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Seng Yang Date

Utilization of Mental Health EHR Data to Identify Candidates for Chronic Care Health Homes in Kansas: Defining a Process to Identify Candidates

BY

Seng Yang

Degree to be awarded: M.P.H
Executive MPH

Sunanda McGarvey, Committee Chair	Date
Karen Suddath, LMSW, Field Advisor	Date
Mark Conde, Committee Member	Date
Kathleen R. Miner, Ph.D., M.P.H., M.Ed., Committee Member	Date
Melissa Alperin, MPH, CHES Chair, Executive MPH Program	Date

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BY

Seng Yang, M.P.H., Emory University, 2014

B.S., Chemistry, Wichita State University, 2008

Thesis Committee Chair: Sunanda McGarvey

An abstract of a thesis submitted to the Faculty of the Rollins School of Public Health of Emory University in partial fulfillment of the requirements of the degree of Master of Public Health in the Executive MPH program 2014

Abstract

Utilization of Mental Health EHR Data to Identify Candidates for Chronic Care Health Homes in Kansas: Defining a Process to Identify Candidates

BY

Seng Yang

Background: Chronic conditions and mental health disorders are both common and compromise the quality of life for affected individuals. According to the Synthesis Project, 68% of adults with mental disorders have medical conditions. Therefore, mental health centers in Kansas, partnered with community health centers for Health Homes, are particularly interested in identifying individuals at their center who may have a qualifying chronic condition, are not classified with severe mental illness, and are not currently enrolled in a Health Home. Enrollment into a Health Home will provide the opportunity to facilitate interdisciplinary care of health for these individuals.

Purpose: Kansas adopted the Health Home model that is positioned to support individuals with chronic conditions. However, health partners are concerned not all qualifying patients will be identified as candidates for Chronic Condition Health Homes. Therefore, the purpose of this study is to define a process to identify candidate patients for enrollment into Chronic Condition Health Homes from the Kansas mental health EHR.

Methods: A data flow analysis was completed on the Kansas Mental Health Electronic Health Record system. The data flow analysis identified where relevant clinical data were being captured within the EHR for use in identifying chronic conditions. A data model of the Kansas Mental Health Electronic Health Record system was created to help depict relevant data tables and a set of structured query language (SQL) queries was defined to extract relevant clinical data from structured and unstructured data fields.

Results: A process was defined that includes six SQL queries to extract relevant clinical data from the mental health electronic health record system and identify candidate patient. Four SQL queries aim to extract clinical data held in the system as structured data and two SQL queries were developed that would allow for extraction of unstructured clinical data.

Conclusions: The developed SQL queries directly links to relevant tables that hold the clinical data, structured or unstructured data, within the Kansas Mental Health EHR. The SQL queries for the structured data should be able to directly extract the required information for qualifying members with the chronic condition of asthma, extensible to additional chronic condition, based on the process defined through this research. However, the SQL queries for unstructured data need further analysis to determine if the data extract meets the correct criteria for enrollment into a Health Home. All the queries require testing against actual data to verify anticipated results.

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Chapter 1: Introduction

Introduction and Background

Electronic Health Record (EHR) systems provide health facilities the ability to store and retrieve detailed patient information that can be utilized by healthcare providers. As more healthcare facilities adopt these systems, a reservoir of health data are collected and stored within electronic databases. This expanding collection of health data creates an opportunity for secondary utilization of the data for healthcare research to improve patient care and health outcomes, increase efficiency, and reduce costs.

As the collection of health data continues to grow, data captured within electronic health record systems continues to be held in divergent formats. Currently, health data captured within electronic health records can be either structured or unstructured. This discord on health data capture is seen across all health electronic health records, but even more so on mental health electronic health records. The varied data types raise the question on the reliability and data quality of the health data captured and stored within the electronic health record and prompts the questions, which data type derived from the electronic health records would better meet the needs of healthcare facilities to support decisions in healthcare; and which data type would provide the most ease for extraction from the database?

These questions are of great importance as healthcare facilities begin to utilize electronic health data to support organizational decisions. The utilization of electronic health data captured within electronic health records for organizational decisions is of high interest for mental health facilities within the State of Kansas. The State of Kansas recently

expanded Medicaid services to include Health Homes for qualifying beneficiaries by partnering with community health centers. Health Home services are intended for individuals with severe mental illness (SMI) or chronic conditions. By partnering with community health centers, many whom are mental health centers, these services will provide those with mental illness with better health care access.

The Health Home provision of the Affordable Care Act provides the opportunity to develop a person-centered system of care that fosters better health outcomes for individuals enrolled in their State Medicaid programs. The Health Home model intends to facilitate access to interdisciplinary health care to include medical care, mental health care, and community-based social services to individuals with chronic conditions. Health Homes intend to play a fundamental role in improving the health care delivered to individuals with chronic conditions (Center for Medicaid 2010). Even though the State of Kansas will assign qualified individuals to community health centers, community health centers are concerned that additional members may qualify but not be identified.

Mental health centers, that are partnered as community health centers for Health Homes, are particularly interested in identifying individuals at their center who have a qualifying chronic condition, and are not classified as SMI, as candidates for enrollment in a Health Home. This need poses the question on how health data held within mental health electronic health records can be used to identify individuals with a qualifying chronic condition?

