspective, we have to look at the various requirements from national and reporting perspective that will be needed

> and a limited subset of that data is abstracted and transported to the corporate data warehouse and there it is collected and made available to various data marts to another program that is called the [Name Removed 45] that helps the data cubes and data marts to report that data. [Interviewee number 9: Chief Medical Information Officer]

Summary of findings: In general, we found that VA manually abstracts data for performance measures. A significant portion of the clinical content for eMeasures is available in electronic format. VA currently has a manual abstraction process for the abstraction of performance measure data that is contracted through the EPRP. VA is making efforts to promote automated data extraction for performance measurement

Internal Organizational Features

Internal organizational features, according to (Sittig and Singh, 2010), are the organization's internal structures, policies, and procedures that affect every other dimension in the socio-technical model. Previous studies have demonstrated that internal organizational factors relate to sustained quality (Young et al., 1997); therefore, we included internal organizational factors as part of one of the dimensions in the socio-technical model assessed in our study. Understanding the internal organizational features was useful to develop the component of the toolkit that included the tools for managing team activity. The section included versioning tools, tools for project evaluation, and planning tools.

Research Question (1 d): What is the context of implementation at the national, VISN, and local level in terms of internal organizational features?

Summary Statement: VA has a culture of continuous quality improvement, which is

enhanced by its internal organizational factors to facilitate eMeasurement.

Examples: Excerpts from stakeholder interviews supporting this theme are as follows:

Theme 1 – VA is making efforts to achieve Meaningful Use certification by 2015.

1. *There is a goal to achieve Meaningful Use certification by 2015*: We are trying to meet the requirements to become Meaningful Use certified. The goal is by 2015 so we have identified our non-eligible provider measures, clinical quality measures and 16 other eligible hospital clinical quality measures. [Interviewee number 2: Management and Program Analyst]
2. *Use of SNOMED for Meaningful Use*: We use mandatory SNOMED taxonomy for Meaningful Use since it is the only coding instrument that is allowed so we are working toward that with a contractor but hoping to have the certification of the EHR by 2015 and measures in place so we can become Meaningful Use certified. [Interviewee number 2: Management and Program Analyst]
3. *Pursuing e-Measurement and complying with Meaningful Use criteria*: Yes, the VA is pursuing e-Measurement and also trying to comply with MU criteria. We are looking at existing measures to convert to extraction as well as asking whether any new measures are candidates for extraction. [Interviewee number 6: Clinical Quality Specialist]
4. *Speedy extraction of MU measures with fewer text and data fields*: The VA is in the beginning stages of developing MU measures as I think everyone is. While measures that have text and or high variation data fields are difficult to translate there are some measures we can move quicker to extraction. [Interviewee number 6: Clinical Quality Specialist]

5. *Identifying IT systems and quality programs impacted by Meaningful Use*: VA is still in the planning process for MU, understanding the impact and identifying various IT systems quality program that VA has, at all the stages of MU. [Interviewee number 9: Chief Medical Information Officer]

Theme 2 – VA currently has a manual abstraction process for the abstraction of performance measure data that is contracted through the EPRP. (This theme reflects both workflow and organizational features).

1. *Process of manual abstraction is currently being used*: The abstractors do a lot of manual chart review remotely at computer and then do exit conferences in the facility or remotely. The abstractors look for the abstraction of information, answering the data based questions that correlate with the measure they are looking at and each data based question is embedded in an algorithm that is used in scoring the measure. [Interviewee number 1: Clinical Quality Specialist]
2. *External Abstractors are contracted through the EPRP for quality measurement at the VA*: This data is collected right now by EPRP (Electronic Peer Review Process) abstractors. The abstractors are contracted to us from the West Virginia Medical Institute (WVMI) and they have 50 to 75 abstractors and there has been an increase because of the amount of data needing collected. [Interviewee number 1: Clinical Quality Specialist]
3. *Inpatient heart failure data is currently available through abstraction*: We continue to pull the inpatient heart failure data though abstraction. This is the information that continues to be sent to the joint commission and that is considered our gold source at this point. [Interviewee number 2: Management and

Program Analyst]

Theme 3 – VA is making efforts to promote automated data extraction for performance measurement. (This theme reflects both workflow and organizational features).

1. *There are high performance levels on performance measures where data elements are more readily available electronically*: On the other hand, if you are functioning in a healthcare system such as the VA where a lot has already been done and the performance levels on the simple performance measures are quite high the remaining patients who fail the measure are usually quite complex patients and it may be worthwhile to have more complex measures for them. [Interviewee number 4: Director of the Geriatrics Research Education and Clinical Center]
2. *Increase measure extraction and reduce measure abstraction*: Goal is to reduce the number of measures abstracted and increase the number of measures extracted with the goal of doing it consistently and accurately. We understand that not all measures are good candidates for extraction and that there will always be some abstraction needed. [Interviewee number 6: Clinical Quality Specialist]
3. *Usage of centralized repository data at the national level*: VA has a large network of data into centralized repositories that are called national databases. Once that data has been collected it is looked in to from the usage perspective at the national and reporting levels. [Interviewee number 9: Chief Medical Information Officer]
4. *Capturing and refreshing outpatient medications within VistA*: VA within the

VistA system did develop a list for their outside medications and it started, the problem is that there is no way to refresh that data. [Interviewee number 12: Clinical Pharmacy Specialist]

5. *Reporting abstracted data to the corporate data warehouse*: Once that data has been collected it is looked in to from the usage perspective, we have to look at the various requirements from national and reporting perspective that will be needed and a limited subset of that data is abstracted and transported to the corporate data warehouse and there it is collected and made available to various data marts to another program that is called the [Name Removed 45] that helps the data cubes and data marts to report that data. [Interviewee number 9: Chief Medical Information Officer]

Theme 4 – VA is using Health Information Technology as a facilitator for quality improvement.

1. *Use of VistA from Corporate Data Warehouse by VISNs*: The data source is the EHR, VistA, and the VistA data is transformed by a national IT team into a SQL data mart. It is the same data and then the data is transformed at one of four regional levels, and then pushed into the Corporate Data Warehouse and it is made available for use at the VISN. [Interviewee number 12: Clinical Pharmacy Specialist]
2. *Availability of various clinician dashboards*: We have dashboards for several of the HEDIS metrics for example, diabetes and hypertension. So we do a population survey, and we don't do any manual chart review. And we use all the electronic data from the electronic health records (EHR). [Interviewee number 12: Clinical

Pharmacy Specialist]

3. *Re-engineering current MUMPS based VistA data in another platform*: In the VA, VistA system is built on a MUMPS platform so they are re-engineering in another platform. It's been going on over a decade and it's a slow process. [Interviewee number 12: Clinical Pharmacy Specialist]
4. *Efforts to make structured data availability for data delivery*: We have recently gone through a very comprehensive process within VISN 21 to look at a variety of areas in which data is unstructured and there is very incomplete data delivery when you want certain pieces of information. [Interviewee number 13: Pharmacy Executive]

Theme 5 – VA is making efforts to overcome challenges to electronic quality measurement by consistently compiling structured data through the VA EHR.

1. *Electronic measurement is challenging through current VA EHR*: We are very advanced in our EHR but to get requirements for these electronic measures and with the VA system, it doesn't always have those capabilities. [Interviewee number 2: Management and Program Analyst]
2. *National results for electronic CHF measure are not readily available in VA*: There is a group that is working on the CHF measures that is not a nationally extracted measure that I am aware of. We don't publish a national result for the electronic CHF measure. We are just starting to publish data for a couple of diabetes measure and I don't know that this data is submitted on a national level. [Interviewee number 2: Management and Program Analyst]
3. *Need for consistent compilation of ejection fraction data*: In your case, ejection

fracture, it is not compiled consistently throughout the VA. There is no structured data presence, a file, where that data would be put, so it is difficult to electronically mine that data from note or figure out where individual medical centers put that information, and that's just one data piece. The less structured the data, the less reliable the opportunities to pull it in for a particular eMeasure. [Interviewee number 13: Pharmacy Executive]

Theme 6 – VA is routinely using quality control reporting as a feedback loop.

1. *Identifying and implementing intervention to improve heart failure care throughout the VA system*: From our QUERI perspective, we are responsible for identifying and helping to implement intervention that will help improve heart failure care throughout the VA system. [Interviewee number 8: Director of echocardiography Laboratory at the VA]
2. *Use of CDW for consistency in data and performance measurement calculations*: I write the SQL code to pull out data from the corporate data warehouse to develop the scores at the VISN levels and some at the national level to pull data as opposed to the manual process that has been used in the past. [Interviewee number 15: Pharmacy Benefits Management Data Manager]
3. *Improving the quality, safety, and value of clinical data in warehouse dashboards*: I am coordinating 13 different taskforces for VISN 21 in various therapeutic areas in an attempt to put clinical data in warehouse dashboards that we use to improve quality and safety and value. [Interviewee number 13: Pharmacy Executive]
4. *Comparison of results of performance measurement at local, VISN and national*

> *levels*: after we develop any kind of e-measure validation tool, we validate through a cohort database so that what we are looking at is correct and it will then run the e-measure. This is then compared locally at a VISN and then at the national level it is compared to the civilian population to see if the measures are met or not met. [Interviewee number 7: Health Systems Specialist]

Summary of findings: In general, we found that VA has a culture of continuous quality improvement, which is enhanced by its internal organizational factors We identified several themes associated with internal organizational features, including efforts made by VA to achieve Meaningful Use certification by 2015, using Health Information Technology as a facilitator for quality improvement, and routine use of quality control reporting as a feedback loop.

People

This dimension represents the humans (e.g., software developers, system configuration and training personnel, clinicians, and patients) involved in all aspects of the design, development, implementation, and use of HIT. Information about this dimension was useful to understand the human-technology relationship, and its interaction with the other dimensions of the socio-technical model.

Research Question (1 e): What is the context of implementation at the national, VISN, and local level in terms of people?

Summary Statement: VA has informed research staff that is engaged at various levels of eMeasurement.

Examples: Excerpts from stakeholder interviews supporting this theme are as follows:

Theme 1 – Key informants for example, directors, and executives provide overall comprehensive knowledge about the efforts that are being made to comply with Meaningful Use at the VA.

<u>*Directors*</u>:

1. *A Director of Epidemiology*: We have nurses and physicians, director of epidemiology, IT people who understand the programming aspect and where to pull the data from the data warehouse. [Interviewee number 2: Management and Program Analyst]
2. *A Director of Geriatric Research*: I lead a large center with a large research program and provide vision and direction for the center that I direct. It involves management of people, strategic planning, hiring, and recruiting. I also have a personal research program which I spend a substantial portion of my time on research projects where I am the Principal Investigator and I have the PI oversight roles for those projects. [Interviewee number 4: Director of the Geriatrics Research Education and Clinical Center]

<u>*Executives*</u>:

1. *A Chief Medication Information Officer*: I serve as the chief officer of informatics, helping with the strategic direction and helping the federal entities primarily like VA, with their strategic planning and future IT direction working with their leadership. Also support global healthcare into direction across the globe on various HIT systems, needs, and future direction.
2. *A Chief Medication Information Officer*: I support a lot of innovation with VA, which is really looking into the future possibilities in terms of technology and

workflow improvement but bring in those technologies and how do you use these technologies to let the end user improve their workflow, output, productivity, and job satisfaction. [Interviewee number 9: Chief Medical Information Officer]

Theme 2 – Subject matter experts for example, department administrators, patient care managers, data analysts, informatics and information technology professionals, and quality improvement and management staff provide a high level of expertise in performing specialized tasks to support eMeasurement.

Department Administrators:

1. *Clinical Application Coordinators*: In my group, VISN 21 program managers that work for me, and we have clinical data warehouse managers, clinical application coordinators, and also ad tacks which are pharmacists generally involved with electronic medical records in the pharmacy system. [Interviewee number 13: Pharmacy Executive]
2. *Benefits Management Staff*: hardware, I assume they have a server on their end and they have a SQL database. If you are benefits managements people you get that information. [Interviewee number 10: Chief of Ambulatory Care]

Patient Care Managers:

1. We have all disciplines that are involved in particular though we have the primary care stakeholders, LPNs, RNs, MDs, pharmacists, doctors included primary care as well as specialists of mental health, who are involved in the transition to automated performance measures. [Interviewee number 10: Chief of Ambulatory Care]
    a) *Physicians*

b) *Residents*

c) *Nurses*

d) *LPNs*

e) *Pharmacists*

2. When you talk about a nurse, you have to say a nurse who is in the frontline taking care of patients in heart failure and PAC team, or a nurse who works in inpatient unit that might admit patients who have heart failure so there is always frontline clinical people and then you have nurses that work in the quality management group who never see patients and have very little connection with front line workers and who analyze the quality of care and hope that somehow that analysis improves care. [Interviewee number 4: Director of the Geriatrics Research Education and Clinical Center]

    a) *Frontline Clinical Staff*

<u>*Data Analysts*</u>:

1. *Data Managers*: I'm a pharmacy data manager so I am responsible for querying the VISN and corporate data warehouses to develop dashboards, scorecards for patient level reports for the reporting and tracking of eMeausures you are discussing here. I interface with different task forces that we have here in VISN 21 to develop the business rules and determine usability of dashboards and reports. [Interviewee number 15: Pharmacy Benefits Management Data Manager]
2. *Program Managers*: In my group, VISN 21 program managers that work for me, and we have clinical data warehouse managers, clinical application coordinators, and also ad tacks which are pharmacists generally involved with electronic

medical records in the pharmacy system. [Interviewee number 13: Pharmacy Executive]

3. Data Management Analysts: They are involved in the transition to automated performance measures. [Interviewee number 1: Clinical Quality Specialist]
4. We have a lot of people, statisticians and program analysts that ensure the quality of data and floatation throughout our system are identified to try to make sure there is inter rater reliability and cross checking of data, which also includes the data validation with the abstracted measures. [Interviewee number 2: Management and Program Analyst]
    a) *Program Analysts*
    b) *Statisticians*
5. *Business Analysts*: I think business analysts will be involved in some way potentially quality safety and value – that office will be potentially involved. [Interviewee number 8: Director of echocardiography Laboratory at the VA]

Informatics Professionals:

1. They are involved in the transition to automated performance measures. [Interviewee number 1: Clinical Quality Specialist]
    a) *Nursing Informaticists*
    b) *Health Informaticists*

Information Technology Professionals:

1. *Programmers*: Once the programmers get the code in, it seems to run very seamlessly unless there are changes in the way that the designation of hospitals in our system has changed so the data person in the CDW has to go back and

crosswalk to make sure that the patients were aligning with the correct facilities so that a proper representation of what was happening at that facility occurred. [Interviewee number 2: Management and Program Analyst]

2. *Abstractors*: The abstractors do a lot of chart review remotely at computer and then do exit conferences in the facility or remotely. The abstractors look for the abstraction of information, answering the data based questions that correlate with the measure they are looking at and each data based question is embedded in an algorithm that is used in scoring the measure. [Interviewee number 1: Clinical Quality Specialist]
3. *Developers*: I have interfaced with developers along with IT personnel who are essential to get data elements that we don't have and maintaining documentation along those lines. [Interviewee number 11: Management and Program Analyst]
4. *Contractors for Meaningful Use and eMeasures*: We pull a sample of cases from VHA facilities and send to the Contractor. The EPRP Contractor will then abstract information either remotely or by going on site (some information is still paper-based). The Contractor uses algorithm software designed with us that guides abstraction and records the abstracted information. As above the information collected is scored using the algorithm and analyzed by the Contractor. The resultant data is transmitted back to us. [Interviewee number 6: Clinical Quality Specialist]

Quality Improvement and Management Staff:

1. *Clinical Program Specialists*: They are involved in the transition to automated performance measures. [Interviewee number 2: Management and Program

Analyst]

2. *Performance Measure Specialists*: They are involved in the transition to automated performance measures. [Interviewee number 3: Director of Heart Failure Clinic]
3. *Quality Management and Quality Assessment Staff*: So there are people who's main job is quality management and quality assessment and there are offices that deal with that and there are a set of people that work in that, and they are quite separate from the front line of people taking care of patients. [Interviewee number 4: Director of the Geriatrics Research Education and Clinical Center]
4. *Implementation science Specialists*: She is a VA leader in implementation and she has published and leads an HSR&D center. She leads a lot of programs of implementation in the VA. [Interviewee number 4: Director of the Geriatrics Research Education and Clinical Center]
5. *Health Systems Specialists*: I am part of the system facing which is looking at e-measures, performance improvement, and electronic reconciliation of different aspects of medical records and in doing so I have reached out to various stakeholders and inquired into what manual process is being used for performance measures. I am then looking at the technology and seeing if it is available for electronic means of capturing that information. I am also a subject matter expert in the electronic medical records and I assist the national team with Meaningful Use standardization, which also has a performance measure compliance component. [Interviewee number 7: Health Systems Specialist]

Summary of findings: In general, we found that VA has informed research staff that is

engaged at various levels of automation of performance measures to facilitate eMeasurement. Key informants for example, directors, and executives provide overall comprehensive knowledge about the efforts that are being made to comply with Meaningful Use at the VA. While, subject matter experts for example, department administrators, patient care managers, data analysts, informatics and information technology professionals, and quality improvement and management staff provide a high level of expertise in performing specialized tasks to support eMeasurement

Barriers to Automation

Common barriers to eMeasure implementation often imply an ineffective use of technology in healthcare, lack of clinical and organizational workflow support, and failure to conduct ongoing research by not utilizing evolving HIT tools. The tool to assess the barriers to the implementation of eMeasures can be found in the Postimplementation assessment of barriers and facilitators.

Research Question (2): What are the barriers to automation of the inpatient CHF performance measure?

Summary Statement: Barriers to the availability of electronic quality measurement data create challenges to support eMeasurement.

Examples: Excerpts from stakeholder interviews supporting this theme are as follows:

Theme 1 – There are challenges in obtaining structured data from reliable data sources.