As of 2012, nearly half of all adults have one or more chronic health conditions (Brian W. Ward 2014). The National Vital Statistics Reports indicates that chronic diseases are the leading cause of death and disability within the United States. They cause seven out

of ten deaths each year and most conditions are preventable and treatable. Additionally, according to The Synthesis Project, 68% of adults with mental disorders have medical conditions, and 29% of adults with medical conditions have mental disorders (Benjamin G. Druss MD 2011).

These numbers are alarming as they indicate chronic conditions and mental health disorders are both common and can disable and compromise the quality of life for affected individuals. As Chapman indicates, "Mental illnesses and chronic diseases are closely related. Chronic disease can exacerbate symptoms of depression, and depression disorders can themselves lead to chronic disease (Daniel P. Chapman PhD 2005)." Given that over fifty percent of individuals with mental disorders have a medical condition that may be manageable, it is imperative that mental health community centers are able to identify eligible individuals with such conditions for enrollment into a Health Home.

With the increase adoption of electronic health records, vast amount of data are being stored collectively within a secure electronic database. That data can be utilized by healthcare facilities to improve care to their patients. Therefore, this study intends to examine possible methodologies for utilizing mental health electronic health record data to identify individuals that meet the State of Kansas criteria for admission into a Chronic Conditions Health Home, using asthma as the chronic condition of focus. The research will examine methods for extracting data elements within mental health electronic health record systems through a literature review of studies that focuses on structured and unstructured data held within their system. This will be used as the basis for defining a process to identify candidates for a Chronic Conditions Health Homes: those who are mentally ill but not classified to have severe mental illness, are not currently enrolled in a

Health Home, and who have a chronic condition. Identification will be done by querying information from a mental health electronic health record system.

Problem, Research Questions and Purpose

During the 2013 pre-conference seminar at the OPEN MINDS Technology and Informatics Institute in Philadelphia, Sharon Hicks, CEO of Askesis Development Group, spoke in regards to mental health institutions beginning to utilize data analytics for predictive values to reduce health care costs and improve the health outcomes of patients. Health data held within these systems hold invaluable information that would be useful in health decisions.

Hicks noted a key difference in medical health in comparison to mental health data, medical health data has vastly more structured data when compared to mental health data (Developments 2013). This non-uniformity in health data is a major issue in utilizing mental health data for health analytics. Clinical data can be categorized into either structured or unstructured data. Structured data are described as discrete values, while unstructured data are text based and descriptive. The main challenge with mental health electronic health records is that many of the clinical data are unstructured. It is significantly more difficult to extract information from unstructured data as conventional data mining techniques were designed for structured data. However, advancement in text mining techniques are gaining ground and discovering information within unstructured data would be extremely useful. With the movement to the Diagnostic and Statistical Manual of Mental Disorders fifth edition(DSM-V), standardized coding intends to become more of the norm. However, one of the major challenges of utilizing structured data for collecting clinical data stems from the resistance of healthcare providers.

One of the major obstacles in adopting electronic health records results from the data entry for healthcare providers. Inputting structured data often requires user to select clinical terms from a list that has already been predefined. Providers often feel this is restrictive and determining the correct clinical term from narrative data to structure requires more effort (Benjamin G. Druss MD 2011). Additionally, clinicians maintain that clinical narratives provide the full richness of the clinical encounter as it allows them to unequivocally describe the event in detail, which may not be possible using a coded item (Kay and Purves 1996, van Ginneken 1996). Furthermore, entering structured coded data may subtly change the meaning of the original thought, which compounds concerns already raised by clinicians on the restrictive nature of structured data (Benjamin G. Druss MD 2011).

Therefore, the purpose of this study is to determine which data type, structure or unstructured data, held within mental health electronic health records allows for better secondary utilization of clinical data for identifying individuals with a chronic condition. A process will be developed to demonstrate methodologies to extract relevant clinical data, held in either structured or unstructured data, from within the mental health electronic health record. This study aims to better understand how clinical data are captured within the Kansas mental health electronic health record to determine data extraction methods so that future health researchers are able to apply or enhance these methodologies in extracting relevant clinical data. For qualification in a Health Home, this study specifically focuses on developing a process to identify individuals that are not classified as SMI and not already enrolled in a health home, are a Medicaid beneficiary, and have asthma as a chronic condition. Although there are other types of chronic conditions that would quality

individuals into a Health Home, for the purpose of this study, only asthma is considered. This study intends to demonstrate the methodology for extracting information from structured and unstructured data to identify qualifying individuals with asthma, which can later be extended to additional chronic conditions.

The research questions this study intends to answer includes where are chronic conditions currently being captured in the Kansas electronic health record? How is structured data being used to identify chronic conditions? How is unstructured data being used to identify chronic conditions? Which data type, structured or unstructured data, allows for better identification of individuals with chronic conditions? The clinical data held within mental health electronic health records are of great value but are captured using a variety of methods. Therefore, it is important to understand the differences in structure and unstructured clinical data to identify barriers to extraction from an electronic health record.

Theoretical Framework

Currently, clinical providers at the Kansas mental health facility capture most of the clinical data in unstructured data format. However, the Kansas Mental Health Electronic Health Record system does allows for clinical data to be also captured in structured data format. Structured data format within the system follows standards adopted by the Health Insurance Portability and Accountability Act. These standards include Healthcare Common Procedure Coding System (HCPCS), International Statistical Classification of Diseases and Related Health Problem (ICD), and National Drug Codes (NDC). Given the standardization of these codes, a defined set of codes can be used in the methodology for extracting relevant clinical data from the electronic health record.

Mental Health organizations are beginning to utilize more health data for advance analytics to improve care and reduce medical costs. However, to be able to perform data analytics utilizing clinical data, the data must be effectively and easily extracted. As previously mentioned, Hicks indicated that mental health clinical data are mainly captured as unstructured data which proved more difficult to extract than structured clinical data. Since clinical data are captured in two different data formats, the challenge lies in how to extract relevant data needed from each data format. Therefore, methodologies in extracting the clinical data from structured or unstructured data must examine capabilities currently available and determine the processes in ways the data are captured into the Kansas Mental Health Electronic Health Record system.

Significance

In developing the process to identify individuals with chronic conditions utilizing clinical data held within Kansas Mental Health Electronic Health Record system, the methodologies provides a framework on how to extract other data held within the system for secondary utilization. Furthermore, the methodologies in extracting structured and unstructured data can provide the inferences of the value of the clinical data held by each data type for data analytics. Effective data analytics can help identify issues that may not be apparent before serious incident occurs and give clinicians additional tool to better address the needs of their patients. As Hicks indicated for the future of data analytics for mental health organizations, there needs to be a focus on how clinical data is being captured within the Mental Health Electronic Health Records if one is trying to extract usable data.

Chapter 2: Review of Literature

Introduction

The literature review utilizes various repositories such as PubMed, DiscoverE, eJournals, and various other discovery databases. The main focus of the literature review is to examine publications that pertain to electronic health records, formats of health data such as structured and unstructured data, extraction methods of health data, chronic conditions, asthma, and health homes.

What are the Benefits of Health Homes?

A provision authorized by the Affordable Care Act allows the development of a person-centered system of care known as a Health Home. The goals of the Health Home are to produce better health outcomes for beneficiaries and provide better services and value to State Medicaid programs. The provision supports the three main overarching goals of the Centers for Medicare and Medicaid Services (CMS): improving the experience of care, improving the health of the populations and reducing per capita cost of health care, without any harm whatsoever to individuals, families, or communities (Center for Medicaid 2010).

The Kansas Health Home Model follows the six core services that must be provided by health homes:

1. Comprehensive care management (provide a plan to guide the consumers, their doctors and other providers).
2. Care coordination (ensure that proper services are provided timely)

3. Health promotion (provide education about conditions and tips for maintaining health).
4. Comprehensive transitional care, including appropriate follow-up, from inpatient to other settings (provide support during and following discharge from hospital or other care facility).
5. Patient and family support (including authorized representative) (provide a coordinated approach to health goals, including the role of family, caregivers and the individual)
6. Referral to community and social support services, if relevant (ensures that members receive the services and supports needed to stay in their homes).

Therefore, to provide these services, Health Homes in Kansas will provided through partnership between Lead Entities, the KanCare managed care organizations (MCOs), and Health Home Partners (HHPs). Health Home Partners are community providers and centers that meet the requirements and contracts with the MCOs (Environment 2014).

Kansas Health Homes set forth four goals to be accomplished which include reducing utilization of associated with avoidable (preventable) inpatient stays, improved management of chronic conditions, improved care coordination, and improved transitions of care between primary care providers and inpatient facilities. These goals intend to meet the overarching goals set out by the Center of Medicare and Medicaid Services and improve the health and lives of Kansas residents.

The health home program intends to have a large impact on the quality of care and services provided to Medicaid beneficiaries. Additionally, the program also anticipates the reduction in healthcare costs without hindering services and care to members. Preliminary

reports from Missouri's Community Mental Health Integrated Healthcare Homes showed an annual reduction in hospitalizations by 12% and emergency room use by 8.2%. These reductions proved to save the state $76.33 per member per month in total Medicaid costs (Secretary 2013). These reductions in hospitalizations and emergency room utilization are great indicators of the impact of Health Homes in improving care and better health coordination access provided to Medicaid members.

The Health Home service delivery model aims to provide a cost-effective, longitudinal home that will facilitate access to an inter-disciplinary of health services such as medical care, behavioral health care, and community-based services that will provide support to the population, both children and adults, with chronic conditions. The Health Home model is a State option provision of the Affordable Care Act enacted by Section 2703. The provision allows the states themselves to create a comprehensive person-centered model for health care coordination services to eligible Medicaid enrollees with chronic conditions (Secretary 2013).

As of December 31, 2013, 17 states, including the State of Kansas, have approved state health plan amendments. As mentioned earlier, the Center for Medicare and Medicaid Services allows the states to design their own Health Home programs to best meet the needs of their own population. However, although the states are allowed to design their own programs, CMS does expect the program to meet the needs of individuals with chronic conditions, including those with severe and persistent mental illnesses (Center for Medicaid 2010).