1. *Dependency of LV function extraction through notes*: The LV functions tend to be more dependent on the notes rather than a quantifiable field that is entered and easily pulled. [Interviewee number 2: Management and Program Analyst]
2. *Lack of standardization of data*: Standardization and the lack of it is one of the

biggest barriers. [Interviewee number 2: Management and Program Analyst]

3. *Variation in quantifiable fields*: Even in quantifiable fields there is some variation that makes it a challenge. [Interviewee number 2: Management and Program Analyst]
4. *Care received outside the VA system*: We have a lot of patients that are co-managed so they have dual insurance and VA coverage and they want to come and they want to come to the VA to get care which is not covered by their private insurance. So we needed a way to capture their medications that they are getting from non-VA sources. [Interviewee number 12: Clinical Pharmacy Specialist]
5. *Specifications found in narrative notes*: Other challenges include some of the specifications being found in a narrative note which becomes a challenge to identify but it is really standardization and outside care. [Interviewee number 2: Management and Program Analyst]
6. *Variation in data sources for data extraction*: It depends on the source of the information, which has to be relatively stable. [Interviewee number 3: Director of Heart Failure Clinic]
7. *Unavailability of echocardiogram reports in a structured format*: if a physician is looking at echocardiogram reports, those may or may not be available in a structured data format. [Interviewee number 3: Director of Heart Failure Clinic]
8. *Unavailability of discharge summaries in a timely manner*: At some medical centers discharge summaries are not available or it takes weeks to get them or a provider that is not doing it in a timely manner when rotating it to other hospitals may take longer. [Interviewee number 3: Director of Heart Failure Clinic]

9. *Inconsistency in clinical data*: Also, certain types of data are more reliable than others. [Interviewee number 3: Director of Heart Failure Clinic]
10. *Difficulty in determining exclusion criteria or clinical characteristics from electronic patient data*: There are a few other barriers such as for some of the exclusion criteria or clinical characteristics, there is not a complete consensus on how to operationalize on patient data. [Interviewee number 4: Director of the Geriatrics Research Education and Clinical Center]
11. *Unavailability of VINCI data to frontline clinicians*: If you want to talk about taking data set up on VINCI and getting into the hands of frontline clinicians, there is a whole host of additional barriers. [Interviewee number 4: Director of the Geriatrics Research Education and Clinical Center]
12. *Free text in notes*: If someone could magically fix the free text problem, i.e., by suing natural language processing that would be most helpful. [Interviewee number 6: Clinical Quality Specialist]
13. *Unavailability of ejection fraction from a single data source*: in the current case of ejection fraction, there is not a standardized field that is populated so that data is extracted from various means progress notes, consults, orders so, there are things that are required to be analyzed for a performance measure where there is not a data or data field that currently exists. [Interviewee number 7: Health Systems Specialist]
14. *Missing data fields in the CDW*: Missing data is a big problem. We draw on our corporate data warehouse, which I imagine you are familiar with. the type of problems we come up with is sometimes the data isn't operational and hasn't been

migrated to CDW. [Interviewee number 11: Management and Program Analyst]

15. *Poor data format*: A lot of the data we accumulated is not a very good format to handle off to developers so I've consolidated that to more sync format for that. [Interviewee number 11: Management and Program Analyst]
16. *Incomplete data fields in the EHR*: The only barrier that I can see is that sometimes we don't have all the data from the EHR, people still want to free text in their notes. [Interviewee number 12: Clinical Pharmacy Specialist]
17. *Unavailability of data elements in a table format from the CDW*: So the main hold back is that the data elements that we want are not in a table format, and not readily extractable. [Interviewee number 12: Clinical Pharmacy Specialist]
18. *Difficulty in identifying systolic versus diastolic function*: We have trouble identifying systolic vs. diastolic dysfunction and the treatment algorithms for that are different. [Interviewee number 12: Clinical Pharmacy Specialist]

Theme 2 – There is untimely and inconsistent capture of electronic data for performance measurement at the VA.

1. *Complexity of data abstraction for performance measures*: I think the complexity of the abstraction depending on the performance measure. [Interviewee number 3: Director of Heart Failure Clinic]
2. *Untimeliness of data reported by physicians for performance measurement*: From the perspective of electronic measure, the timeliness of the data being reported by the physicians is important. [Interviewee number 3: Director of Heart Failure Clinic]
3. *Inconsistency in documentation at different medical centers*: Different medical

centers report their data differently. For example we have PDF reports that are in our imaging files while other medical centers may send it as text documents. [Interviewee number 3: Director of Heart Failure Clinic]

4. *Lack of standardized input data fields for CHF performance measures*: So, the barrier would be the lack of standardized input data fields for CHF measures. [Interviewee number 7: Health Systems Specialist]
5. *Electronic extraction is challenging*: I think the VA has a challenge in going all electronic because there are feature services that we pay for but are done through the basics in getting data into our system so we can track that care for veterans is difficult and time consuming. [Interviewee number 2: Management and Program Analyst]

Theme 3 – There is a shortage of trained technical staff for eMeasurement.

1. *Additional staff required for understanding SNOMED used in specification manuals*: Some of the challenges we have are the additional need to include some people due to the use of SNOMED in specification manuals that we did not have in the past. [Interviewee number 2: Management and Program Analyst]
2. *Unavailability of technical staff for running specific software program*: This has been extremely difficult and in our case it has been difficult because of VINCI rules about who is allowed to access data in which site and in which folder or because of availability of staff that have the knowledge to run a program. [Interviewee number 4: Director of the Geriatrics Research Education and Clinical Center]

Theme 4 – There is constant evolution of methodologies, technologies, and tools that affect an organizations workflow during the automation of performance measures.

1. *Transition to ICD10*: The transition to ICD10 creates another challenge and we need to be ready for engaging. [Interviewee number 2: Management and Program Analyst]
2. *Unavailability of software for the extraction of ejection fraction as a data element from free text*: The number one biggest barrier is getting the software that can extract the ejection fraction out of the free text connected up with the rest of the patient data so the ejection fraction is available as a data element. [Interviewee number 4: Director of the Geriatrics Research Education and Clinical Center]
3. *Conditioned access to VINCI data*: This has been extremely difficult and in our case it has been difficult because of VINCI rules about who is allowed to access data in which site and in which folder. [Interviewee number 4: Director of the Geriatrics Research Education and Clinical Center]
4. *Slower evolution of VistA in comparison to the rapidly changing data formats*: But the changes to VistA haven't been that fast so we are not able to collect all the desired data and there are no storage places in the current VistA data dictionary. [Interviewee number 9: Chief Medical Information Officer]
5. *Lack of storage capabilities of the desired data in the VistA data dictionary*: we are not able to collect all the desired data and there are no storage places in the current VistA data dictionary. [Interviewee number 9: Chief Medical Information Officer]

Theme 5 – There are challenges in data sharing between the VA and other medical centers.

1. *Challenges in data sharing to the researcher or operational staff for data analytics*: Even the data formats have changes for example 30 years ago we didn't have echocardiography, robust cath labs that produces tons of data through automated processes. So a lot of data gets collected and stored in to local data bases and it gets printed and scanned in to VistA data base which takes it to the next level of data sharing. [Interviewee number 9: Chief Medical Information Officer]
2. *Difficulty in data exchange between the VA and other medical centers due to lack of standardization of data*: And it is also hard to exchange that data because its not standardized across VA and the outside world and also from one VA to another VA. [Interviewee number 9: Chief Medical Information Officer]

Summary of findings: The barriers associated with the implementation of emeasures; such as the measurement of timeliness, unavailability of a structured form for CHF data, and lack of available structured data (for example, Ejection Fraction data) for CHF patients can be overcome by the implementation of automated system for CHF patients.

Facilitators

Prior studies have shown that HIT can be used as a facilitator of evidence-based practice to improve care and clinical outcomes and key to successful use of HIT is determination of end user needs. The tool to assess the facilitators to the implementation of eMeasures can be found in the postimplementation assessment of barriers and

facilitators, postimplementation assessment of process improvement requirements, postimplementation processes to finalize workflows.

Research Question (3): What facilitation is needed to overcome barriers for the purpose of automation of performance measures?

Summary Statement: Automated quality measurement could potentially provide accurate data for eMeasurement.

Examples: Excerpts from stakeholder interviews supporting this theme are as follows:

Theme 1 - There is a need for standardization and consist availability of structured data**.**

1. *Nationwide data consistency*: Yes, there has to be consistency of common data definitions and consistency of data collection throughout the country. [Interviewee number 1: Clinical Quality Specialist]
2. *Mapping outpatient data to data definitions*: Also need mapping from an outpatient perspective (SNOMED codes) to the data definition. [Interviewee number 1: Clinical Quality Specialist]
3. *Standardization of clinical data*: A way to standardize even simple clinical reminders that are nationally standardized may help because it allows the facilities and networks to customize them and adds to the challenge of where the data is found and ensures that it can be easily located in one place. [Interviewee number 2: Management and Program Analyst]
4. *Automated system to extract ejection fraction data from free text*: Find a way to link up a system that extracts ejection fraction from free text and link it up to put that output data in a place that is accessible to the other patient data assessable to the processing of the system so that things technically run. [Interviewee number

4: Director of the Geriatrics Research Education and Clinical Center]

5. *Creating data fields within VistA to capture CHF data*: My suggestion is to create a data field within the medicine package of Vista for a data field that would capture the current ejection fractions and any other pieces of data related to CHF. [Interviewee number 7: Health Systems Specialist]
6. *Availability of electronic data to clinicians and supporting staff to conduct longitudinal and retrospective research*: They really want to collect data and do studies both longitudinal and retrospective studies and then build more of perspective models to identify what interventions would be useful. [Interviewee number 9: Chief Medical Information Officer]
7. *Availability of valid and accurate data*: When you have the data, it's important to have it valid and accurate. [Interviewee number 10: Chief of Ambulatory Care]

Theme 2 – There is a potential for superior use of informatics tools for eMeasurement.

1. *Extracting and measuring qualitative data*: If we could pull out qualitative discussion and measure that. [Interviewee number 1: Clinical Quality Specialist]
2. *Integration of informatics techniques into electronic data reporting*: Extracting the data from subjective statements to try to quantify NLP (Natural Language Processing). Integration of informatics techniques into this reporting. [Interviewee number 1: Clinical Quality Specialist]

Theme 3 - Engaging informed clinical staff for quality improvement can potentially facilitates eMeasure implementation in a timely manner.

1. *Engaging clinical experts for data validation*: You need to have a clinical presence in the beginning when you start this process because they are going to

know how and where this information is and if it is there at all. From there you can work with your analysts and others to extract it. But if you are just looking at fields and saying that is what I need, we are comparing it to some data elements and might miss pieces, which is what we find out in the validation phase. [Interviewee number 6: Clinical Quality Specialist]

2. *Engaging data analysts with clinicians for a better understanding of the database*: You also need to have analysts that understand the database and can work with clinicians. [Interviewee number 6: Clinical Quality Specialist]
3. *Engaging project managers to understand workflow and communication during eMeasure implementation*: You need a project manager to understand flow and communicate what's happening. [Interviewee number 6: Clinical Quality Specialist]

Theme 4 – Natural Language Processing (NLP) and other Information Extraction (IE) techniques can be used for extracting free text from clinical notes.

Using NLP for data extraction: Currently they are using Natural Language Processing (NLP) to read the data, to extract that data. [Interviewee number 7: Health Systems Specialist]

Theme 5 – VA emphasizes on sustaining a culture of continuous quality improvement to support eMeasurement.

1. *Evaluating the eMeasure for validity at various medical centers and staffing*: I think carefully looking at the validity of the eMeasures across different types of medical centers and different types of staffing. [Interviewee number 3: Director of Heart Failure Clinic]

2. *Creating eMeasures for non-traditional performance measures for internal quality improvement*: If eMeasure were available and easier to create, then we can create eMeasures for non-traditional performance measures for internal quality improvement. [Interviewee number 3: Director of Heart Failure Clinic]
3. *eMeaure for ejection fraction to support clinical reminders*: An eMeasure for ejection fraction would support my efforts to create a clinical reminder to prompt providers to use this drug. [Interviewee number 3: Director of Heart Failure Clinic]
4. *VA centric eMeasures for quality improvement at the VA*: More VA centric eMeasures can be beneficial because the eMeasure could support measurements of other quality indicators that may not be required from the regulators but is of importance to the VA. [Interviewee number 3: Director of Heart Failure Clinic]
5. *Understanding the electronic reporting requirements for Meaningful Use*: Second is the reporting requirements, so the reporting requirements are increasing both from the compliance perspective and the MU perspective. [Interviewee number 9: Chief Medical Information Officer]

Theme 6 – VA emphasis on undertaking gap analysis to support best practices, as well as, reduce time constraints on the users to maintain good business practices.

1. *Gap analysis to understand system limitations*: Really to ensure the philosophy of providing the right data to the right user in the right format at the right time and to look in to a more gap analysis approach 2) look into our systems, and do system analyses... what are the system limitations. [Interviewee number 9: Chief Medical Information Officer]

2. *Timely delivery of data to users as part of good business practice*: Understand the business needs, get business users to understand what are the limitations in business practice because of non-availability of data, delay in the availability of data. [Interviewee number 9: Chief Medical Information Officer]
3. *Complying with HIPAA and privacy Act to reduce time constraint on the end users accessing the automated data*: We have to look into the privacy, security and confidentiality. How do we automate certain processes in terms of IRB approval process so that we can comply with the HIPAA and privacy Act that reduces the burden and time constraint on the end users and researchers who are going through those processes? [Interviewee number 9: Chief Medical Information Officer]
4. *Focusing on the changing business needs and limitations on the IT system during automation*: While the user need in the business side is constantly changing. So, it is very hard to keep pace with the changing business needs and the limitations on the IT system. [Interviewee number 9: Chief Medical Information Officer]
5. *Understanding the gaps from the best practice perspective*: What is baseline as far as quality and excellence and what are the gaps from the best practice perspective? This effort will help create baseline and identify gaps. [Interviewee number 9: Chief Medical Information Officer]
6. *Staff buy in to comply with the changing workflow*: The key would be there would be staff buy-in because it does take a change in their workflow. [Interviewee number 10: Chief of Ambulatory Care]

Theme 7 – VA uses mandatory clinical terminology and standards for Meaningful Use.

1. *Using ICD9 codes, length of stay, etc., for good measurement of healthcare outcomes*: So, for us to do a good measurement of healthcare outcomes, it would be good to tap into health records from their other co-insurance so that we could get a better idea of how many hospitalizations based on their ICD9 codes, length of stays, so we could better assess the impact of the care we provide. [Interviewee number 12: Clinical Pharmacy Specialist]
2. *Using LOINC codes to capture laboratory results in a structured format*: Required things from a policy standpoint require the lab to make sure the LOINC codes are always populated or the labs names are standardized. [Interviewee number 15: Pharmacy Benefits Management Data Manager]

Theme 8 – VA implements methodologies, technologies, and tools that encourage Meaningful Use of Electronic Health Records (EHR).

1. *Embedding CDS in CPRS for patient by patient recommendations to frontline clinical staff*: This is a prototype system it is not ready for primetime, it would need a lot of development to be used but it gives a way to put the outputs of HF CDS and put them into CPRS to be in the workflow of the frontline providers. [Interviewee number 4: Director of the Geriatrics Research Education and Clinical Center]
2. *Drill down capabilities at the provider level and individual level*: It would be nice if there were things interfaced with the future aspects could be used. It needs to be segmented to the point where it is at the provider level and the individual level and at the team level. [Interviewee number 10: Chief of Ambulatory Care]
3. *Development of structured data systems for the extraction of data elements from*

the EHR: In the EHR there is a need to develop structured data system for the data elements that we need. [Interviewee number 12: Clinical Pharmacy Specialist]

4. *Selecting an EHR that is more compliant with electronic measurement*: We are very advanced in our EHR but to get requirements for these electronic measures and with the VA system, it doesn't always have those capabilities. [Interviewee number 2: Management and Program Analyst]

Theme 9 – VA is making efforts to achieve Meaningful Use certification by 2015.

1. *Meaningful Use certification by 2015*: we are working toward that with a contractor but hoping to have the certification of the EHR by 2015 and measures in place so we can become Meaningful Use certified. [Interviewee number 2: Management and Program Analyst]
2. *VA is pursuing eMeasurement and complying with the Meaningful Use criteria*: Yes, the VA is pursuing e-Measurement and also trying to comply with MU criteria. [Interviewee number 6: Clinical Quality Specialist]
3. *VA is extracting data elements for the specific measures as part of Meaningful Use*: We are guided by the measures selection that is part of MU and chose accordingly. We just completed a stroke measure that was part of that selection group. We had to be able to show that we could accurately and consistently collect the data elements (dictated by the measure specifications) using extraction. [Interviewee number 6: Clinical Quality Specialist]
4. *VA uses Meaningful Use measure specification to identify data elements and do a gap analysis to compare manual abstraction versus electronic extraction*: Using the MU measure specifications to identify the elements we do a gap analysis

comparing where we see the needed elements in the chart (abstraction) versus extracting them from the central data warehouse. [Interviewee number 6: Clinical Quality Specialist]

5. *Free text and high variation data fields are a barrier to extracting measures for Meaningful Use*: The VA is in the beginning stages of developing MU measures as I think everyone is. While measures that have text and or high variation data fields are difficult to translate there are some measures we can move quicker to extraction. [Interviewee number 6: Clinical Quality Specialist]
6. *VA is in the beginning stages of developing Meaningful Use measures*: The VA is in the beginning stages of developing MU measures as I think everyone is. [Interviewee number 6: Clinical Quality Specialist]
7. *VA is assessing system requirements and evaluating the impact of IT systems to comply with Meaningful Use criteria*: VA is still in the planning process for MU, understanding the impact and identifying various IT systems quality program that VA has, at all the stages of MU. [Interviewee number 6: Clinical Quality Specialist]
8. *VA has selected 9 outpatient and 16 inpatient measures as part of the Meaningful Use criteria*: We selected 9 outpatient 16 inpatient measures that we were pursuing and my main job is to kind of manage the requirements. [Interviewee number 11: Management and Program Analyst]

Theme 10 – VA encourages electronic extraction of data to provide greater time for additional analysis or use of professional skills.

1. *Availability of real time data without lag to the clinical frontline*: On the clinical

frontline side, it is going to get them real time data without the lag. It will be a population rather than a sample. [Interviewee number 2: Management and Program Analyst]

2. *Immediate response of directives to the program offices*: I think it will give program offices a more immediate response to directives. [Interviewee number 2: Management and Program Analyst]
3. *Availability of easily extractable structured data to the IT professionals at the back end*: As far as the people involved in the calculation at the back end, the technician and data people are involved in the development of these measures. There are different pieces, which add up, so when the algorithm and the scoring methodology is developed cross-walking it is necessary so we have all the key pieces. Once the programmers get the code in, it seems to run very seamlessly. [Interviewee number 2: Management and Program Analyst]
4. *Availability of good quality data to the statisticians and program analysts to ensure inter-rater reliability and data validation for the abstracted measures*: We have a lot of people, statisticians and program analysts that ensure the quality of data and floatation throughout our system are identified to try to make sure there is inter rater reliability and cross checking of data, which also includes the data validation with the abstracted measures. [Interviewee number 2: Management and Program Analyst]
5. *Re-deployment of manpower that is made available from automation for use in other quality improvement activities*: Also, the idea would be that what ever manpower is freed up from automating the process that can be re deployed for

other quality improvement activities. [Interviewee number 5: Associate director for quality and safety]

6. *Time saved by automated extraction versus manual extraction from medical records*: The process of manually abstracting data takes longer therefore, you need to always have an IT person or some sort of specialist in the computer field anytime a new measure is developed upfront. Can we do this electronically; if not here is what we need to do to do it electronically instead of saying here is what we need, now figure out how it can be done. [Interviewee number 7: Health Systems Specialist]
7. *Removing the need for manual extraction to prevent data quality issues and removing unnecessary job titles associated with it*: Data is byproduct of business process so, the data should be automatically be produced if we are doing the right thing, it should be captured and stored and made available for future business transaction. There should not have manual intervention required, and we should not have jobs or job titles associated with this. [Interviewee number 9: Chief Medical Information Officer]
8. *Encouraging eMeasurement and eQuality reporting to establish good business practices*: Keeping the current state in mind we really want to move towards eMeasures and e quality reporting. [Interviewee number 9: Chief Medical Information Officer]

Summary of findings: Stakeholders described several aspects of data and its use related to quality measurement for which we developed themes we considered were facilitating factors. They identified major potential benefits of the automated NLP process as well as alignment of the technology with organizational goals.

APPENDIX B

eMEASURE IMPLEMENTATION TOOLKIT

2015 Version

eMeasure Implementation Toolkit for the Evaluation of Workflow during the Automation of a Performance Measure Using the Heart Failure eMeasure as an Exemplar

Prepared for:
Department of Biomedical Informatics
University of Utah
421 Wakara Way
Suite 140
Salt Lake City
Utah 84108-3514

Prepared by:
Megha Kalsy

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Introduction

We are pleased to present this version of the eMeasure Implementation Toolkit for your review. The purpose of the toolkit is to assist your healthcare organization in the evaluation of workflow during the implementation of eMeasures. This toolkit is intended to provide step-by-step guidance for Quality Improvement (QI) and Information Technology (IT) professionals to implement eMeasures at an inpatient setting. Users can apply this toolkit in its entirety, or only apply certain portions that are informative for their needs.

You might ask: "Why evaluate the workflow?" The impact on workflow is an important component in determining whether an HIT implementation will be successful, but little research has been conducted on workflow pertaining to quality improvement professionals' and their team in an HIT adoption. Workflow is, unfortunately a concept that is often ignored when implementing HIT and the literature about workflow found in domains such as quality improvement, system implementation, and process improvements is not adequate. HIT is not always designed to fit the workflow of a given organization, making it difficult to truly assess its impact [1]. To ensure that HIT successfully integrates with workflow, it is essential to understand the current system before implementing the new technology. Therefore, assessing and understanding workflow is essential when determining where and how to best integrate HIT into an eMeasure implementation [2].

The proposed solution: The eMeasure Implementation Toolkit in the form of an implementation guide that will provide checklists, forms, and planning documents to enhance the workflow pertaining to quality improvement (QI) and Information Technology (IT) professionals' and their team and guide them during the process of implementing eMeasures. Thus, the question posed today is no longer why should we focus on workflow but how can we enhance the workflow during the implementation of eMeasures? This toolkit will help assist you through the process of evaluating the workflow during the automation of a performance measure. We invite and encourage your feedback on the content, organization, and usefulness of this toolkit as we continue to expand and improve it. Please send your comments or questions about the eMeasure Implementation Toolkit to megha.kalsy@utah.edu

Purpose

Although several automated approaches have proven capable of extracting individual values from clinical records, formidable challenges remain in realizing reliable and quick access to current clinical outcomes and performance measurement data. First, some degree of workflow related customization is often required to account for the sublanguage and documentation practices of specific medical subdomains. This can be a costly and resource-intensive endeavor. Both the cost and the technical complexity of these tasks can increase considerably in attempts to extract data from the records of multiple institutions. Beyond abstracting information from the record, clinical records-based research poses logistical challenges, including the import of data from multiple

sources into a single repository, the standardization of that data for statistical analysis, and the auditing of extracted results to guarantee data integrity [3].

The eMeasure Implementation Toolkit is designed to overcome the workflow challenges and facilitate the implementation of eMeasures at your healthcare organization. The toolkit will provide your inpatient setting with a collection of resources, for assessing workflow when automating electronic performance measures (eMeasures).

The eMeasure Implementation Toolkit is designed to support and provide guidance on developing and implementing plans for achieving optimal workflow during the implementation of eMeasures at any acute inpatient setting. The eMeasure Implementation Toolkit is intended to provide guidance or assistance; it may provide a template or blueprint for what to do, when to do it, and how to do it. Users can apply the implementation toolkit in its entirety, or only apply certain portions that are informative for their needs.

Background about workflow

Technology is rapidly transforming healthcare by enabling the sharing of real-time health information across institutions to support patient care, administration, and research. HIT tools are being used as a component of interventions to improve the quality of care and to reduce costs. For example, these tools reduce medication errors and improve medication management [9]. Given their capacity to reduce costs, informatics methods are integral to healthcare quality metric assessment and reporting. QI activities (e.g., data gathering) from sources such as electronic health records (EHRs), data warehouses, and decision support facilitate the evaluation of quality metrics. Although HIT support for QI activities is increasing, little research has been done on the workflow involved in the automation of quality metric assessment and reporting. Furthermore, this lack of attention to workflow could be a barrier to successful implementation of information systems intended to support QI activities. This barrier to implementation of an automated system can potentially be overcome by the design, or redesign, of operational workflow coupled with informatics techniques to provide a solid framework for the development and implementation of an automated system for quality improvement [92].

Workflow is the set of tasks—grouped chronologically into processes—and the set of people or resources needed for those tasks, that are necessary to accomplish a given goal. An organization's workflow is comprised of the set of processes it needs to accomplish, the set of people or other resources available to perform those processes, and the interactions among them.

Workflow is, unfortunately a concept that is often ignored when implementing HIT and the literature about workflow found in domains such as quality improvement, system implementation, and process improvements is not adequate. HIT is not always designed to fit the workflow of a given organization, making it difficult to truly assess its impact. To ensure that HIT successfully integrates with workflow, it is essential to understand the current system before implementing the new technology [96]. Therefore, assessing and

understanding workflow is essential when determining where and how to best integrate HIT into a variety of healthcare systems [97]. The literature demonstrates inadequate sophistication in studies regarding the role of workflow in the adoption of HIT due to the absence of formal workflow design and methodologies, current lack of comprehensive knowledge about the system, and a lack of interest demonstrated by the quality improvement staff towards the use of the new technology [92]. Workflow pertaining to quality improvement concerns can lead to failure to adopt new technologies as organizations involved in implementing them may not have the right tools, the time or the resources to focus on the critical aspects of workflow.

The automated approach to healthcare quality measurement and improvement follows a series of steps beginning with a decision of what to measure, appropriate tools that can be used for the measurement, the identification of data sources for data extraction, analysis and aggregation of data, understanding, and dissemination of the results [93]. This human-technology interactive approach can be dynamic and often complex [94]. The eMeasure Implementation Toolkit is intended to provide a deep understanding of the dynamics of eMeasure implementation and to assist you through the process of evaluating the workflow during the implementation of eMeasures.

Impact of eMeasurement and workflow on healthcare organizations

Quality measurement, a key lever to improve healthcare, has traditionally relied on administrative claims data and time-consuming manual chart abstraction [18]. Health information technology (HIT) promises to generate quality measurement and public reporting through automated data collection more readily [19]. Many believe that electronic health records (EHR) offer new potential for quality measurement [20]. The US Health Information Technology for Economic and Clinical Health (HITECH) Act of 2009 invested US$20 billion for health IT infrastructure and Medicare and Medicaid 'Meaningful Use' (MU) incentives. The proportion of acute care hospitals adopting at least a basic EHR more than doubled between 2009 and 2011, and in 2011 85% of hospitals planned to attest to MU of certified EHR technology by 2015, which includes submitting clinical quality measures [21].

The taxonomy for measuring and reporting performance from EHR is evolving; we use the terms 'e-measures' and 'electronic performance measures' interchangeably to refer to all partly or fully automated processes for generating performance information from EHR-contained data. eMeasure implementation occurs at the interface between measure developers and providers using EHR [18]. Understanding the work of retooling paper-based quality measures for automated reporting illuminates the gap between the current and desired states of e-measures; we report herein the eMeasure Implementation Toolkit with the workflow during the implementation of electronic measures (Figure 1) [22].

Too often healthcare organizations believe workflow should only be assessed after an automation process has been decided and just before the HIT is implemented. By understanding workflows and preparing for changes to them throughout the planning and implementation process, a healthcare organization is better prepared for the workflow

changes post implementation of electronic performance measures [23].

Background about eMeasures

Quality measures are quantitative tools to assess the performance of an individual or organization through the measurement of an action, process, or outcome of clinical care. With the passage of the Health Information Technology for Economic and Clinical Health Act (HITECH) of 2009 and the increasing focus on Meaningful Use (MU) of Electronic Health Records (EHRs), quality measures are transitioning from manual data abstraction to electronic data collection and calculation [4].

Electronic measures or eMeasures are standardized performance measures in an electronic format. They help to ensure that measures are consistently defined and implemented, thereby promoting higher quality and more appropriate care delivery for safer, more affordable, and better-coordinated care [5]. eMeasures can promote greater consistency in measure development and in measuring and comparing performance results. They can also provide more exact requirements about where information should be collected, and drive greater standardization across the measures and greater confidence in comparing outcomes [7, 8].

National Quality Forum (NQF)-endorsed electronic performance measures are now commonly recognized throughout the health-care industry because they go through a rigorous development process [8-10]. Organizations that have developed measures can submit them to NQF for consideration and NQF evaluates them based on standards that have been determined through a consensus process with input from a variety of stakeholders in the health-care industry. The NQF website has a database of 113 endorsed performance measures from paper to eMeasure format. For each measure, NQF describes the source of the measure, the numerator, the denominator, and any exclusions (characteristics that cause something or someone to not be included in the measure). eMeasures, as quality enhancement tools, have the potential to quantify healthcare processes, outcomes, patient perceptions, and organizational structure and systems that are associated with ability to provide high quality healthcare and that relate to one or more quality goals for healthcare. These goals include: effective, safe, efficient, patient-centered, equitable, and timely care [10-15].

Best practices for implementing eMeasures at an inpatient healthcare setting

Measure developers cannot build the most effective quality measures – and healthcare systems cannot accurately measure and assess performance - without comparable high quality data that is captured through effective clinical workflow. In accordance with the National Quality Forum (NQF), the ultimate goal of eMeasurement is to improve care through the use of better measures and better data. In order to achieve this goal, measure developers, federal agencies, health IT professionals, providers and the stakeholders from across the healthcare quality continuum need to collaborate to foster widespread implementation of eMeasures. By building bridges between these groups, NQF is helping to promote more efficient and standardized adoption of eMeasures. Through knowledge sharing between all the stakeholders, identification of gaps, and creation of solutions, improvement of data and reporting can be achieved.

As part of the process of implementing eMeasures, it is important to engage key stakeholders, who are involved in the process of implementing eMeasures at an inpatient healthcare setting. Stakeholder engagement, involves individuals or organizations affected by changes in healthcare policy, and is critical for successful implementation of systems and processes that can support the use of health information technology in hospital settings. In a healthcare setting, clinicians, patients, staff, scientists, policy makers, information technology and quality improvement experts, informatics, and all related fields have a role to play as stakeholders. Their input can address key challenges, and include important information on the potential facilitators to bridge any technological gaps in healthcare. It is important to ensure that the process of implementation is transparent to them, and driven by their workflow needs as well as external requirements and management goals [16]. Effective stakeholder engagement not only informs the design of optimal technical solutions but also supports change management. Moreover, the development of tested, locally appropriate procedures for stakeholder engagement and the establishment of a relationship with the subject matter experts provides a useful organizational resource for determining post eMeasure implementation requirements.

eMeasure implementation planning best practices

In accordance with the goal of enhancing the workflow during the implementation of eMeasures, the following steps were identified as steps to advance eMeasure adoption, implementation, and use.

Step 1: Evaluate organizational priorities and employ best practices

The purpose of implementing electronic performance measures (eMeasures) is to make progress toward specific objectives, for example, achieving Meaningful Use, that support a healthcare organization's overarching goals of quality improvement. Before selecting eMeasures, you should take time to consider your organization's primary goals.

Overall Organizational Best Practices to support eMeasure Implementation:

1. Create inter-professional teams focused on an integrated approach to eMeasure adoption, including data capture, reporting, workflow, CDS and evidence-based practice.
2. Develop a strategy and plan for data standardization under the guidance of executive leadership and operational teams.
    a) The data standardization plan should span point of care needs, eMeasures, data analytics, and quality improvement across the entire continuum of care.
    b) The data strategy and plan is informed and guided by the clinical intent of the quality measures, which spans point of care delivery through quality measurement and improvement.
3. Educate all stakeholders on the importance, meaning, and methods of eMeasurement before moving ahead with any project.
4. Develop an organization-wide plan for execution of small-scaled pilots using a technique such as the Plan, Do, Study, Act (PDSA) cycle to move towards capturing discrete data elements from the EHR.

It is important to consider these goals as relevant indicators to a implementing eMeasures and then performing action-oriented steps to achieve them.

Step 2: Choose the eMeasures that need to be implemented

The following process describes the selection of eMeasures for an inpatient healthcare setting:

1. Include healthcare staff in the eMeasure selection process: The eMeasures should be meaningful to the healthcare staff, because they may be involved in collecting the data and the data will be a reflection of the work they do. They should be able to clearly see how implementing these eMeasures can support their work.
2. Choose performance measures with the following characteristics: One that aligns with your healthcare organization's goals and demonstrates a relationship to positive health outcomes. The selected eMeasures should be reliable, valid, and standardized.
3. Use established measures for example, National Quality Forum (NQF), or The Healthcare Effectiveness Data and Information Set (HEDIS). Ensure that the eMeasures you use, meet the criteria described above, Use available data sources.
4. eMeasures should use data that your healthcare organization already collects or could collect using existing resources. Once the measurement process is more advanced, you could consider what additional resources would be necessary to gather the data that best captures what you want to measure electronically. If you determine that a certain measure would be burdensome to implement, consider whether it can be justified by the potential for quality improvement.
5. Use a variety of eMeasures: Using a mix of structural, process, and outcome eMeasures will provide a comprehensive picture of your organization's healthcare quality. Outcome eMeasures are the most desirable, because they show direct impact on patient health. Structural and process eMeasures can be used in cases where outcome eMeasures are not available or feasible

Step 3: Develop an implementation plan

When implementing eMeasures, it is important to develop an implementation plan to track the completion of goals. The eMeasure Implementation Toolkit presents information for analyzing the workflow during the implementation of eMeasures.

Step 4: Data representation

Use eMeasurement standards such as the Quality Data Model (QDM), The Health Quality Measures Format (HQMF), HL7 Quality Reporting Document Architecture (QRDA), National Library of Medicine's (NLMs) value sets, and structured codes terminologies for the purpose of standardized data.

Step 5: Determine the workflow requirements

All stakeholders involved in eMeasure implementation need to understand and consistently use relevant terminology. It is important for information technology and quality improvement staff to understand the data sources and hardware and software availability for a successful implementation.

Step 6: Evaluate performance

There are 2 ways to evaluate performance:

1. Percent Compliance: The simplest eMeasure is a numerator/denominator equation that measures compliance:
    a. Numerator: The number of times that the care was provided or the 'case'.
    b. Denominator (base population – exclusions): The number of times a provider had the opportunity to provide an element of recommended care to a patient or the 'population risk'.
2. Performance Against a Benchmark: Under this approach, your organization would compare your performance to a regional or national benchmark, ideally one that represents optimal care, rather than average performance.

Step 7: Report results

When presenting results, you may want to tailor the information to different audiences (stakeholders) to ensure that the information is presented in a way that is easy to understand. It is important to report performance measurement results internally so staff can be proud of where targets have been met and motivated to make changes where the data indicates a need for improvement. Also, it may be desirable or necessary to report results externally. It is important to provide context surrounding the eMeasures. The context could include why certain eMeasures were chosen or factors that influence the eMeasures that were chosen.

Step 8: Monitor performance over time

After you begin monitoring performance and making changes to improve performance in certain areas, it's important to continue to measure the postimplementation effects, to see whether the eMeasures had the intended impact and ensure that they don't result in unintended consequences in the targeted area or other areas of the care you provide.

How to use the eMeasure Implementation Toolkit

The eMeasure Implementation Toolkit describes a step-by-step process for understanding the workflow pertaining to quality improvement (QI) and Information Technology (IT) professionals' and their team, and to guide them during the process of implementing eMeasures. The toolkit is intended to serve as an essential tool for assessing your organizations workflow, and identifying opportunities for improvement.

We have prepared this toolkit for 2 primary purposes:

1. A step-by-step practical guide to implement eMeasures at an inpatient setting for:
    a. Start up or existing healthcare organizations seeking to incorporate eMeasurement into their day-to-day operations or implement eMeasures for the first time.
    b. Organizations seeking to refine an existing eMeasurement implementation process.

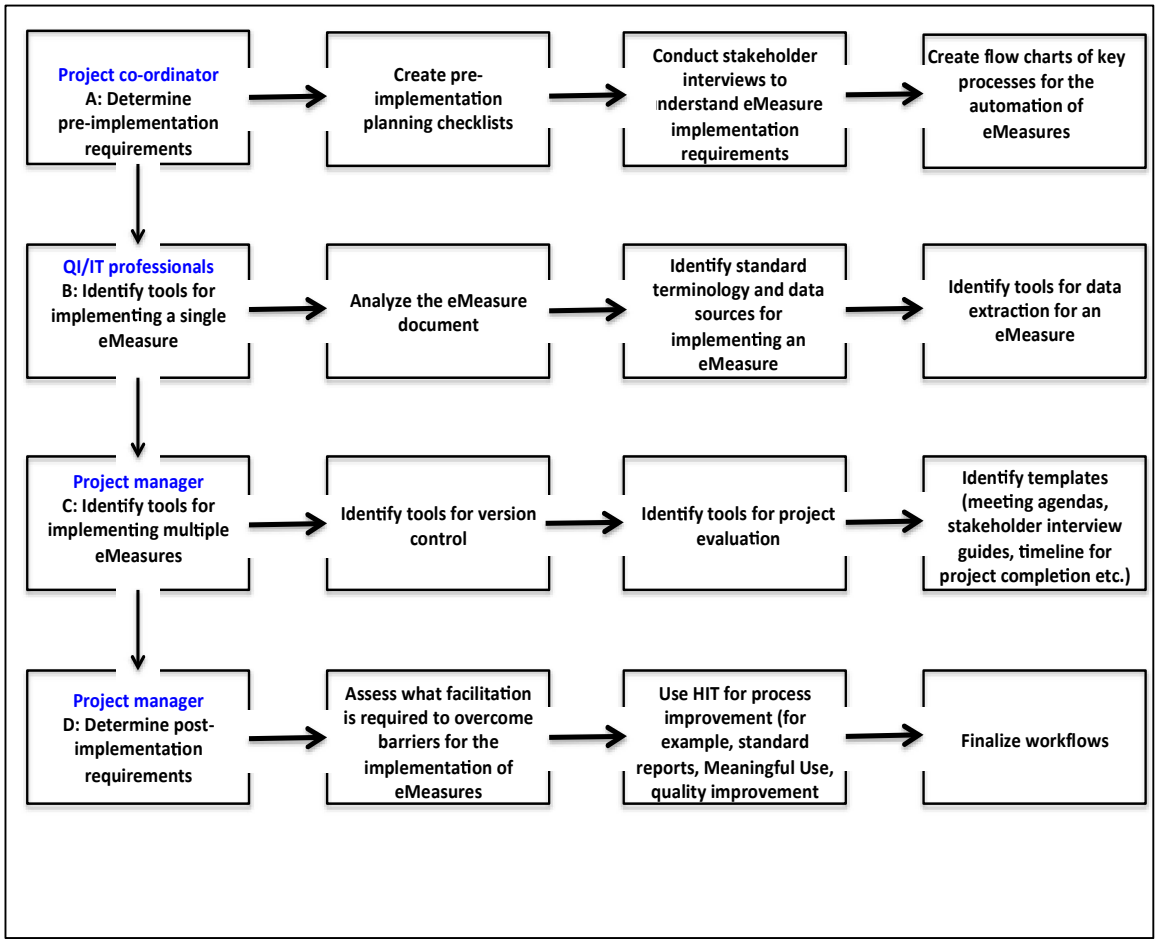
We recommend reading the toolkit through once in its entirety before getting started on your own eMeasure implementation. The toolkit contains several templates and examples

to help you understand the workflow during eMeasurement. You may choose to use these templates as points of reference for formatting your own documents.