The minimum eligible criteria are set forth by Section 1945(h) of the Social Security Act (the Act) that indicates individuals with:

- two chronic health conditions;
- one chronic health condition and are at risk for developing a second; or
- serious and persistent mental health condition

may qualify for a health home program. Furthermore, the statute defines "chronic conditions: to include, but not be limited to: heart disease, diabetes, body mass index of greater than 25, mental health conditions, substance use disorders, and asthma (Secretary 2013). The State of Kansas elected to target initially eligible enrollees for the health home program were members with diabetes and/or asthma who are also at risk for developing substance use disorder, hypertension, coronary artery disease, depression, being overweight or obese (Environment 2014).

Furthermore, three types of health home provider arrangements are identified by the health home provision:

1. Designate providers, (e.g., physicians, physician practices, rural health clinics, community, mental health clinics, community health centers);
2. A team of health care professionals, including a nurse or social worker and
3. An interdisciplinary, inter-professional health team, as created by Section 3502 of the Affordable Care Act.

Although states are required to adhere to these requirements, the Center of Medicare and Medicaid does allow flexibility for the states to administer their programs with understanding on resource limitations and support of states' goals (Secretary 2013). Therefore, the structure of Health Home teams varies across states.

How Do Chronic Conditions Impact the Health Outcomes of the Mentally Ill?

Traditionally, chronic diseases, which mainly only identify individual chronic diseases, were the main focus of medical, public health and social programs. However, in recent years, health initiatives expanded from chronic diseases to chronic conditions. Chronic conditions includes functional limitations, anatomic problems (such as developmental disorders or visual impairment) which are not manifestations of physical disease and a wide range of behavioral health problems, which some have not been traditionally classified as diseases (Richard A. Goodman 2013).

As indicated earlier, as of 2012, about half of all adults have one or more chronic health conditions. This equates to one in four adults, or 117 million individuals.(Brian W. Ward 2014). In 2010, seven of the top ten causes of deaths were due to chronic conditions. Even more astonishing is that two of those chronic diseases, heart disease and cancer, accounted for nearly 48% of all deaths (Donna L. Hoyert Ph.D. 2012).

Health initiatives are recognizing the emerging high prevalence of individuals with multiple chronic conditions (Services 2010). Multiple chronic conditions pose an increasing burden on public health. It is overwhelming that one in four adults have multiple chronic conditions and one in fifteen children suffer from multiple chronic conditions. Furthermore, three out of four individuals over the age of 65 or older have multiple chronic conditions with two thirds of Medicare beneficiaries having multiple chronic conditions (Anderson 2010).

In a recent study, it was shown that there was an increase in prevalence of individuals with multiple chronic conditions from 21.8% in 2001 to 26.0% to 2010 (Brian W. Ward 2013). This increase is of concern as chronic conditions result in increased health

care costs and negative health outcomes. Health care associated costs increased as number of chronic conditions increased with the largest jump in cost of 92% increase from zero chronic conditions to one condition and additional cost increase of 79% with two or more chronic conditions (Kathryn Anne Paez 2009).

Beyond the health costs of individuals with multiple chronic conditions, individuals also suffer from poorer health outcomes. Studies have shown that individuals with chronic conditions have functional impairment and individuals with multiple chronic conditions experience greater functional impairment compared to individuals with fewer chronic conditions (Dunlop 2004). Additionally, individuals with multiple chronic conditions are more likely to receive suboptimal care (Anderson 2010). Individuals with multiple chronic conditions utilize more health care services and more frequently than individuals with lesser or no chronic conditions. These individuals also saw a larger number of different providers, which can make the coordination of care challenging. In a study with Medicare beneficiaries, those with one chronic condition saw on average of four different providers, while individuals with five or more chronic conditions saw more than fourteen providers (Insurance 2003).

Coordination of care becomes more difficult for individuals as the number of providers increases. Also, having multiple chronic conditions creates a challenging environment for individuals themselves in caring for their own health care management (Gerard F. Anderson 2003). Individuals with chronic conditions take more than one medication as well, and this presents a unique set of challenges for pharmacology management (Christine Vogeli 2007).

It is quite evident that chronic conditions are a huge burden on public health. Therefore, the Health Home provision from the Affordable Care Act is set in place to tackle some of the burden of chronic conditions and coordinate better care. One of the chronic conditions the Health Home program intends to target individuals with asthma (Center for Medicaid 2010). As defined by the National Heart, Lung, and Blood Institute, asthma is a chronic lung disease that causes inflammation and narrowing of the airways (National Heart 2014).

The CDC estimates that 39.5 million individuals had been diagnosed with asthma in their lifetimes. Out of the 39.5 million, 18.9 million adults and 7.1 million children suffer from asthma daily. From 2001 to 2011, individuals with asthma increased by 28%, and in 2010, asthma accounted for 3,404 deaths, 439,400 hospitalizations and 1.8 million emergency department visits. Medical expense for asthma is around 50 billion dollars each year (CDC 2013).

Asthma is a manageable condition with proper medical care. However, managing chronic conditions can be quite challenging for individuals, therefore, the development of Health Home programs could help individuals with asthma obtain and coordinate better medical care to help reduce unmanaged asthma for better health outcomes. Better care and coordination intends to reduce the number of deaths, hospitalizations and emergency visits due to asthma. Expectations of better management and utilization of medical and reduction of hospitalizations and emergency visits will improve quality of care individual's receive and reduce medical expense (Center for Medicaid 2010, CDC 2013).

As indicated earlier, chronic conditions and mental health are not independent of one another. Over fifty percent of individuals with a mental disorder also have a medical

condition (Benjamin G. Druss MD 2011). There is growing evidence that comorbidity of medical conditions and mental health disorders potentially have a negative impact on quality of life and increase healthcare utilization. Several studies have shown links between asthma and mental disorders (Goodwin, Jacobi et al. 2003, Goodwin, Fergusson et al. 2004). In one study, it was found that patients who had asthma and at least one mental health disorder reported significantly higher levels of asthma symptoms, impairment to daily functions, medication uses and emergency room visits compared to patients without a mental disorder (Feldman, Siddique et al. 2005).

The negative impact of comorbidities including chronic conditions, such as asthma, and mental health disorders, make it imperative to identify individuals as they may heavily benefit from the Health Home model for better coordination of care.

How Can Electronic Health Records Help Identify Individuals with Chronic Condition?

In 1991, the Institute of Medicine (IOM) wrote an article titled, "The Computer-Based Patient Record: An Essential Technology for Health Care," that described the need for electronic health records. The report indicated that a computer-based patient record is needed to provide better and more accurate patient care data to improve the performance and functions of the healthcare system. The IOM believes that the utilization of a computer-based patient record will improve quality of care to patients strengthening the scientific basis of clinical practice (Medicine 1997).

Since that 1991 article, the term computer-based patient record has evolved itself to electronic medical record (EMR) to the more modern term of electronic health record (EHR). The Health Information Systems Society defines EHRs as a longitudinal electronic record of patient health information generated by one or more encounters in any care

delivery setting. In essence, an EHR is a digital version of paper medical records where health data is stored electronically (Modernization 2006).

The first electronic health records were implemented in the 1960s. EHRs had a slow adoption rate due to significant technical and programmatic challenges, which are still a challenge today (Petersen 2003). However, EHRs gained further traction in the late 1990s and with the passing of the Health Information Technology for Economic and Clinical Health (HITECH) Act of 2009, widespread adoption of EHRs were further observed. From 2008 to 2013, hospital adoption of a basic EHR systems increased by more than five times, with only 9.4% of hospitals adopting a basic EHR in 2008 to 59.4% in 2013 (Dustin Charles 2014). Additionally, from 2008 to 2013, a large number of hospitals adopted advanced functionality in their EHR systems.

With the wider adoption of EHRs, a large reservoir of patient health data is being stored in electronic form. An electronic database can be of value to providers as it can allow providers to access more complete information of their patients and promote better coordination of care between health care teams (Neil Calman 2012). In addition to providing better quality of care, electronic health databases hold immense value in capturing clinical data that can be utilized for secondary purposes. For instance, providers and public health organizations can utilize the data to determine disease trends or identify patients with comorbidities. The data held within the database holds great potential as a data source for healthcare research.

Data Types Of Electronic Health Records: Structured and Unstructured Data

Electronic health records are maintained by the institution that utilizes them. Even though electronic health records are defined as longitudinal electronic records of patient

health information, which the electronic record does equate to holding all of the care records received by the patient from all service providers. Therefore, electronic health records are vendor and organization specific. However, vendors do adopt a few health information standards as they develop their electronic health records (Marcelline R. Harris 2003). The adoption of standard clinical vocabularies and structured data organization enhances the abilities of electronic health record systems for interoperability (Lee Min Lau 2005).

One of the main components of electronic health records is electronic clinical documentation. Clinical notes, patient assessments, and clinical reports can all be stored electronically within an EHR system. A majority of electronic health records allow clinical notes to be either stored in structured or unstructured format. Clinical structured data refers to data stored within the EHR based on standard clinical vocabularies. Standard clinical vocabularies allow providers to use standardized vocabulary to associate a variety of terms with the same meaning (Modernization 2006). For instance, a provider may write "hypertension" while another provider may write "high blood pressure" in a patient record. Structured data allows the providers to use a singular vocabulary to document the condition in the electronic system.

Structured clinical data follows standard clinical vocabulary set by industry standards. Structured data is often linked to payment and claims processing. Claims-based structured data uses structured billing codes such as International Classification of Diseases (ICD), Diagnosis Related Groups (DRG) and Current Procedure Terminology (CPT) codes. However, these data sets were mainly developed for billing and were not designed

to capture clinical details. This data may also be useful in identifying individuals with certain diseases and conditions as structured data expresses discrete values.

The other form of electronic clinical data is unstructured data Unstructured data follows the traditional method of producing clinical progress notes through the entry of free text and descriptive notes (David M. Rind 1993). Healthcare providers are allowed the freedom to express clinical encounters in a narrative manner not possible with standardized structured data. Natural language input allows providers to qualify descriptive symptoms, convey relationships, provide descriptions for patterns of causality, defend logic of findings and provide alternative options for care (Carol Friedman 2006).

Structured and unstructured clinical data represents the two major forms of clinical data held within electronic health records. Unstructured data allow the capture of narrative data that can be expressive while coded data captures data through a standardized template. The increased adoption of electronic health records will allow organizations to have quick and direct access to patient data. The availability of electronic health data will provide the opportunity for insight into clinical and healthcare practices and offer new opportunities for research.