2. While this toolkit focuses on the particular concern that inpatient healthcare settings face in implementing eMeasures, it also provides an introduction to eMeasurement for:
    a. Organizations of all types – nonprofit, government, and corporations.
    b. Students and researchers involved in quality improvement and eMeasurement.

Below are the various stages associated with HIT implementation and use of the electronic performance measures. For each stage, key workflow assessment activities are listed. When selecting a specific activity, you are then provided with an example of the tool and a more complete description of its use.

Figure 1: Overall determination of workflow requirements during the implementation of eMeasures



Section A: Determine Preimplementation Requirements

1. Preimplementation planning

Description: Preimplementation planning is a critical step in the eMeasure implementation process. Assessing workflow by using checklists for the implementation of eMeasures involves the following:

1. Determining the scope of the eMeasure implementation process
2. Listing required tasks and deliverables expected from the team members
3. Revealing the required internal and external resources and their individual roles, responsibilities and time commitments
4. Outlining project timelines
5. Defining the Project Metrics of Success

The examples of preimplementation checklists below offers a simple means of understanding the workflow during an eMeasure implementation. This can be accomplished by:

- Observing individuals as they perform their duties and recording their observations as tasks completed on the checklist. This is generally accomplished by someone who understands the duties that are being performed with an overall picture of the organization in mind, for example executives, directors, etc., who serve as key informants during an implementation process.
- Understanding workflow helps identify the current and future processes for implementing eMeasures at an inpatient hospital setting. This can be accomplished by ensuring that the various tasks recorded on a checklist are being completed in a timely manner for successful transition to eMeasures.

The examples of checklists provided in this section include:

1. Workflow assessment checklist: Examples of workflow assessment checklists can be retrieved from https://www.healthit.gov/sites/default/files/tools/nlc-ehr-implementation-go-live-planning-checklist.docx.
2. Job task diary: Examples of job task diary checklists can be retrieved from http://healthit.ahrq.gov/sites/default/files/docs/workflowtoolkit/JobTaskDiary.pdf
3. Gap assessment checklist: Examples of gap assessment checklists can be retrieved from https://www.complianceonline.com/images/supportpages/10206/13485-Gap-Checklist.pdf

Example 1: Workflow assessment checklist

☐ Review the system requirements:
- ☐ Network: devices, connectivity, security
- ☐ Hardware: computers, monitors, navigational devices, cables, printers, scanners, servers, universal power supply (UPS), storage, back-up server
- ☐ Interfaces: lab, radiology, billing/clearinghouse, admission/discharge/transfers as applicable, other
- ☐ Software:
  - ☐ Unit testing to ensure all system build is complete for:
    - ☐ Screens
    - ☐ Templates
    - ☐ Reports
  - ☐ System testing to ensure data pass from one function to another:
    - ☐ Tasking
    - ☐ Ordering
    - ☐ E-prescribing
    - ☐ Backup

☐ Check workflow and process improvements
- ☐ Ensure changes to workflows and processes are documented and practiced.
- ☐ Obtain sign off on each workflow and process map for the new HIT from each user for each process they will be performing.

☐ Review policy for use and achievement of goals with key stakeholders and reaffirm. Make any necessary changes if software precludes accomplishing goals.

☐ Review staff schedules

☐ Check training
- ☐ Every user has completed basic computer navigation, keyboarding, and other applicable training; provide refresher if necessary
- ☐ Every user has completed the training necessary to use implement eMeasures; remedy immediately if not
- ☐ Every user has a user ID and password, and they remember them

Example 2: Job task diary

Date: _____

Position: _____

Time	Activity	Function	Contact	Notes
8:00				
8:30				
9:00				
9:30				
10:00				
10:30				
11:00				
11:30				
12:00				
12:30				
1:00				
1:30				
2:00				
2:30				
3:00				
3:30				
4:00				
4:30				

Activity	Function	Contact
A1-Absent	F1-Extracting data	C1-Program Coordinator
A2-Documentation	F2-Retrieving information	C2-Physician
A3-Meeting 1+	F3-Testing process	C3-Informaticist
A4-Meeting 3+	F4-Training	C4-Developer
A5-Reviewing/Checking	F5-Scheduling	C5-Program manager
A6-Supervising	F6-Reporting problems	C6-Programmer
A7-Other	F7-Other	C7-Other

Example 3: Gap assessment checklist

Issues	Process	Task description	Cause (if known)	Caused by lack of functionality	Caused by unavailability of data	Avg. time lost per week (in hours)
Problems caused by the unavailability of structured data			Y/N	Y/N	Y/N	0.00
Problems caused by unavailability of software			Y/N	Y/N	Y/N	0.00
Problems caused by hardware			Y/N	Y/N	Y/N	0.00
Problems caused by unavailability of technical staff			Y/N	Y/N	Y/N	0.00
Other			Y/N	Y/N	Y/N	0.00

2. Stakeholder interviews for understanding implementation requirements

Description: Assessing workflow using semistructured interviews for understanding the eMeasure implementation requirements can be accomplished by:

- Engaging stakeholders individually, in-person or in small groups over the phone with virtual meeting software (LiveMeeting and Lync), using open-ended, semistructured interviews.
- Having two independent note-takers populate the interview guide, summarize the interview and then combine the two summaries into a single summary through a consensus process. The single summarized interview is then sent to each interviewee for review and editing (validation). A collective set of validated summaries to generate preliminary themes (codes) to answer research questions is used to understand the eMeasure implementation requirements.
- Applying thematic analysis, a method for identifying, analysing, and reporting patterns (i.e., themes) to the information retrieved from the semistructured interviews [24] can be used to generate patterns in the stakeholder interviews. “Applied” thematic analysis, involves the following: first, two independent note takers transcribe

the interviews during the stakeholder interview process and each independent note taker creates a summary of the transcriptions. From the transcriptions, patterns or themes are identified to answer research questions for understanding the eMeasure implementation requirements.

Additional information about semistructured interviews can be retrieved from https://cahps.ahrq.gov/quality-improvement/improvement-guide/analysis-of-results/Deeper-Qualitative-Analyses/Stakeholders-Feedback/SemiStructuredInterviews.html

The examples of semistructured interview guides provided in this section include:

1. Interview guide for information technology professionals
2. Interview guide for quality improvement professionals

Example 1: Example of a semistructured interview guide for information technology professionals

Semistructured Interview Guide Questions for Information Technology Professionals

General subject Information:

1. How long have you worked at your organization?
2. How long have you been involved in quality improvement?
3. Does this represent the total time you have been in your organization?
4. What is your current position title?
5. Please briefly describe your current roles and responsibilities.

Stakeholder Engagement Questions:

6. From the perspective of automation of performance measures, what data sources do you use to obtain electronic data?
7. What data is collected, by whom is it collected and how do you get it?
8. Please describe any initial data manipulation or data cleaning that is required prior to analyzing the data for performance measures?
9. Please describe any missing data fields that you encounter during the process of data analysis for the purpose of automation of performance measures.
10. Please describe the software packages and tools that are used to analyze the data for the purpose of automation of performance measures?
11. Please describe the final output after data analysis has been completed for performance measures?
12. If this process is automated or semi automated what are job titles of those individuals involved?
13. What are the barriers to the automation performance measures?
14. Is there something that could be changed or added that would enhance automation or make the processes better?

Final questions and closing

15. Do you have any other thoughts that you would like to share?

Example 2: Example of a semistructured interview guide for quality improvement professionals

Semistructured Interview Guide Questions for Quality Improvement Professionals

General subject Information:

1. How long have you worked at your organization?
2. How long have you been involved in quality improvement?
3. Does this represent the total time you have been in your organization?
4. What is your current position title?
5. Please briefly describe your current roles and responsibilities.

Stakeholder Engagement Questions:

6. Based on my research I understand that VA is moving away from manually abstracted data for quality measurement for inpatient heart failure with the aim of using an automated process. Are you involved in this and if yes, please explain your role in this transition?
7. What is your involvement with Meaningful Use (MU) and how has it impacted you?
8. From your perspective, are there barriers to automation of performance measures?
9. In light of these potential barriers, what suggestions do you have for their resolution?
10. During the transition to automated performance measures, what are the job titles of individuals in the VA that you think will be involved in this transition?
11. Are there other people you recommend I talk with to gain more knowledge about this automation of heart failure quality measures?

Final questions and closing

12. Do you have any other thoughts that you would like to share?

3. Flowcharts for identifying key process during the implementation of eMeasures

Description: Assessing workflow using flowcharts/workflow diagrams during the implementation of eMeasures
A flowchart/workflow diagram provides a meaningful visualization of workflow. This can be accomplished by:

- Conveying the sequence and interactions of activities and tasks and thus clarifying key work processes
- Identifying who performs what activities and tasks
- Recognizing activities and tasks that should be performed by another person, and
- Identifying unnecessary or non-value added activities and tasks that could be eliminated

Potentially negative consequences that may occur after eMeasure implementation can easily be overlooked due to the widely varied and multiple tasks performed at an inpatient setting. The detailed workflow that is captured and conveyed in flowcharts provides useful information to help eMeasurement professionals, prepare for implementation.

Flowcharting will help you identify the work processes your eMeasurement team must support. You can accomplish this by:

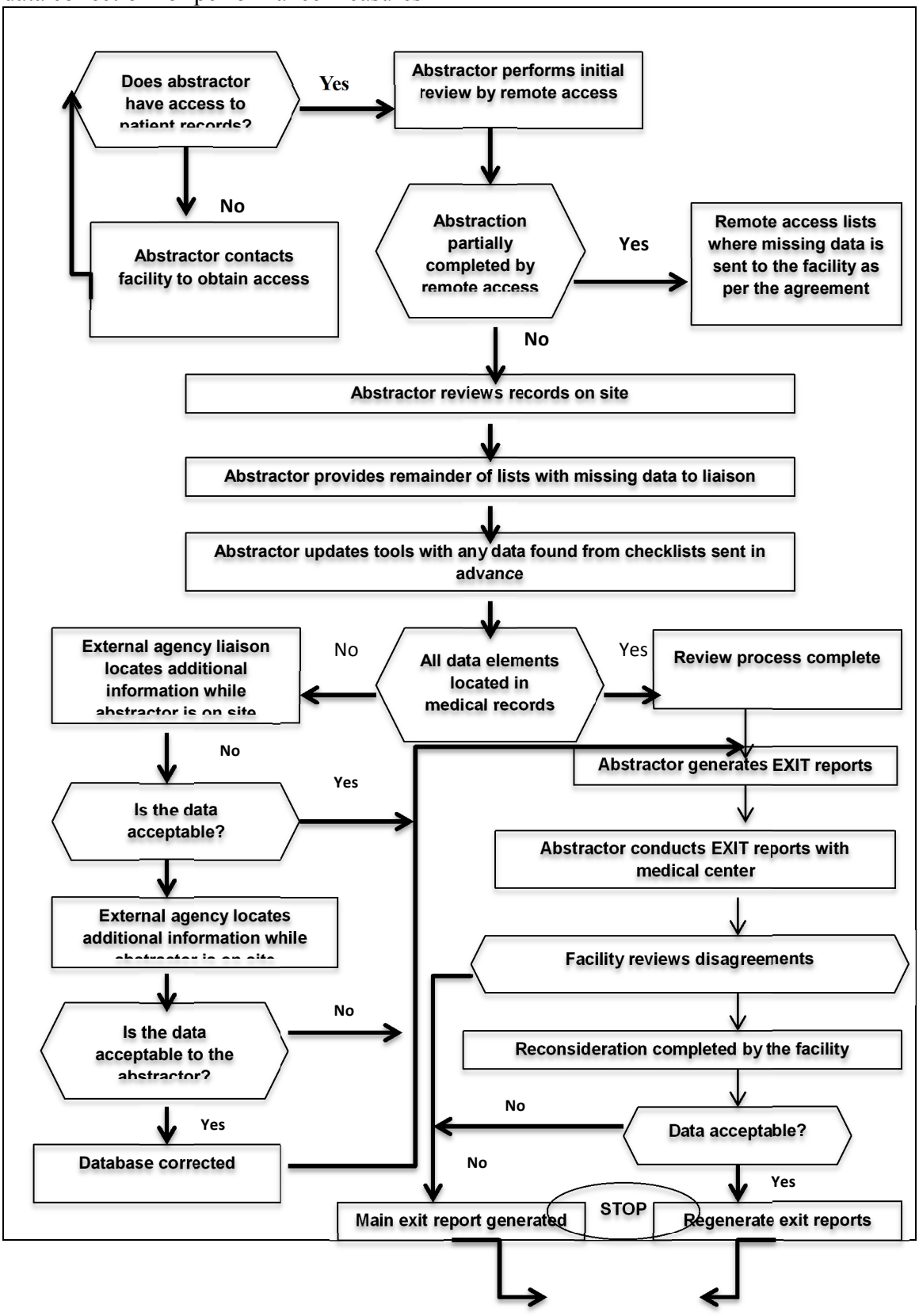
- Including the work processes in your request for proposal
- Requiring that the key workflow processes are supported by the system

Flowcharting will also help you identify tasks and processes that can become more efficient with the use of the health IT application.

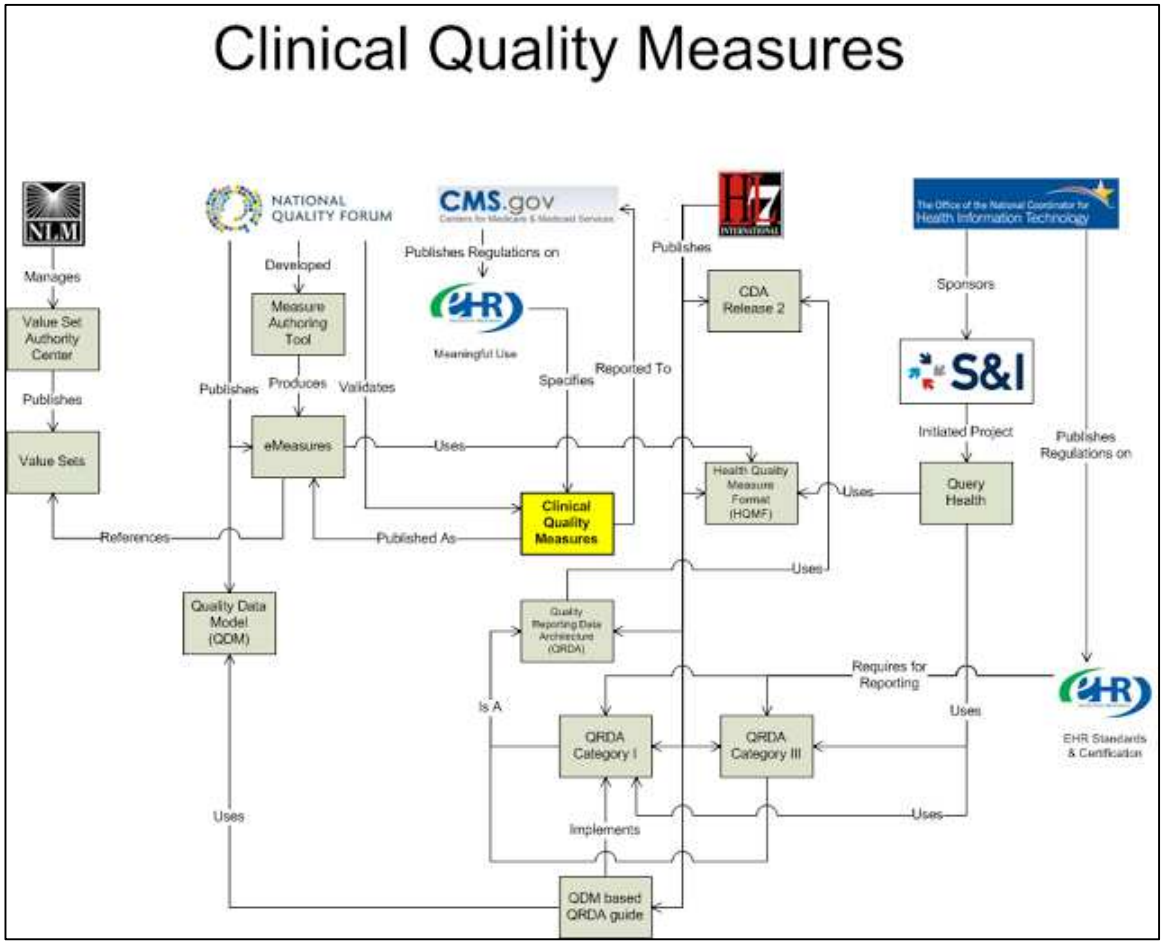
The examples of flowcharts provided in this section can be retrieved from:

1. Data collection for performance measures: Examples of flowchart/workflow diagram for the general process of routine data collection for performance measures can be retrieved from http://www.va.gov/vhapublications/ViewPublication.asp?pub_ID=2951
2. Interaction of quality improvement organizations for eMeasurement: Example of a flowchart/workflow diagram for the interaction of various quality improvement organizations to support the eMeasurement initiative can be retrieved from http://motorcycleguy.blogspot.com/2012/11/hashtag-soup-relating-qdm-hqmf.html
3. Classification process for the heart failure performance measure: Example of a flowchart/workflow diagram for classifying heart failure patient's care as meeting the performance measure or not meeting the performance measure can be retrieved from http://medicine.utah.edu/bmi/documents/seminar-slides/2014-03-06_garvin_meystre.ppt

Example 1: Example of a flowchart/workflow diagram for the general process of routine data collection for performance measures



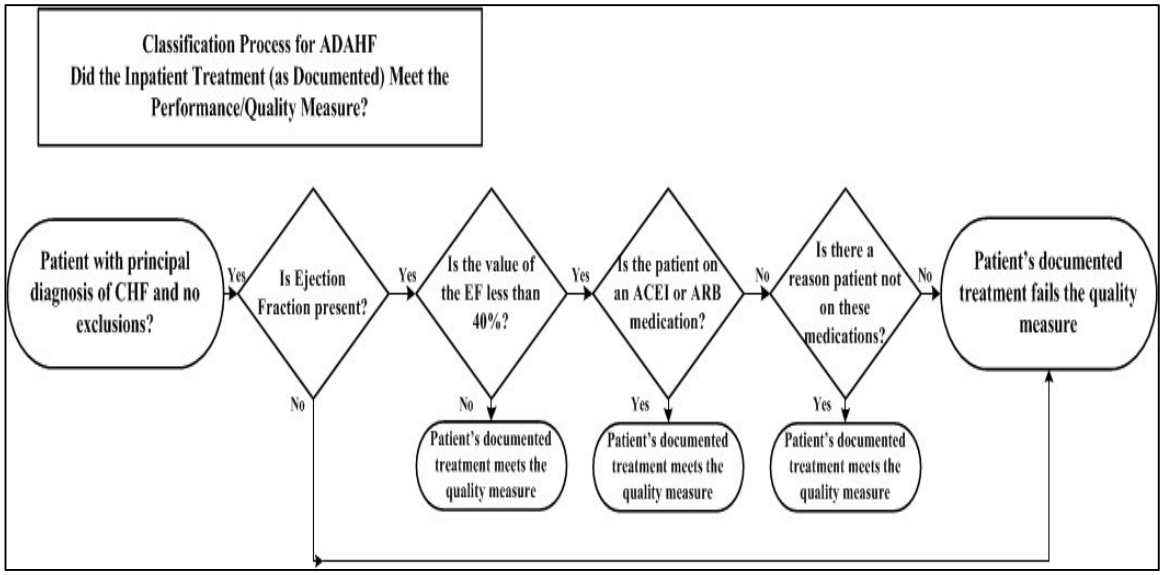
Example 2: Example of a flowchart/workflow diagram for the interaction of various quality improvement organizations to support the eMeasurement initiative



* QDM is the National Quality Forum's (NQF) Quality Data Model. It is an information model representing the essential data needed to generate quality measures.
* eMeasures is a term describing the electronic representation of quality measures. In common use, it often refers to the electronic measures that NQF developed to represent the quality measures required under the ONC & CMS Meaningful Use regulations. It is also used to refer to the HL7 HQMF.
* HQMF stands for Health Quality Measure Format. This is an HL7 Draft Standard for Trial Use (DSTU). The DSTU is presently being reballoted by HL7 for a second release. This is an electronic format for the representation of quality measures. Release 1 is currently used by NQF to deliver eMeasures for Meaningful Use.
* Query Health is an ONC Standards and Interoperability Framework project whose purpose is to develop standards to enable sending the questions to the data. Its key goal is to enable clinical research.
* QRDA stands for Quality Reporting Data Architecture. If HQMF/Query Health/eMeasures represent the question, then QRDA represents the answers. QRDA is an HL7 implementation guide on CDA Release 2 that describes the format for reporting quality data on a single patient (Category I), or aggregate results on multiple patients

(Category III).
* MAT is the Measure Authoring Tool. This is a tool for creating eMeasures currently being maintained by NQF, but which will be transitioned to a new maintainer in early 2013.
* VSAC is the NLM Value Set Authority Center, where value sets used for eMeasures and other standards used in Meaningful Use regulation are published.

Example 3: Example of a flowchart/workflow diagram for classifying heart failure patient's care as meeting the performance measure or not meeting the performance measure



Section B: Tools for implementing a single eMeasure

1. Analyzing the eMeasure document

Description: The guide for reading Eligible Provider (EP) and Eligible Hospital (EH) Measures provides guidance for understanding and using the electronically specified measures identified as 'retooled' that were published as Eligible Provider (EP) and Hospital Measures in .xml and .html format. Collecting and reporting accurate, comparable healthcare performance data is complex and largely a time consuming, manual process. Much of the information required for performance measurement is available in electronic health records (EHRs) but it has not been routinely available for export and use to compute measures. NQF has published 113 eMeasures in a human readable format for public comment and review. These eMeasures are geared towards providing a less-burdensome approach to gathering and publicly reporting performance information. eMeasures have the potential to support Meaningful Use, value-based purchasing, and other innovative programs, however, their implementation remains challenging. This guide is intended to assist the reader in interpreting and understanding eMeasures.

The guide for reading Eligible Provider (EP) and Eligible Hospital (EH) Measures version 4 (May 2013) can be retrieved from:
http://www.cms.gov/Regulations-and-Guidance/Legislation/EHRIncentivePrograms/Downloads/Guide_Reading_EP_Hospital_eCQMs.pdf

Each measure folder contains **four** files that are necessary to understand the electronic measure.

1. The HQMF standard .xml format (example: NQF_nnnn_XML _Updated_Dec_2011.xml) The HQMF file contains the eMeasure specifications including measure background information, required data elements, measure logic, and measure calculation instructions. This file uses the eMeasure Health Quality Measure Format (HQMF).
2. A *style sheet,* a related file that allows the .xml format to open directly in a web browser (example: eMeasure_Updated_Dec_2011.xsl). It is best to download these files into the same folder on your system.
3. The human readable format of the eMeasure in **html** to open directly in a web browser. This file does not include the underlying .xml format (example: NQF_nnnn_Human Readable_Updated_Dec_2011.html).
4. The Excel spreadsheet (example: NQF_nnnn_Value Sets_Updated_Dec_2011.xls) with the value sets (synonymous with code sets) used for the measure. The value sets also contain code descriptors for all taxonomies except CPT.

The figure below is an example with headers displayed to show retooled Hospital Measure 0081 Angiotensin converting enzyme (ACE) inhibitor or Angiotensin Receptor Blocker (ARB) Therapy for Left Ventricular Systolic Dysfunction (LVSD). The figure includes eMeasure name, eMeasure Id, version number, eMeasure Set Id, available date, measurement period, measure steward, endorsed by, description, copyright, measure

scoring, measure type, stratification, risk adjustment, data aggregation, rationale, clinical recommendation statement, improvement notation, measurement duration, reference, guidance and supplemental data elements.

Example 1: Example of a guide for reading Eligible Provider (EP) and Eligible Hospital (EH) Measures to show the retooled hospital measure 0081 for heart failure.

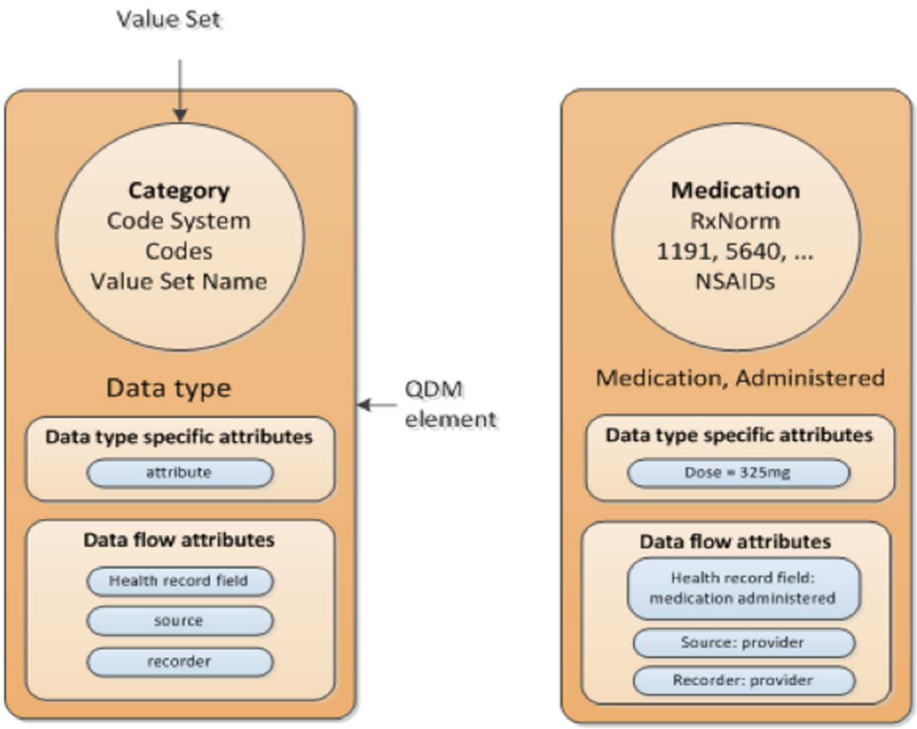
EMeasure Name	Heart Failure (HF): Angiotensin-Converting Enzyme (ACE) Inhibitor or Angiotensin Receptor Blocker (ARB) Therapy for Left Ventricular Systolic Dysfunction (LVSD)	**EMeasure Id**	Pending
Version Number	1	**Set Id**	Pending
Available Date	No information	**Measurement Period**	January 1, 20xx through December 31, 20xx
Measure Steward	American Medical Association – Physician Consortium for Performance Improvement		
Endorsed by	National Quality Forum		
Description	Percentage of patients aged 18 years and older with a diagnosis of heart failure and LVSD (LVEF < 40%) who were prescribed ACE inhibitor or ARB therapy.		
Measure scoring	Proportion		
Measure type	Process		
Rationale	In the absence of contraindications, ACE Inhibitors or ARBs are recommended for all patients with symptoms of heart failure and reduced left ventricular systolic function, as measured by left ventricular ejection fraction (LVEF). Both drugs have been shown to decrease mortality and hospitalizations. Heart Failure: Angiotensin-Converting Enzyme (ACE) Inhibitor or Angiotensin Receptor Blocker (ARB) Therapy for Left Ventricular Systolic Dysfunction (LVSD).		
Clinical Recommendation Statement	Angiotensin converting enzyme inhibitors are recommended for all patients with current or prior symptoms of HF and reduced LVEF, unless contraindicated. (Class I Recommendation, Level of Evidence: A)(ACC/AHA) Angiotensin II receptor blockers approved for the treatment of HF are recommended in patients with current or prior symptoms of HF and reduced LVEF who are ACEI-intolerant. (Class I Recommendation, Level of Evidence: A) (ACC/AHA) Angiotensin II receptor blockers are reasonable to use as alternatives to ACEIs as first-line therapy for patients with mild to moderate HF and reduced LVEF, especially for patients already taking ARBs for other indications (Class IIa Recommendation, Level of Evidence: A) (ACC/AHA).		
References			
Definitions			

Description: The QDM describes clinical concepts in a standardized format to enable electronic quality performance measurement in support of operationalizing the Meaningful Use Program of the Health Information Technology for Economic and Clinical Health Act. This model is the backbone for representing criteria used in quality measures by stakeholders involved in electronic quality measurement development and reporting. Stakeholders of the QDM include measure developers, federal agencies, Health Information Technology (HIT) vendors, standards organizations, informatics experts, providers, and researchers. The QDM is intended to enable automation of structured data captured through routine care in electronic health records (EHR), personal health records (PHR), and other electronic clinical sources. It provides a structure for describing clinical concepts contained within quality measures in a standardized format, allowing individuals (e.g., providers, researchers, or measure developers) who monitor clinical performance and outcomes to communicate information concisely and consistently. The QDM is one of several standards in the broader electronic Clinical Quality Improvement (eCQI) landscape and operates concurrently with changing measure concepts, tools, and other standards for electronically representing quality measures.

The guide for the Quality Data Model for eMeasures can be retrieved from:
http://www.healthit.gov/sites/default/files/qdm_4_0_final.pdf

Example 2: Example of a guide for accessing information about the Quality Data Model for eMeasures

Figure 1. QDM Element Structure



2. Identifying standard terminology and data sources for implementing an eMeasure

Description: For healthcare systems to be interoperable-to exchange data in a uniform format that can be integrated automatically-they require medical terms that are universally understood. Standardized clinical terminologies supply that framework. They represent the meaning of medical terms that can be uniformly understood by all users of EHR systems inside and outside of healthcare enterprises.
Messaging standards, content standards, and terminologies in EHRs today include:

- ***The Continuity of Care Record (CCR)***, being developed by the American Society for Testing and Materials (ASTM). It contains a uniform healthcare summary of the patient's healthcare that is accessible to both clinicians and patients. The CCR will be exchanged whenever a patient is being transferred or treated by other clinicians. Benefits include greater continuity of care, reduced medical errors, and interoperability. ASTM also has other standards related to the content of the EHR.
- ***Health Level Seven (HL7)***, which has been adopted as an EHR messaging standard for the transmission of consistent data between both the sender and receiver of the data. It has also been adopted to standardize immunizations, units of measure, and text-based documents. The HL7 Clinical Data Architecture has been adopted to standardize the structure and meaning of clinical text documents such as discharge summaries and progress notes. It ensures that the text document maintains the same content and structure when shared between healthcare entities. It uses coded vocabularies such as Systematized Nomenclature of Medicine Clinical Terms (SNOMED CT) and Logical Observation Identifiers, Names, and Codes (LOINC) to encode concepts in the documents. It is both machine and human readable. HL7 has also been tasked with developing a standardized functional model for EHR systems. The goal is to produce a standardized model for use by system builders to help accelerate adoption of EHR systems. The model requires that consistent terminologies be used to provide a standardized language for all EHR systems. EHR systems that use local terminologies will be required to map these to the specified standard terminologies.
- ***LOINC*** provides a universal method to identify and encode laboratory and clinical observations for electronic exchange and pooling of results. It was adopted as the federal interoperability standard for lab test orders and drug label section headers. It provides a uniform means of sharing standardized lab test orders between healthcare entities, especially between facility-based and outsourced laboratories. It is also being used to encode other healthcare information, such as text document titles, mental health instruments, ventilator settings, and radiology exams.
- ***SNOMED CT*** provides a common language for indexing, storing, retrieving, and aggregating clinical data across specialties and sites of care. It contains more than 993,000 descriptions for clinical concepts. The National Committee on Vital and Health Statistics recommended SNOMED CT as the standard for non-laboratory interventions and procedures, laboratory test results, anatomical locations, diagnoses, problem lists, and nursing care. The National Library of Medicine purchased a license for SNOMED CT that allows its free use in the US. This purchase is intended to accelerate the adoption and interoperability of EHR systems.
- ***National Council for Prescription Drug Programs (NCPDP)*** Script has been

adopted as the standard for electronically transmitting prescription data between prescribers and pharmacies. CMS has mandated the use of NCPDP by all Medicare plans. It is also the official standard for HIPAA pharmacy claims. Benefits include reduced prescription errors and increased prescription legibility.

Additional information about standardized clinical terminologies to support eMeasurement and Meaningful Use, can be retrieved from:
http://files.himss.org/FileDownloads/2014-05-29%20Orchard%20Software%20Structured%20Data.pdf

Example 1: Example of Messaging standards, content standards, and terminologies for extracting an eMeasure, in EHRs today include
Clinical terminology for NQF eMeasures can be summarized as:

Data from	**Standard terminology**
Diagnosis/Problems	ICD 9/SNOMED
Procedures	ICD 9/CPT-4/HCPCS/LOINC
Medications	RxNorm
Lab Results	LOINC
E-Prescribing	NCPDP Version 8.0
Immunizations	HL7 code set CVX
Data Exchange	HL7
Patient Summary	CCD/CCR

Description: There are several data sources available for collecting eMeasures; generally different data sources require different sets of measure specifications, due to the structure of the systems storing the data. The primary data sources for extracting an eMeasure are:

- Electronic health record (EHR) data
- Administrative Data/Claims (inpatient or outpatient claims)
- Administrative Data/Claims Expanded (multiple-source)
- Paper medical record

Electronic health record (EHR) data: It include more robust clinical and administrative data from the patient care documentation process as recorded though the use of an electronic health record (EHR) or health information registry. It is anticipated that many meaningful, accurate and reliable eMeasures can be computed relying on the expanded EHR data. The eMeasure documents currently include relevant coding and logic to query an EHR for data and compute the measure provided in words and tables consistent with the NQF's Quality Data Set (QDS) framework. It is understandable that not all EHRs in use have the functionalities to support every data element required for identifying the data sources for eMeasures and, in some cases, such functionalities are available but are not being used. It is important to prioritize eMeasures for EHR integration in order to provide a road map for EHR developers and users of EHR systems. The eMeasures provide the context for the various measure data elements, the corresponding codes from the appropriate clinical code-sets, and the logic for the measure calculation.

Electronic administrative data/claims*:* Inpatient or outpatient claims data includes data typically used to bill for physician or physician group services, including diagnosis (ICD-9-CM) codes and service/procedure (CPT Category I) codes, as well as supplemental tracking codes (CPT Category II) developed specifically for performance measurement. Until expanded and linked administrative databases or electronic health record systems are more widely available and utilized, various pay-for-performance and pay-for-reporting programs (including the Physician Quality Reporting Initiative [PQRI] of the Centers for Medicare and Medicaid Services [CMS]) continue to rely on this type of claims data. The specifications included here are for use with either inpatient or outpatient claims, depending on the setting of the eMeasure.

Expanded (multiple-source) administrative data: It includes administrative data routinely captured during the course of care delivery through either payment or care documentation purposes and accessible through the use of large electronic databases. Multiple organizations may gather such electronic data, including health plans (e.g., medical claims), health systems (e.g., patient registries), and large data aggregators or warehouses. In addition to physician claims data (as described above), these databases may aggregate data from multiple care settings (e.g. outpatient, inpatient, emergency department and other sites of care) and may include data elements not typically available on physician claims (e.g., pharmacy and laboratory data) or at the point of care. While this data source enables the use of large data sets that can be joined and analyzed through complex, programmed algorithms, most data are currently confined to coded diagnosis and procedural claims and typically do not include more robust clinical detail.
Administrative claims data collection requires users to identify the eligible population (denominator) and numerator using codes recorded on claims or billing forms (electronic or paper). Users report a rate based on all patients in a given practice for whom data are available and who meet the eligible population/denominator criteria.

Paper medical records: Data can be collected manually, abstracted either from paper medical records or by retrospective manual review of clinical encounter information contained in electronic medical records. Medical record data, despite being more expensive to acquire, can provide much richer clinical information usually not available in electronic transactional data; alongside typical administrative claims information from the patient encounter.

An example of a selection of data sources for eMeasures can be retrieved from:
http://www.effectivehealthcare.ahrq.gov/ehc/assets/File/Ch_8-User-Guide-to-OCER_130129.pdf

Example 2: Example of a data source template for implementing an eMeasure

Data Sources - As you think through your study design, you will need to consider where you will obtain your data. Potential sources of data include:
A. Study Databases
B. Paper Charts
C. Electronic Data Repositories and EMR databases
- -Lab System
- -Pharmacy System
- -Billing System
- -Registration System
- -Radiology Information System
- -Pathology Information System
- -Health Information Exchange
- -Personal Health Record
- -EMR data (ICD/Procedures)
- -Administrative

D. Pharmacy Logs
E. Disease Registries
F. Prescription Review Databases
G. Direct Observation Databases
H. Real-Time Capture from Medical Devices (Barcoders, and so on)
I. Hospital Quality Control Program (Hospital may already be collecting this information for quality reporting.)

Description: **Heart Failure eMeasure (0081)** is defined as the Angiotensin converting enzyme (ACE) inhibitor or Angiotensin Receptor Blocker (ARB) Therapy for Left Ventricular Systolic Dysfunction (LVSD).Percentage of patients aged 18 years and older with a diagnosis of Heart Failure (HF) and LVSD (Left Ventricular Ejection Fraction (LVEF) <40%) who were prescribed ACE inhibitor or ARB therapy.

Rationale: In the absence of contraindications, ACE inhibitors or ARB therapy are recommended for all patients with symptoms of Heart Failure (HF) and reduced Left Ventricular Systolic Dysfunction (LVSD), as measured by Left Ventricular Ejection Fraction (LVEF). This measure is to be reported for all patients with current or prior symptoms of HF and reduced LVEF, unless contraindicated, i.e. reason for no medications is present. According to the American College of Cardiology (ACC) or American Heart Association's (AHAs) Class I Recommendation, Level of Evidence A [25, 26] Angiotensin II receptor blockers approved for the treatment for HF are recommended in patients with current or prior symptoms of HF and reduced LVEF who are ACEI-intolerant. Angiotensin II receptor blockers are reasonable to use as alternatives to ACEIs as first line therapy for patients with mild to moderate HF and reduced LVEF, especially for patients already taking ARBs for other indications. Both drugs have been shown to decrease mortality and hospitalizations [27-29].