Unstructured Health Data Utilization

Meaningful Use Stage 2 sets the stage to largely address the integration of structured and unstructured data into electronic health record system as health organizations must meet the requirements for meaningful use for a certified electronic health record system. Certified electronic health record systems are primarily designed for structured data, however, a significant portion of health data is unstructured. The Health Story Project indicates that 1.2 billion clinical documents are produced each year in the

United States and approximately 60 percent of the data are produced as unstructured data (Project 2014).

Unstructured clinical data includes the clinician's comments following a patient visit and can hold valuable information such as patient history, intake, examination and discharge notes. Utilization of such data is immensely useful as narrative text allows for more detail to be written about a patient visit than can be captured though structured data. However, unstructured clinical data is heavily text-based and clinicians find it frustrating having to look through reams of electronic documents to discover what they need to determine a medical decision (Terry 2013).

Given the vast amount of clinical data captured as unstructured data, researchers are developing novel methods to extract relevant information from unstructured clinical data held within electronic health records. Researchers Scott Spangler and Jeffrey Kruelen at IBM describe a three-step approach in extracting unstructured clinical data based on exploring, understanding and analyzing (Barry 2010). The first process is exploring the data to find relevant information by using a keyword search or by selecting specific structured fields to limit the amount of data that needs to be examined. However, this portion of the process does not have the ability to understand the contents, such as determining a potential diagnosis.

In order to understand the selected information, an analyzable structure needs to be created. Natural language processing (NLP) provides the ability to derive meaning from natural language input, such as unstructured clinical data, by utilizing methods of pattern matching or rule-based techniques (Barry 2010). Massachusetts General Hospital developed a Queriable Patient Inference Dossier (QPID) based on NLP that extracts data

from unstructured clinical data to answer clinical questions (Terry 2013). QPID has a library that encompasses thousands of clinical concepts that allows it to identify medical concepts captured in unstructured clinical data.

Beyond utilizing a queriable database system, many researchers manually extract unstructured data from the electronic health record system and convert the narrative data to codes or parameters to support data analytics. Extracting the data manually requires extensive time and resources as evidenced in one study took the researchers several months to convert narrative text to computable data (Elliott, Davidson et al. 2012).

As electronic health records become more widespread, although challenging, having the ability to extract valuable information from unstructured clinical data provides new opportunities to utilize the data for secondary purposes. Examining unstructured clinical data can help healthcare produce better reports, improve research, and improve overall health outcomes.

Structured Health Data Utilization

In contrast to unstructured clinical data, structured health data, such as diagnosis codes, are easier to capture and categorize into a database. Structured clinical data can be entered from a dropdown down box or through a predefined selection within the electronic health records. This type of data remains consistent as it is captured in the electronic health record and saved as a discrete value in the database.

Structured clinical health data hold potential for secondary utilization purposes, but the current lack of uniformity in terminology and definitions limit their true potential. Furthermore, clinicians' capturing clinical data as unstructured free-text after each patient encounter compounds this limitation to utilizing structured data (Raths 2013). Therefore, a

movement to standardize clinical data has been conferred by the Structured Data Capture Initiative. The goal of the initiative is to develop and validate a standards-based data architecture where structured set of data can be access from the electronic health record (Initiative 2012). The initiative has am ambitious goal of identifying, evaluating and harmonizing four new standards that will allow electronic health records to capture and store structured data.

Current structured clinical data coding elements comes from uncontrolled vocabulary that is derived from a variety of clinical definition sources such as First Data for drug databases, Systematic Nomenclature of Medicine (SNOMED) for clinical terminology, ICD for coding diseases, signs and symptoms that are classified by the World Health Organization and Logical Observation Identifiers Names and Codes (LOINC) for identifying medical laboratory observations. These current standard structure data coding elements allows data to be captured in the electronic health record that can be easily identifiable for data-mining and analytic purposes (Futrell 2013).

Structured clinical data encoded with a standardized vocabulary ensures the data are captured and structured in consistent format each time a data element is entered into the system. This allows for more direct extraction and use of the data for secondary purposes and review (Initiative 2012, Futrell 2013). For instance, if a electronic health record system utilizes ICD-9 codes for coding diseases, clinicians can select the specific code for a particular disease, that code will be captured in the database. To find clinical records for that disease at a later time, a query against the database can be utilized to retrieve the electronic records with matching codes.

Current methodology in extracting structured data from electronic health records for disease identification relies on information retrieval methods based on Structured Query Language (SQL) or through business intelligence interface. SQL is a programming language that was created to provide the ability to manage and querying data held in a relational database management system. Business intelligence (BI) interfaces (e.g. SAP, Oracle BU, etc.) presents a graphical user interface to the user in which they may select the criteria needed in their query.

Structured health data captured in electronic health record systems are positioned to be a powerful information resource for data analytics (Futrell 2013). Healthcare facilities utilizing structured health data can produce better reporting and provide better clinical decision support information to their clinicians. The advancement of standardized structured data elements enables synoptic reporting to be quick, complete and concise when compared to unstructured clinical data, which lacks relational structure.

Conclusion

This chapter reviews the goals of Health Homes and the current burden of individuals with comorbidities of mental health disorders and chronic conditions on the healthcare system. This burden presents the need to be able to identify qualifying individuals utilizing electronic health record data. However, clinical data held within electronic health record systems can be either captured as structured or unstructured data. It can be concluded that a majority of clinical health data held within electronic health records are captured as unstructured data. Although most research have been firmly focused on medical electronic health records, those concepts and conclusions can be easily extended to mental health electronic health records as they both share similar capabilities.