Population criteria:
Initial patient population: The number of patients 18 years and older with a diagnosis of HF.
Numerator statement: Patients who were prescribed ACE inhibitor or ARB therapy either within a 12 month period when seen in an outpatient setting or at hospital discharge.
Denominator statement: All patients aged 18 years and older with a diagnosis of HF with a current or prior LVEF<40%. LVEF<40% corresponds to qualitative documentation of moderate or severe dysfunction.
Exclusion criteria: All of the below conditions were factors used to exclude patients from this project so it is unlikely that these factors will be mentioned in the documents. Annotate any of these exclusion factors if in the unlikely event they appear in the documents and then stop any further annotation.

1. Clinical trial - participation for ACEI or ARB medications
2. Comfort measures – outlined in advanced directives
3. Heart assist device or heart assist system
4. Does not include pacemakers or defibrillators
5. Heart transplant – was performed during this hospital stay. Past transplant is not an exclusion.
6. Heart-lung transplant– was performed during this hospital stay. Past transplant is not an exclusion**.**
7. Replacement heart or system

Data elements for NQF 0081 with category, format, and automation method:
The following generalizable documents are used for the extraction of data elements for NQF 0081 HF eMeasure:

- Paper medical record/flow-sheet
- Electronic administrative data/claims
- Electronic clinical data
- Electronic Health/Medical Record
- Registry data

The following data sources are used within the VA for the extraction of data elements for NQF 0081 HF eMeasure:

- Pharmacy benefits
- History and physical
- Discharge summary
- Progress note
- Consultation note

Additional information about the data elements present in the HF 0081 eMeasure, can be retrieved from:
https://manual.jointcommission.org/releases/archive/TJC2010B/HeartFailure.html

Example 3: Example for identifying the type of data elements from the HF eMeasure XML file (structured, unstructured, semistructured), using SQL or NLP

Data Element	Category*	Format	Extraction
Admission Date	Demog/admin	Structured	SQL
Birthdate	Demog/admin	Structured	SQL
Clinical Trial	Demog/admin	mixed, multiple locations	complex
Comfort Measures Only	Risk/exclusion	Structured	SQL
Discharge Date	Demog/admin	Structured	SQL
Discharge Status	Demog/admin	Structured	SQL
ICD-9-CM Other Diagnosis Codes	Diagnosis	Structured	SQL
ICD-9-CM Principal Diagnosis Codes	Diagnosis	Structured	SQL
LVSD	Lab/radiology	text, 1 document	complex
ACEI prescribed at discharge	Treatment	text, multiple locations	complex
ARB prescribed at discharge	Treatment	text, multiple locations	complex
Reason for NO ACEI and NO ARB at discharge	Risk/exclusion	text, multiple locations	complex

***Categories:** demographic/administrative data (demog/admin), lab or radiology tests (lab/radiology), treatment, diagnosis, risk or exclusion (risk/exclusion)

Description: Coding is rapidly changing. One of the biggest changes is the expansion of coding from its traditional role of translating narrative clinical text into diagnosis and procedure codes. Coding must meet an emerging need to capture healthcare data in a standard format that has universal meaning and can be applied both at the individual and aggregate levels. ICD-9-CM (International Classification of Diseases, 9th Revision, Clinical Modification) coding system has two parts. ICD-9 Diagnostic Codes are used to code signs, symptoms, injuries, diseases, and conditions. ICD-9 Procedure codes are used to code hospital inpatient procedures. The Healthcare Common Procedure Coding System (HCPCS) is solely a procedure coding system that is owned and developed by the American Medical Association. It consists of Level 1 Current Procedural Terminology (CPT) codes and Level 2 codes, which provide standardized coding for submitting claims for a variety of services, supplies, and equipment that are not identified by CPT codes (e.g., ambulance services).

Additional information about the standard terminology codes for the HF 0081 eMeasure, can be retrieved from:
http://www.qualityforum.org/Projects/c-d/Cardiovascular_Endorsement_and_Maintenance_2010/Measure_Specs_-_Phase_II.aspx

Example 4: Example for identifying the standard terminology codes for the eligible cases of patients with HF from the HF eMeasure XML file, using SQL.

Clinical terminology standard	Code
Diagnosis for heart failure (ICD-9-CM)	402.01, 402.11, 402.91, 404.01, 404.03, 404.11, 404.13, 404.91, 404.93, 428.0, 428.1, 428.20, 428.21, 428.22, 428.23, 428.30, 428.31, 428.32, 428.33, 428.40, 428.41, 428.42, 428.43, 428.9
Diagnosis for heart failure (ICD-10-CM)	I11.0, I13.0, I13.2, I50.1, I50.20, I50.21, I50.22, I50.23, I50.30, I50.31, I50.32, I50.33, I50.40, I50.41, I50.42, I50.43, I50.9
Patient encounter during the reporting period (CPT)	99201, 99202, 99203, 99204, 99205, 99212, 99213, 99214, 99215, 99238*, 99239*, 99304, 99305, 99306, 99307, 99308, 99309, 99310, 99324, 99325, 99326, 99327, 99328, 99334, 99335, 99336, 99337, 99341, 99342, 99343, 99344, 99345, 99347, 99348, 99349, 99350
Two CPT II codes are required on the claim form	4009F (ACE inhibitor or ABR therapy prescribed), 3021F (LVEF <40% or documentation of moderately or severely depressed Left Ventricular Systolic Function – LVSF)

3. Identifying Structured Query Language (SQL) tools for extracting structured data for an eMeasure

Description: The need for analyzed healthcare data to improve delivered care and to better meet the Meaningful Use requirements for automated quality measurement is in great demand. There is an even greater requirement for better health IT systems that allow information technology professionals and quality measurement professionals to sift through large amounts of crude data and turn it into 'meaningful' information.

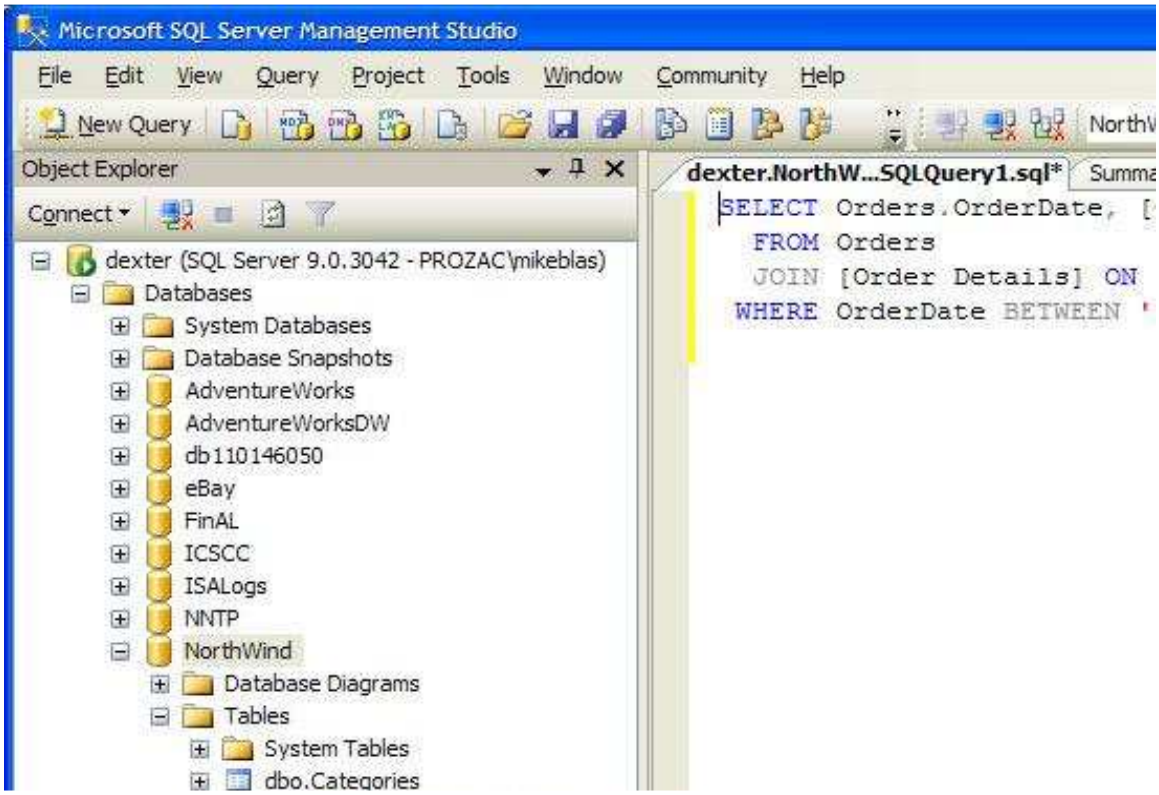
In many healthcare organizations, spreadsheets and similar file management systems and applications are still predominantly used for collecting and analyzing patient data. Though effective as personal productivity tools, spreadsheets for example MS Excel have limitations. They are not collaborative planning applications, nor are they designed to handle large volumes of data. Planning for and managing the requirements of Meaningful Use demand secure, accurate consolidation of large amounts of disparate data, while supporting collaboration across a geographically dispersed enterprise. This is where file management systems and applications such as Excel spreadsheets fall short.

The majority of database solutions in any healthcare enterprise are relatively simple. By relying on products such as Structured Query Language (SQL), in conjunction with the SQL Server, makes the automated extraction of structured data elements easier for the purpose of eMeasurement. The SQL environment provides tools to configure, manage, and administer eMeasurement requirements. It is better suited to provide more complex solutions that allow healthcare organizations to transition to electronic measurement more efficiently. There are a large number of SQL tools that are currently available, but choosing the right tool for ease of transition to eMeasures depends on a large number of factors, such as cost, data availability, Electronic Medical Record system in use, etc.

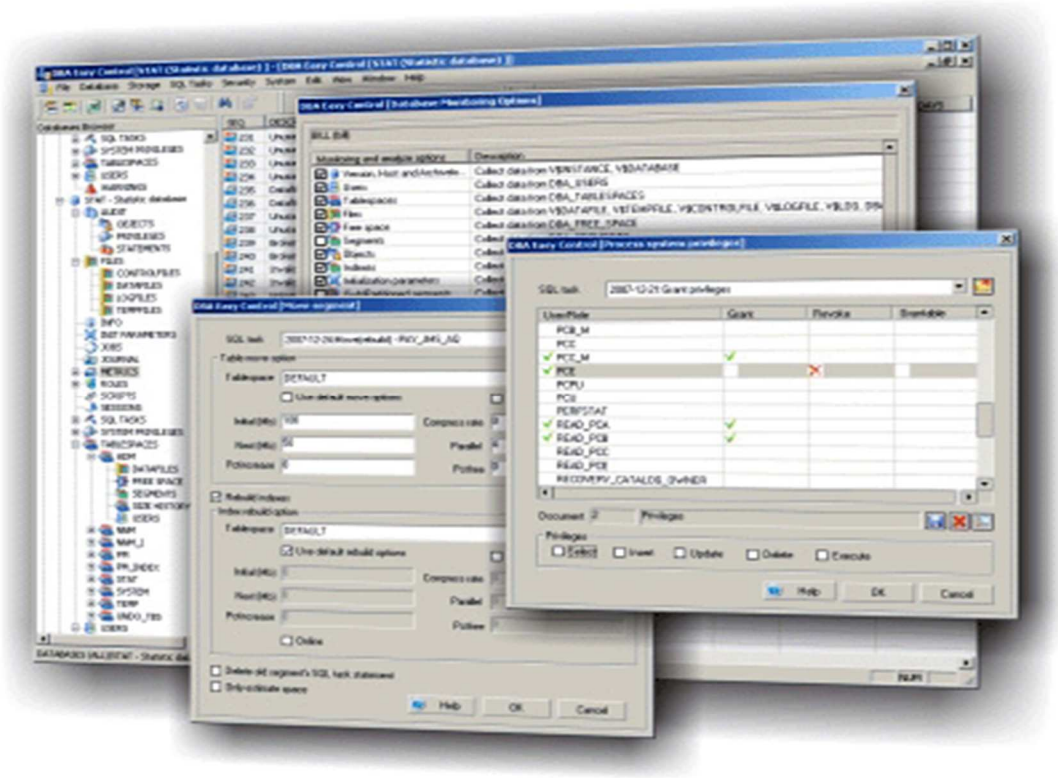
The list of Structured Query Language (SQL) tools for the extraction of structured data elements from the Electronic Health Record (EHR), can be retrieved from:

1. Microsoft SQL Server Management Studio
   http://www.microsoft.com/en-us/download/details.aspx?id=7593
2. Oracle Database Management Suite
   https://www.oracle.com/downloads/index.html
3. MySQL Workbench
   https://www.mysql.com/products/workbench/

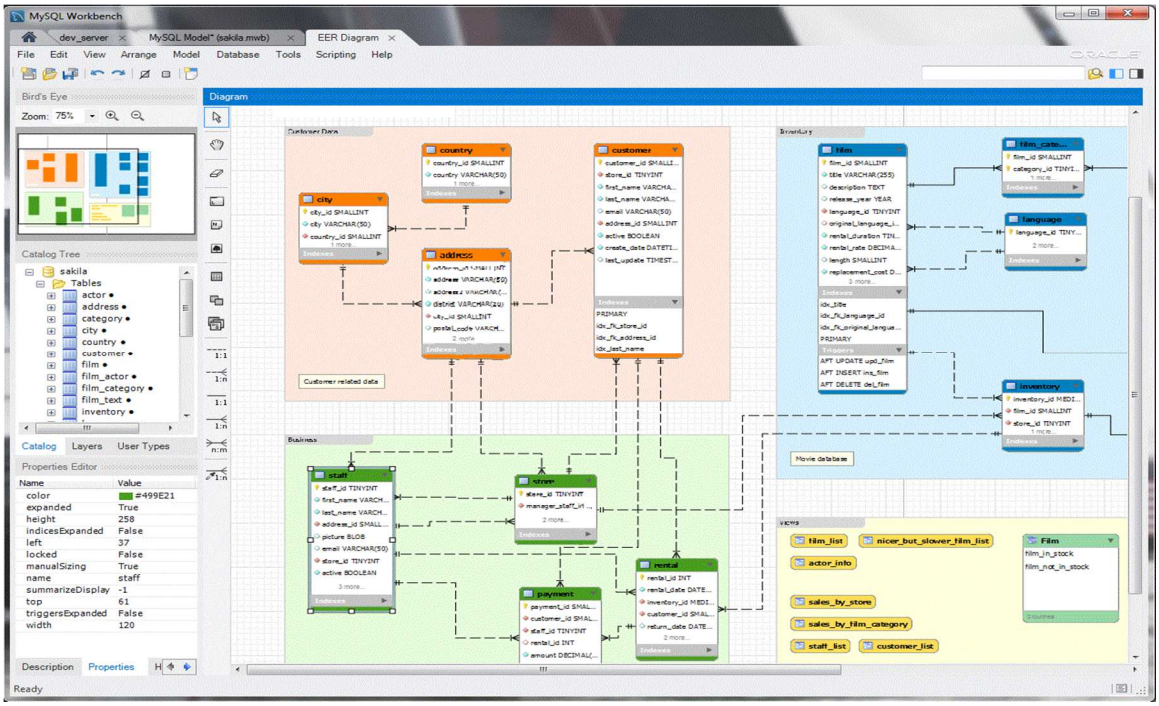
Example 1: Screenshot of the Microsoft SQL Server Management Studio



Example 2: Screenshot of the Oracle Database Management Suite



Example 3: Screenshot of the MySQL Workbench



4. Identifying Natural Language Programming (NLP) tools for extracting free text from clinical notes for eMeasurement

Description: Human abstraction is time consuming and expensive. The free text present in electronic medical notes is considered to be a rich source of data for eMeasurement. Furthermore, readily adaptable information technologies exist to automate and reliably extract this type of information from free-text data. Information extraction and information retrieval methods using natural language processing (NLP) and machine learning have been successfully applied to electronic notes to extract free text data from clinical notes. The value of text data has been shown in several clinical and informatics domains including electronic performance measurement, and quality improvement.

Natural language processing (NLP) approaches have been developed to identify patients with heart failure to extract clinical concepts related to heart failure from radiology and echocardiogram reports. Natural language processing (NLP) is defined as "the formulation and investigation of computationally effective mechanisms for communication through natural language." Information extraction (IE), one of areas of NLP, is "the process of scanning text for information relevant to some interest, including extracting entities, relations, and, most challenging, events." Clinical NLP applications have been used to extract diagnoses and other findings from clinical text documents with reasonable accuracy. For example, information extraction with NLP methods has been used to accurately identify clinical concepts in medical texts including comorbidities pathology reports and findings, adverse events, and pneumonia cases. IE retrieves predefined types of information from text. NLP techniques can be used to determine the context of care, such as timing of events (temporality), and identify negated events such as "no allergies" and other modifying factors.

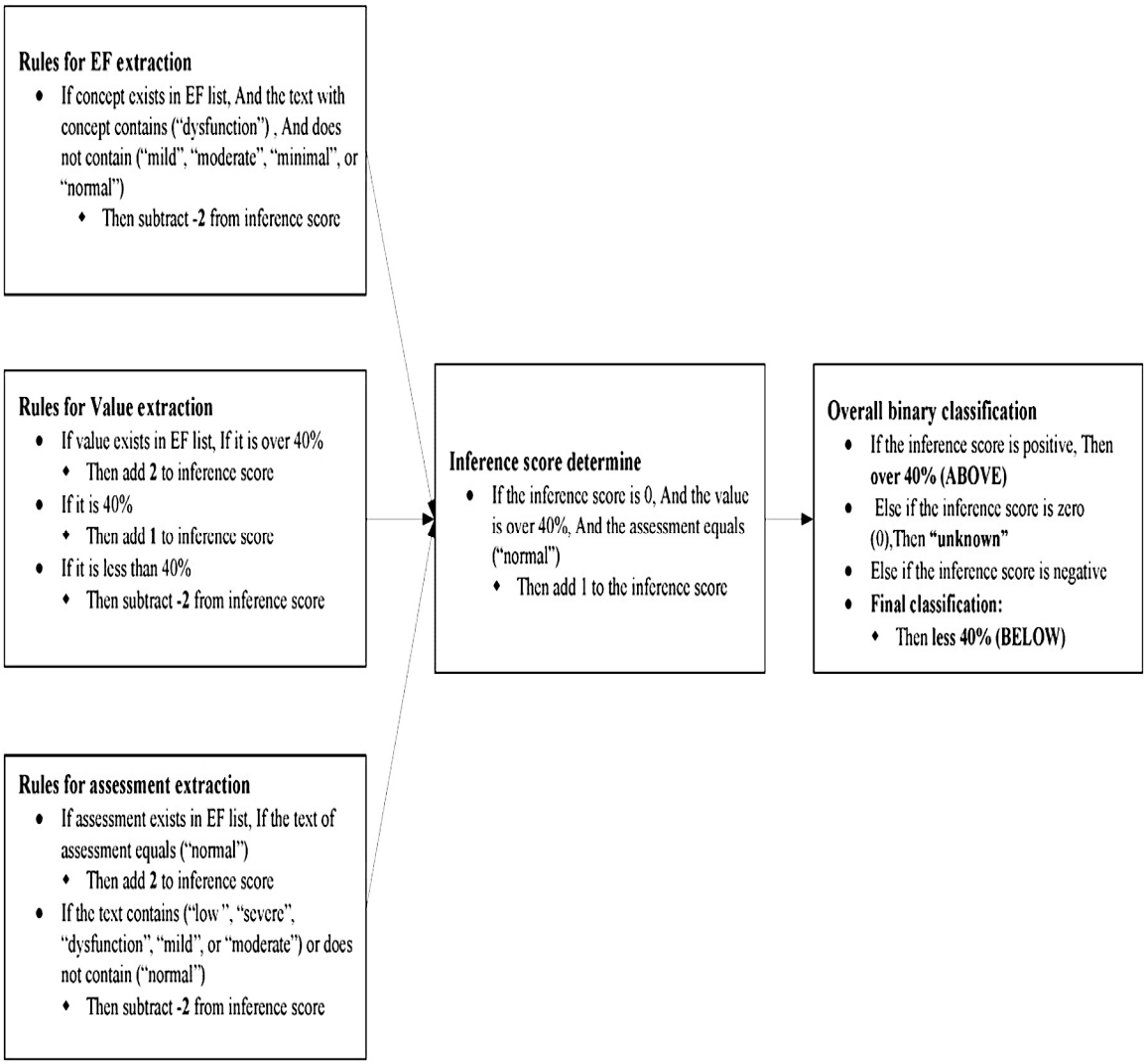
With ever expanding medical databases, there is a need to bring information retrieval tools into the hands of all eMeasurement staff. SQL is not a very efficient tool in extracting free text from clinical notes, and NLP can be a possible solution to the free text problem. For example, left ventricular ejection fraction (EF), which is a key component of heart failure quality measures, is not easily available as a structured data element. The extraction of EF requires the consideration of several factors, such as dates and times (for e.g. choosing the right admission time, note time, and laboratory information). Natural Language Processing can successfully be used to extract this free text information from complex clinical notes.

The list of Natural Language Processing (NLP) tools for the extraction of unstructured data elements from the Electronic Health Record (EHR), can be retrieved from:

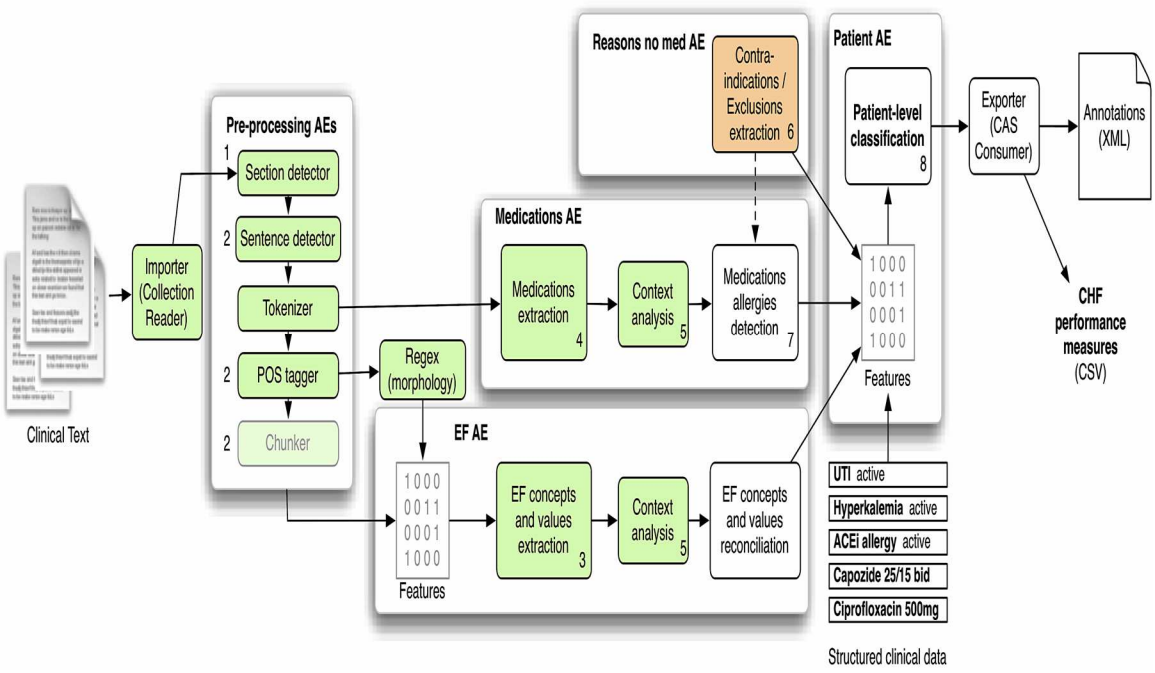
1. Capture with UIMA of Needed Data using Regular Expressions for EF (CUIMANDREef) system
   Garvin JH, et al., Automated Extraction of Ejection Fraction for Quality Measurement using Regular Expression in Unstructured Information Management Architecture (UIMA) for heart failure. J Am Med Inform Assoc. 2012; 19(5): 859-866.
   http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3422820/

2. Congestive Heart Failure Information Extraction Framework (CHIEF)
   Meystre SM, Kim Y, Redd A, Garvin JH. Congestive Heart Failure Information Extraction Framework (CHIEF) Evaluation. AMIA Annu Symp Proc, Washington, DC; 11/2014
   http://www.researchgate.net/publication/269409174_Congestive_Heart_Failure_Information_Extraction_Framework_%28CHIEF%29_Evaluation
3. REgenstrief data eXtraction tool (REX)
   Friedlin K, McDonald C. A Natural Language Processing System to Extract and Code Concepts Relating to Congestive Heart Failure from Chest Radiology Reports. AMIA Annu Symp Proc, 2006; 269-273.
   http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1839544/

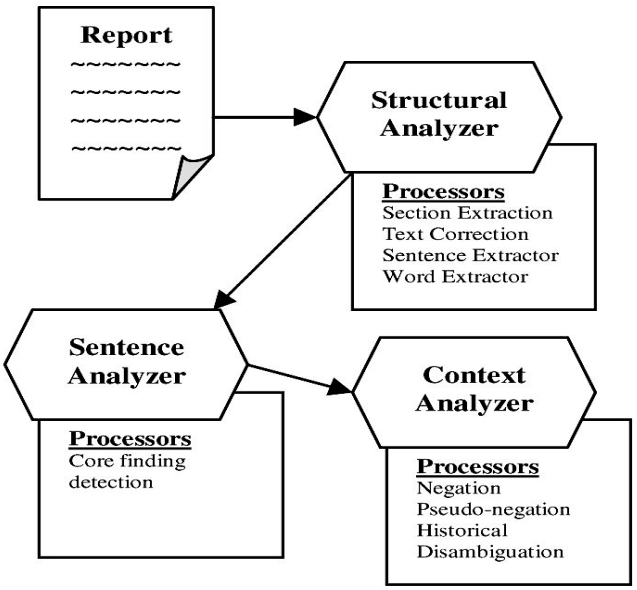
Example 1: Screenshot of rules and sequence of use for ejection fraction from the (CUIMANDREef) system



Example 2: Screenshot of the Congestive Heart Failure Information Extraction Framework (CHIEF), based on the Apache UIMA framework with modules for EF, medications, and contraindications/exclusions with general linguistic analysis functionalities and patient-level analysis.



Example 3: Screenshot of the Processing schema for REgenstrief data eXtraction tool (REX)



Section C: Tools for Managing Team Activity

1. Identifying tools for version control

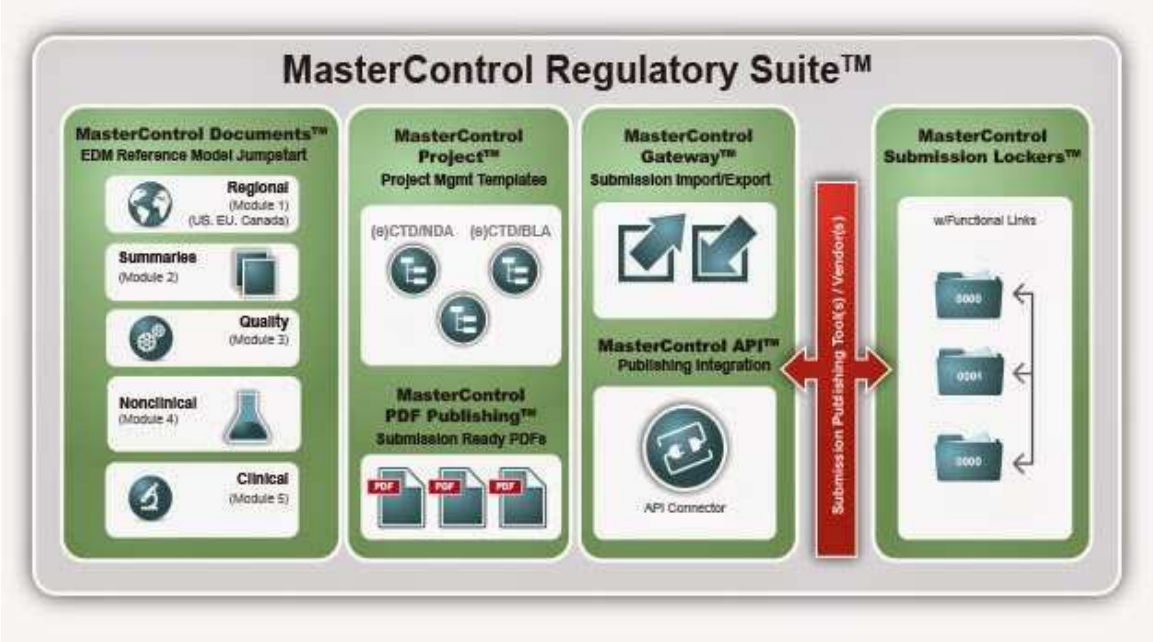
Description: An important part of any quality management system is the ability to control and quickly report on the different versions and revisions of any document, file, or drawing. Document version control software systems, such as MasterControl software, with document control and management, revision control, and change control functionality, can be useful in eMeasure implementation environments. The MasterControl Documents Solution and the isoTracker Document Control software act as document and version control software systems for tracking documents from version to version and assigning meta-data to every revision, making documents easier to search.

The version control software features also ensures that only one authorized user can edit the latest version of a document at any given time, guaranteeing the safety and transparent maintenance of all essential documents. Regardless of the type, the document is securely stored in a centralized repository that can only be accessed by authorized users. The softwares are fully capable of tracking down changes made at the minutest level. The document version control software systems also require the user to enter the reason for change before storing it in the virtual vault for access. All these features ensure that only the latest version of the document is maintained and accessed by users from virtually any location. In addition to the benefits and features already mentioned, the MasterControl Documents solution and the isoTracker Document Control software can also be automated to route documents automatically along approval pathways.

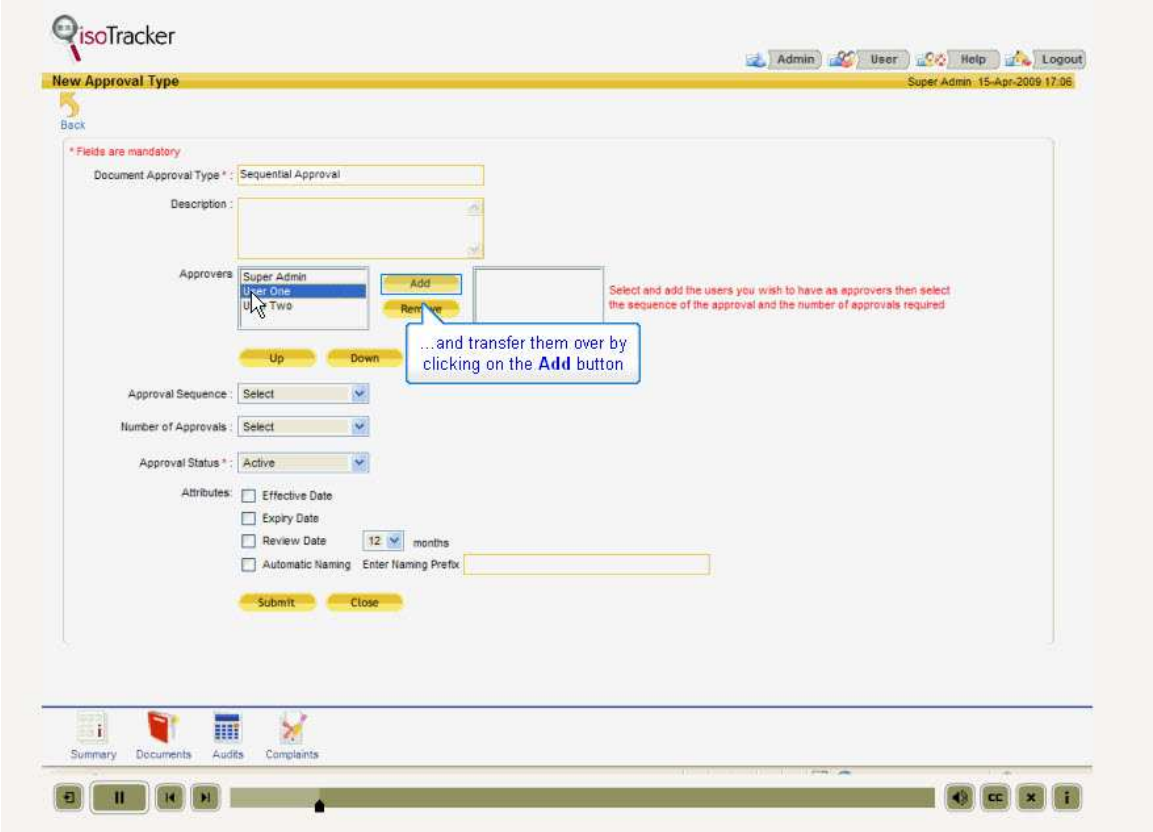
The version control software, can be retrieved from:

1. MasterControl documents solution version control software system http://www.mastercontrol.com/document-control-software/version-control/software-system.html
2. isoTracker documents version control software system http://www.isotracker.com/document-version-control-software.html

Example 1: Screenshot of the MasterControl documents solution version control software system



Example 2: Screenshot of the isoTracker documents version control software system



2. Identify tools for project evaluation

Description: During the implementation of multiple eMeasures, it is useful to have a planning file to track the status of how you will assess each measure. Some questions that arise during the implementation of eMeasures relate to the timeframe of the implementation, the statistical analysis that is most ideal, and the data collection process that is most efficient, etc. The project evaluation toolkit will walks you and your team step-by-step through the process of determining the goals of implementing multiple eMeasures, what is important to your organization, what needs to be measured, what is realistic and feasible to measure, and how to measure these items.

Project evaluation toolkit for implementing Health Information Technology (HIT) can be accessed at:
http://healthit.ahrq.gov/sites/default/files/docs/page/Evaluation%20Toolkit%20Revised%20Version.pdf

Example 1: Example of project evaluation can be found in the Project evaluation toolkit for implementing Health Information Technology (HIT).

You now have everything you need to write your evaluation plan: project description, goals, measures, and methodology for your evaluation.

1. Short Description of the Project
2. Goals of the Project
3. Questions to be Answered by the Evaluation Effort
4. First Measure to be Evaluated – Quantitative
    - A. Overview– General Considerations
    - B. Timeframe
    - C. Study Design/Comparison Group
    - D. Data Collection Plan
    - E. Analysis Plan
    - F. Power/Sample Size Calculations
5. Second Measure to be Evaluated – Qualitative
    - A. Overview – General Considerations
    - B. Timeframe
    - C. Study Design
    - D. Data Collection Plan
    - E. Analysis Plan
6. Subsequent Measures to be Evaluated in the Same Format

3. Identify templates (meeting agenda, timeline for project completion, planning file to track the status of implementing multiple eMeasures)

Description: Planning tools are useful tools to help eMeasurement teams think systematically about their eMeasurement project, including a listing of the changes the team is testing. Planning Tools include timelines, action items, to-do lists, and meeting agendas, etc.

Planning tools, can be retrieved from:

1. Template for meeting agenda
   http://calswec.berkeley.edu/toolkits/implementation-toolkits/how-build-implementation-toolkit-start-finish
2. Timeline for project completion
   http://calswec.berkeley.edu/toolkits/implementation-toolkits/how-build-implementation-toolkit-start-finish
3. Planning file to track the status for implementing multiple eMeasures
   http://www.rootcause.org/docs/Resources/Books/Building-a-Performance-Measurement-System/Building-a-Performance-Measurement-System.pdf

Example 1: Example of a template for meeting agenda.

MEETING AGENDA Title of Meeting Date| Time
Goals of the meeting:
Goal # 1 Goal # 2 Goal # 3
Welcome and Introductions of Participants…….Time Overview of Project and Timelines…….Time Demonstration Activity…….Time Findings…….Time Technical Assistance…….Time LUNCH Regional Discussions…….Time Administrative Update…….Time

Example 2: Example of a timeline for project completion.

	ACTIVITIES AND TIMELINE FOR IMPLEMENTING EMEASURES	Year Oct 2014-Sep 2015												Year 2 Oct 2015-Sep-16			
	Activities to occur on or before:	C	N	D	J	F	M	A	M	J	J	A	S	Q 1	Q 2	Q 3	Q 4
1.1. Pre-implementation planning	1.1.1. Develop a brief description of the project	x	x														
	1.1.2. Determine the goals of the project	x	x	x	x	x	x	x									
	1.1.3. Set evaluation goals		x	x			x	x									
	1.1.4. Choose evaluation measures				x	x	x	x	x	x	x	x	x	x	x	x	
	1.1.5. Consider both quantitative and qualitative measures				x	x											
	1.1.6. Consider ongoing evaluation of barriers, facilitators, and lessons learnt			x	x												
	1.1.7. Consider project impacts on potential eMeasures					x											
	1.1.8. Create design for display of geographic-level data			x	x	x	x										
	1.1.9. Rate chosen emeasures in the order of importance and feasibility					x	x	x									
1.2. eMeasure implementation plan	1.2.1. Overview		x	x	x	x	x	x	x	x	x						
	1.2.2. Timeframe	x	x	x	x	x	x	x	x	x	x						
	1.2.3. Study design comparison group			x	x	x	x	x	x	x	x	x					
	1.2.4. Data collection plan									x	x	x	x	x			
	1.2.5. Analysis plan										x	x	x	x			
	1.2.6. Power/sample size calculations											x	x	x			
	1.2.7. Subsequent measures to be evaluated in the same format														x		
	1.2.8. Budget														x		
	1.2.9. Conclusion															x	

Example 3: Example of a planning file to track the status for implementing multiple eMeasures.

Measure	1st eMeasure	2nd eMeasure	3rd eMeasure
Briefly describe the eMeasure			
Describe the expected impact of implementing the eMeasure?			
What are the data elements that need to be measured?			
How will you make your measurements?			
How will you design your study; (Qualitative, Quantitative, mixed methods, etc.)			
Estimate the number of observations you need to make in order to demonstrate that the eMeasure has changed statistically.			
What is the planned timeframe for your project?			
Who will take the lead for the project?			
Who will take the lead for data collection?			
Who will take the lead for data analysis			
Who will take the lead for presentation of findings?			
Who will take the lead for final write-up and reports?			