Given the fact that clinical data can be captured as unstructured data or structured data, the definitions and extraction methods discussed can be used to develop a method to extract relevant information from the Kansas Mental Health Electronic Health Record to identify individuals with chronic conditions.

Chapter 3: Methodology and Approach

Introduction

This chapter intends to describe the methodology for deriving the process to determine individuals with chronic conditions, utilizing data held within the Kansas Mental Health Electronic Health Record system.

Methodology and Approach

A data flow analysis was completed on the Kansas Mental Health Electronic Health Record system to identify where the clinical data was being captured within the electronic health record. The identification on where the data were being captured provided the insight to extrapolate a potential data model. Methodologies were developed to extract the relevant information based on the data model, and identify candidate individuals for Chronic Care health Homes.

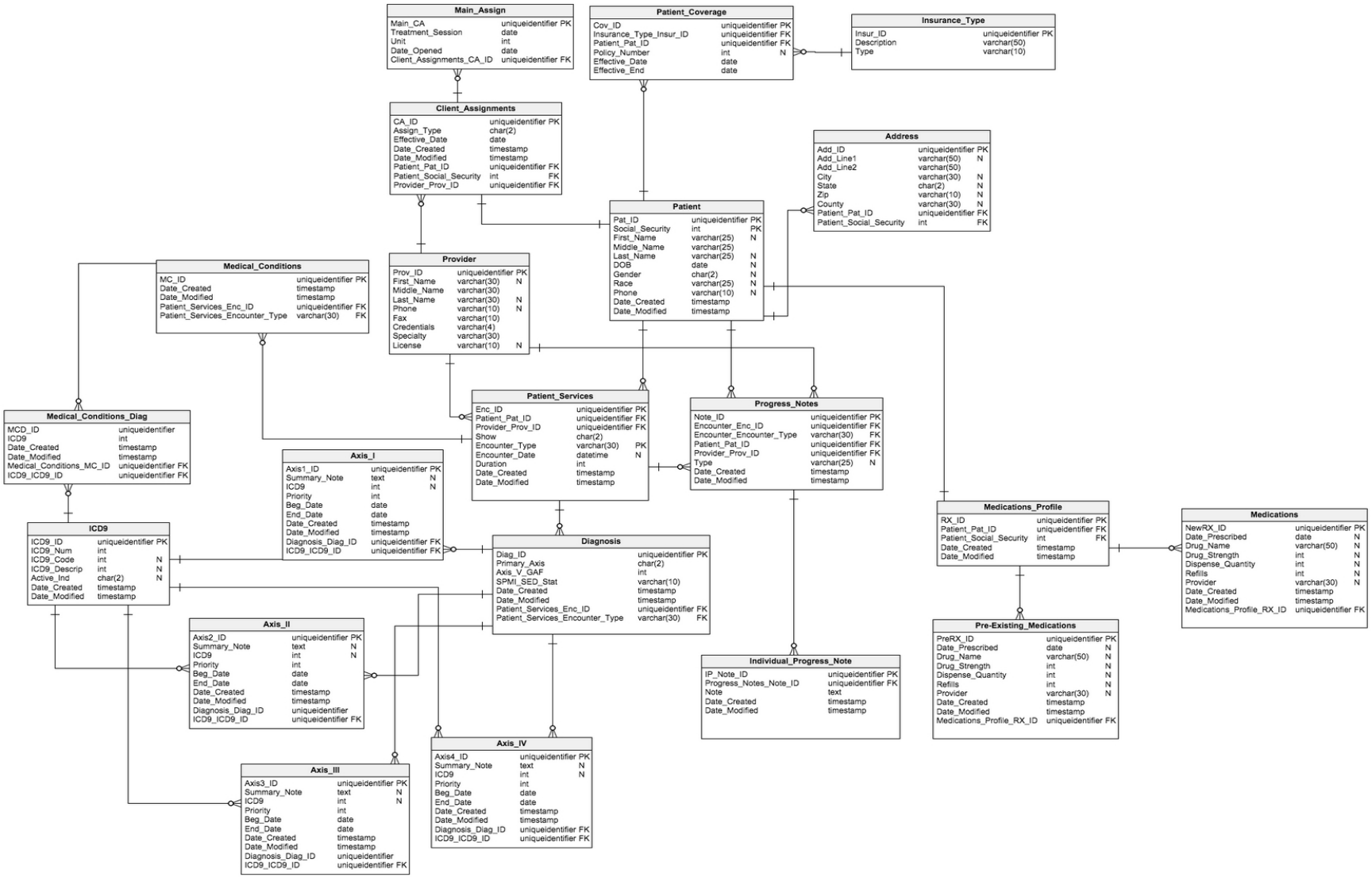
Utilizing the access to the mental health electronic health record, several reviewing sessions were conducted with the information officer at the mental health organizations and a data-modeling analyst to define and map the possible structure of the database. Figure 1 shows the relationship between relevant data tables in capturing data from the electronic health record. The Patient Table provide as the central table for this particular model as this study is interested in defining the process in identifying individuals with

chronic conditions. Within this system, the clinical data can be captured as unstructured or structured data, therefore, careful consideration was given to how the system captures and stores the clinical data within the database. Attributes of each table were identified and shown on the data model. However, only relevant attributes that pertain to the identification of individuals based on the criteria set forth for this study, (individuals who are Medicaid beneficiaries, have a chronic condition, such as asthma, are not classified as SMI, and are not already enrolled in a Health Home) were shown on this model.