Section D: Determine Postimplementation Requirements

1. Postimplementation assessment of barriers and facilitators

Description: By conducting stakeholder interviews with key informants and subject matter experts, who have expertise in quality improvement and information technology, you can identify the facilitation that is required to overcome barriers to the implementation of eMeasures. The information pertaining to the identification of facilitators to avoid barriers postimplementation, can be used to:

- Modify workflows
- Re-design software applications an informatics tools
- Include pertinent information in training programs

An Evaluation of the Use of Performance Measures in Healthcare, can be retrieved from: http://www.rand.org/content/dam/rand/pubs/technical_reports/2011/RAND_TR1148.pdf

Example1: Example of barriers and facilitators to the implementation of eMeasures.

Barrier	Description of Barrier	Facilitator
Lack of standardization /consistency of common data definitions for implementing an eMeasures	Some of the challenges include the use of SNOMED in specification manuals and the transition to ICD10, which requires preparedness for implementation of eMeasures	Address standardization issues in data elements and prepare for new standard vocabulary utilization in the future
Unavailability of data from a standard source in a structured data format	Lack of standardization in a single medical center and the variation amongst different medical centers poses a barrier to the implementation of eMeasures	Address unstructured data issues within the data warehouse/repository
Absence of an informatics infrastructure	The lack of an informatics infrastructure in medical centers causes difficulty in the extraction and dissemination of eMeasures	Address the issue of incorporating more informatics tools in an inpatient setting
Challenges concerning the automation of performance measures	Performance measures may not be a 100% automated due to the absence of structured data, informatics infrastructure, trained staff, etc.	Address unstructured data issues within the data warehouse/repository. Use Natural Language Processing to extract the free-text in clinical notes. This will allow the team/staff to invest greater time for additional analysis and use of professional skills at other areas.

2. Postimplementation assessment of process improvement requirements

Description: By conducting stakeholder interviews with key informants and subject matter experts, who have expertise in quality improvement and information technology, you can identify the process improvement requirements post implementation of eMeasures that are needed to enhance quality improvement efforts. The information pertaining to process improvement requirements, can be used to:

- Modify workflows
- Re-design software
- Include pertinent information in training programs

Example for assessing postimplementation requirements for process improvement by using HIT, can be retrieved from: http://healthit.ahrq.gov/health-it-tools-and-resources/workflow-assessment-health-it-toolkit/examples/hit

Example 2: Example of use of HIT for process improvement that includes quality improvement, Meaningful Use, etc.

Example	Used in
Quality improvement	Establishing informatics based tools for implementing eMeasures, can be useful in quality improvement efforts by directly reporting performance measurement information and clinical leads nationally
Meaningful Use	Fulfilling Meaningful Use requirements, i.e. identifying non-eligible provider measures, clinical quality measures and 16 other eligible hospital clinical quality measures to improve clinical quality and cost of care
Informatics-based reporting	Integration of informatics techniques in the implementation of eMeasures to lower human errors. This can be achieved by using Natural Language processing and information extraction techniques for extracting free text data from clinical notes

3. Postimplementation assessment to finalize workflows

Description: By now your flowcharts will provide a meaningful visualization of the workflows you can expect postimplementation of eMeasures.
Flowcharts can:

- Convey the anticipated sequence of activities and tasks that will occur postimplementation,
- Identify who will most perform what activities and tasks, and
- No longer include unnecessary or non-value-added activities and tasks.

Flowcharts offer significant planning assistance related to both information technology and quality improvement professionals.

Additional information about finalizing workflows to assess post implementation requirements, can be retrieved from:
http://healthit.ahrq.gov/health-it-tools-and-resources/workflow-assessment-health-it-toolkit/examples/finalize

Similarly, Swim lane flowchart provides a meaningful visualization of the workflows you should expect postimplementation of eMeasures. Swim lane flowchart is a map that displays processes carried out for multiple roles across multiple stages. The use of swim lanes can help you understand how various work processes will be integrated in to your HIT system for implementing eMeasures. You can now:

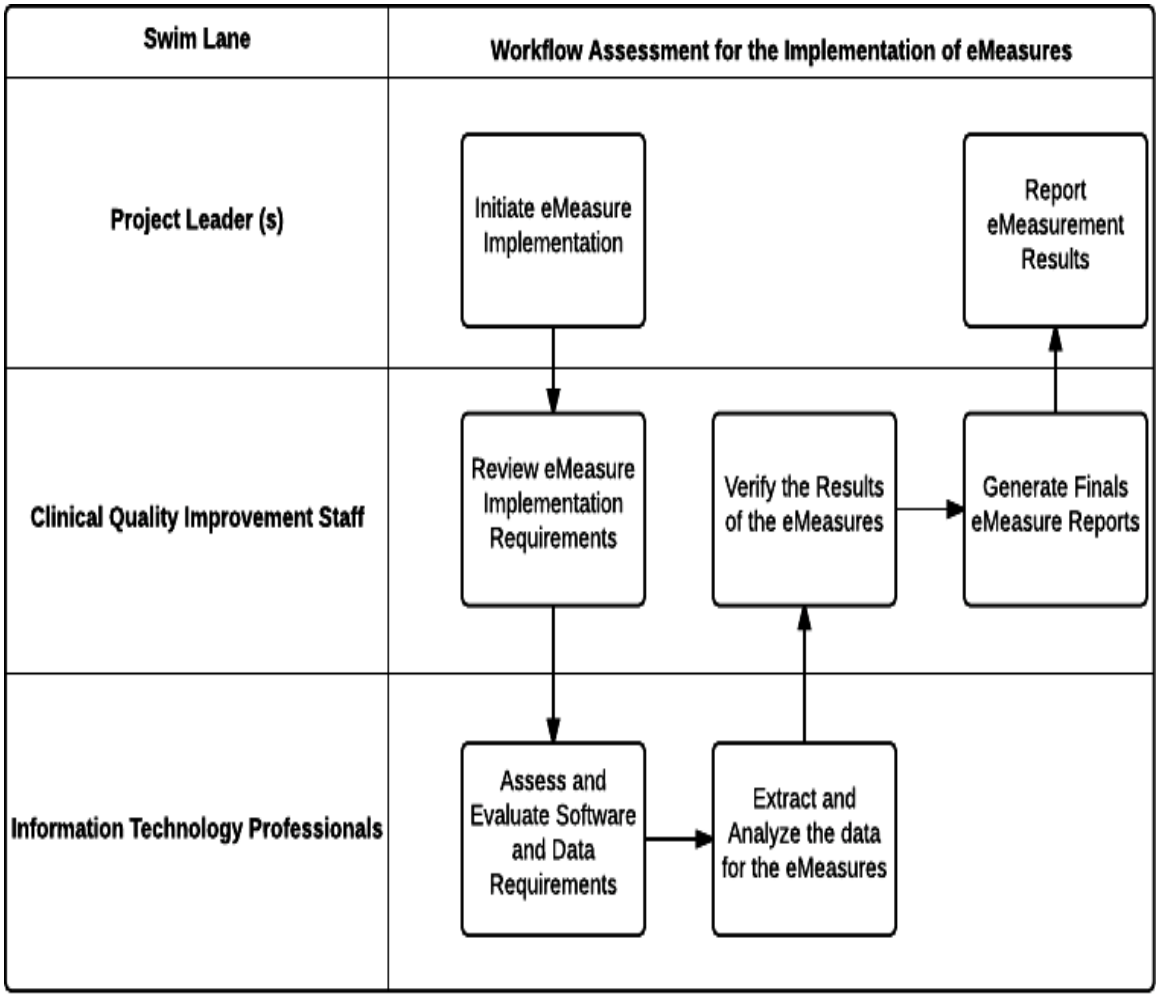
- Confirm who will perform what task and when
- Finalize the planned eMeasure implementation process
- Approach the implementation with significant confidence

A swim lane map displays processes that are carried out for multiple roles across multiple stages. Each swim lane is representative of a role, in this case: Project leader (s), Clinical Quality Improvement Staff, and Information Technology Professionals. The stretch of each lane is marked by the stages in the process.

Additional information about swim lane diagrams can be retrieved from:
http://www.ahrq.gov/professionals/prevention-chronic-care/improve/system/pfhandbook/mod5appendix.html#sl5

Example 3: Example of a swim lane diagram for the implementation of eMeasures at an

inpatient setting



Definitions/Terminology:

The following definitions are taken from Health Information: Management of a Strategic Resource (Abdelhak, Grostick, Hanken, and Jacobs, 2001); the National Quality Forum (2013); and Health Information Management: Concepts, Principles and Practice (LaTour and Eichenwald-Maki, 2006) unless otherwise noted.

The Agency for Health Research and Quality (AHRQ) is a United States government agency that functions as a part of the Department of Health and Human Services (HHS) to support research to improve the quality of healthcare.

Electronic Health Records (EHRs) is an evolving concept defined as a systematic collection of electronic health information about individual patients or populations.

eMeasures Electronic measures or eMeasures are standardized performance measures in an electronic format. eMeasures can promote greater consistency in measure development and in measuring and comparing performance results. They also can provide more exact requirements about where information should be collected, and drive greater standardization across the measures and greater confidence in comparing outcomes and provider performance.

Health Information Technology (HIT) is the area of Information Technology (IT) that involves the design, development, creation, use, and maintenance of information systems for the healthcare industry.

The Health Information Technology for Economic and Clinical Health Act (HITECH) was passed by Congress in 2009 to stimulate the adoption of electronic health records (EHR) and supporting technology in the United States. HITECH is part of the American Recovery and Reinvestment Act (ARRA) of 2009.

Information Technology (IT) is the use of computers and telecommunications equipment to store, retrieve, transmit, and manipulate data.

The Joint Commission (TJC) is an independent, not-for-profit organization that evaluates and accredits many healthcare organizations and programs in the United States.

Meaningful Use (MU) is using certified electronic health record (EHR) technology to: Improve quality, safety, efficiency, and reduce health disparities. Engage patients and family. Improve care coordination, and population and public health. The American Reinvestment & Recovery Act (ARRA) was enacted on February 17, 2009. ARRA includes many measures to modernize our nation's infrastructure, one of which is the "Health Information Technology for Economic and Clinical Health (HITECH) Act". The HITECH Act supports the concept of electronic health records - Meaningful Use [EHR-MU], an effort led by Centers for Medicare & Medicaid Services (CMS) and the Office of the National Coordinator for Health IT (ONC). HITECH proposes the Meaningful Use of interoperable electronic health records throughout the United States healthcare

delivery system as a critical national goal. CMS grants an incentive payment to Eligible Professionals (EPs) or Eligible Hospitals (EHs), who can demonstrate that they have engaged in efforts to adopt, implement or upgrade certified EHR technology. In order to encourage widespread EHR adoption, promote innovation and to avoid imposing excessive burden on healthcare providers, Meaningful Use was showcased as a phased approach, which is divided into three stages which span 2011 (data capture and sharing), 2013 (advanced clinical processes) and 2015 (improved outcomes).

The National Committee for Quality Assurance (NCQA) is an independent nonprofit organization in the United States created to improve patient care quality and health plan performance in partnership with managed care plans, purchasers, consumers, and the public sector.

National Quality Forum (NQF) is a nonprofit organization based in Washington, D.C., that is dedicated to improving the quality of healthcare in the United States.

Performance measures include the specific representation of a capacity, process, or outcome deemed relevant to the assessment of performance. A performance measure is quantifiable and therefore can be documented.

Performance measurement is the process of collecting, analyzing, and/or reporting information regarding the performance of an individual, group, organization, system, or component.

Quality is the degree to which physicians and healthcare institutions fulfill their care obligations to individual patients and the degree to which patients, physicians, trained healthcare staff, and healthcare institutions enable these obligations to be fulfilled fairly across the population.

Quality assurance is the maintenance of a desired level of quality in product or service. The term has largely been replaced by “quality improvement”.

Quality Improvement (QI) is the combined efforts of everyone—healthcare professionals, patients and their families, researchers, payers, planners, and educators—to make the changes that will lead to better patient outcomes (health), better system performance (care), and better professional development (learning).

Continuous quality improvement is a structured process to improve all aspects of care and service continually; ongoing study to improve performance.

Semistructured interview is a flexible interview in which the interviewer does not follow a formalized list of questions. Instead, there is a list of general topics called an interview guide.

Thematic analysis is a method of qualitative analysis based on participants’ conceptions of actual communication episodes; a theme is identified based on recurrence and

repetition of statements that reflect a common pattern or ‘theme’.

Workflow is the set of tasks—grouped chronologically into processes—and the set of people or resources needed for those tasks, that are necessary to accomplish a given goal. An organization’s workflow is comprised of the set of processes it needs to accomplish, the set of people or other resources available to perform those processes, and the interactions among them.

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APPENDIX C

REDCap SURVEY

eMeasure Implementation Toolkit Survey

Demographics

Type of organization
- ◯ Federal government
- ◯ State government
- ◯ Non-profit
- ◯ Academic institution
- ◯ Other

(Please enter your response here)

Other organization

_____
(Please enter your text here)

Number of years of work experience at your organization
- ◯ 0-5 years
- ◯ 6-10 years
- ◯ 11-15 years
- ◯ 16-20 years
- ◯ 21-25 years
- ◯ 26 years & above

(Please enter your response here)

Which most closely describes your current position
- ◯ Directors or associate directors of quality/ safety
- ◯ Primary care providers (MD, APRN, PA etc.)
- ◯ Clinical quality program specialists (QI team member)
- ◯ Informatics professionals or IT team
- ◯ Other

(Please enter your response here)

Position title

_____
(Please enter your text here)

Number of years work experience in Quality Improvement (QI) (QI) is the combined efforts of everyone--healthcare professionals, patients and their families, researchers, payers, planners, and educators--to make the changes that will lead to better patient outcomes (health), better system performance (care), and better professional development (learning).
- ◯ 0-5 years
- ◯ 6-10 years
- ◯ 11-15 years
- ◯ 16-20 years
- ◯ 21-25 years
- ◯ 26 years & above

(Please enter your response here)

Number of years work experience in Health Information Technology (HIT) (HIT) is the area of Information Technology (IT) that involves the design, development, creation, use, and maintenance of information systems for the healthcare industry.
- ◯ 0-5 years
- ◯ 6-10 years
- ◯ 11-15 years
- ◯ 16-20 years
- ◯ 21-25 years
- ◯ 26 years & above

(Please enter your response here)

Brief description of your current roles and responsibilities

_____
(Please enter your text here)

Section B: Determine Pre-implementation Requirements

(The next set of questions will ask about relevance and clarity for section B of the toolkit)

Pre-implementation planning checklist RELEVANCE	◯ 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5 (1 = Very Relevant 5 = Not at all relevant)
Pre-implementation planning checklist CLARITY	◯ 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5 (1 = Very Relevant 5 = Not at all relevant)
Stakeholder interviews for understanding the eMeasure implementation requirements RELEVANCE	◯ 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5 (1 = Very Relevant 5 = Not at all relevant)
Stakeholder interviews for understanding the eMeasure implementation requirements CLARITY	◯ 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5 (1 = Very Relevant 5 = Not at all relevant)
Flowcharts of key process for the implementation of eMeasures RELEVANCE	◯ 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5 (1 = Very Relevant 5 = Not at all relevant)
Flowcharts of key process for the implementation of eMeasures CLARITY	◯ 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5 (1 = Very Relevant 5 = Not at all relevant)
Would you like to add any comments about your ratings?	_____

Section C: Tools for implementing a single eMeasure

(The next set of questions will ask about relevance and clarity for section C of the toolkit)

Click this link to see it (really goes to nursing home page now) CLICK HERE

Analyzing the eMeasure document (XML) RELEVANCE	◯ 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5 (1 = Very Relevant 5 = Not at all relevant)
Analyzing the eMeasure document (XML) CLARITY	◯ 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5 (1 = Very Relevant 5 = Not at all relevant)
Identifying standard terminology and data sources for implementing an eMeasure RELEVANCE	◯ 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5 (1 = Very Relevant 5 = Not at all relevant)
Identifying standard terminology and data sources for implementing an eMeasure CLARITY	◯ 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5 (1 = Very Relevant 5 = Not at all relevant)
Identifying Structured Query Language (SQL) tools for extracting structured data for an eMeasure RELEVANCE	◯ 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5 (1 = Very Relevant 5 = Not at all relevant)
Identifying Structured Query Language (SQL) tools for extracting structured data for an eMeasure RELEVANCE	◯ 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5 (1 = Very Relevant 5 = Not at all relevant)
Identifying Structured Query Language (SQL) tools for extracting structured data for an eMeasure CLARITY	◯ 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5 (1 = Very Relevant 5 = Not at all relevant)
Identifying Natural Language Programming (NLP) tools for extracting free text from clinical notes for eMeasurement RELEVANCE	◯ 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5 (1 = Very Relevant 5 = Not at all relevant)
Identifying Natural Language Programming (NLP) tools for extracting free text from clinical notes for eMeasurement CLARITY	◯ 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5 (1 = Very Relevant 5 = Not at all relevant)
Would you like to add any comments about your ratings?	_____

Section D: Tools for Managing Team Activity

(The next set of questions will ask about relevance and clarity for section D of the toolkit)

Identifying tools for version control RELEVANCE	◯ 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5 (1 = Very Relevant 5 = Not at all relevant)
Identifying tools for version control CLARITY	◯ 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5 (1 = Very Relevant 5 = Not at all relevant)
Identifying tools for project evaluation RELEVANCE	◯ 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5 (1 = Very Relevant 5 = Not at all relevant)
Identifying tools for project evaluation CLARITY	◯ 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5 (1 = Very Relevant 5 = Not at all relevant)
Identify templates (meeting agenda, timeline for project completion, planning file to track the status of implementing multiple eMeasures) RELEVANCE	◯ 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5 (1 = Very Relevant 5 = Not at all relevant)
Identify templates (meeting agenda, timeline for project completion, planning file to track the status of implementing multiple eMeasures) CLARITY	◯ 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5 (1 = Very Relevant 5 = Not at all relevant)
Would you like to add any comments about your ratings?	_____

Section E: Determine Post-implementation Requirements

(The next set of questions will ask about relevance and clarity for section E of the toolkit)

Post-implementation assessment of barriers and facilitators RELEVANCE	◯ 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5 (1 = Very Relevant 5 = Not at all relevant)
Post-implementation assessment of barriers and facilitators CLARITY	◯ 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5 (1 = Very Relevant 5 = Not at all relevant)
Post-implementation assessment of process improvement requirements RELEVANCE	◯ 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5 (1 = Very Relevant 5 = Not at all relevant)
Post-implementation assessment of process improvement requirements CLARITY	◯ 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5 (1 = Very Relevant 5 = Not at all relevant)
Post-implementation assessment to finalize workflows RELEVANCE	◯ 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5 (1 = Very Relevant 5 = Not at all relevant)
Post-implementation assessment to finalize workflows CLARITY	◯ 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5 (1 = Very Relevant 5 = Not at all relevant)
Would you like to add any comments about your ratings?	_____

OVERALL COMMENTS

Is there anything else you would like to comment on?

Are there any additional tools that you think could be included in the toolkit?

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