It was determined during the evaluation of the mental health electronic record system that the structured clinical data only utilized standardized structured data coding from ICD-9 for disease identification. A data table referencing the ICD-9 codes linked to the Axis and medical conditions table. It was further determined that Axis III holds the relevant clinical data for medical conditions within the mental health electronic health record system. However, the system is in preparation to accept the new methods in capturing health data through the medical conditions table from unstructured to structured clinical data.

The medical conditions table was developed to follow the new guidelines set forth by the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5) where the multi-axial system of diagnosis have been retired. Even though DSM-5 has not been fully adopted, the medication conditions table for capturing structured clinical data has been made available to clinicians and some have begun to utilize the new capability. Therefore, it is important to identify the table's significance in identifying qualified individuals for Health Homes.

Figure 1: Data Model of the Kansas Mental Health Electronic Health Record System Depicting Relevant Data Tables Holding Clinical Data for Identifying Individuals with Chronic Conditions.



The requirements for enrollment into the Kansas Health Home program requires that the individual be a Medicaid beneficiary, have one severe and persistent mental illness or have one chronic condition with risk for developing a secondary condition. Chronic conditions that currently qualify include anyone with asthma or diabetes (including pre-diabetes and metabolic syndrome) (Environment 2014). The State of Kansas will identify eligible members and assign them to community health partners who are designated to provide Health Home services. However, there is a concern that individuals who may qualify are being missed by the State's process. For the purpose of this study, asthma is the only chronic condition that will be used to qualify individuals with the belief that the process can later be extended to include additional chronic conditions To determine the qualification set by the State in identifying individuals with asthma for enrollment into a Health Home, several interviews were conducted with business analysts that were responsible for identifying members for enrollment. This resulted in the case definition for asthma that was used for this study. Enrollment identifications parameters for individuals with asthma were derived from the case definition and used in the methodology for identifying individuals at the mental health center through electronic health record data extraction that were not previously identified by the State..

During the development of the process, several important questions were identified:

- Is there a standard case definition for chronic conditions?
- Is there one for asthma?
- How are the unstructured clinical data stored within the database?
- What type of query method may suitable in extracting the data?
- Are the structured data captured consistent?

- Would using SQL query method be able to extract the necessary data?
- How taxing will the query methods be on the system?

Answering these questions helped define a clearer process for identifying individuals with chronic conditions that qualify for enrollment into a Health Home.

Chapter 4: Process to Identify Individuals with Chronic Conditions

Application of Known Techniques for Data Extraction

Clinical health data is captured as either structured or unstructured data within the Mental Health electronic health record system. Therefore, two separate data extraction methods were developed. SQL is one the more common languages to query data held within relational databases. Therefore, several SQL queries were developed to query the database and extract the information needed to identify individuals who may qualify for enrollment into a Kansas Health Home. The suggested code for querying the database is only based on the perceived relationships of the tables in the data model developed previously (Figure 1).

Case Definition for Asthma

The case definition for this study was established to follow the Surveillance Case Definition for Asthma as defined by the National Center for Environmental Health (NCEH) at the Center for Disease Control and Prevention (CDC). The NCEH defines cases for asthma based on mortality and hospital discharge, prevalence, and clinical and laboratory records. The following classification table is from NCEH (Health 2010):

III. Clinical and Laboratory Classification	
Clinical Criteria	**Definitive Laboratory Criteria**
Presence of wheezing lasting 2 or more consecutive days, chronic cough that responds to bronchodilation that persists 3-6 weeks in the absence of allergic rhinitis or sinusitis, nocturnal awakening with dyspnea, cough and/or wheezing in the absence of other medical conditions known to cause these symptoms.	Pulmonary function testing (spirometry: FEV_1, FVC) demonstrating a 12% increment after the patient inhales a short-acting bronchodilator; a 20% decrement in FEV1 after a challenge by histamine, methacholine, exercise or cold air 20% diurnal variation in peak expiratory flow over 1 to 2 weeks

Case Classification
Confirmed A confirmed case met any of the clinical symptoms at least 3 times during the past year AND at least one of the laboratory criteria.
Probable A probable case meets any of the following: In the absence of supporting laboratory criteria, presence of any of the clinical symptoms which have been reversed by physician treatment with asthma medications and have occurred at least 3 times during the past year. In the absence of supporting clinical criteria, met at least one of the laboratory criteria during the past year. In the absence of supporting laboratory or clinical criteria, taken medications in the past year that were prescribed by a physician for asthma.
Possible A suspect case meets any of the following: the presence of any of the following during the past year: shortness of breath on exertion, presence of wheezing or chronic cough in the absence of obvious respiratory infection presence of increased nasal secretion, mucosal swelling, nasal polyps, or chronic sinusitis hyper expansion of the thorax, sounds of wheezing during normal breathing prolonged phase of forced exhalation, chest x ray showing hyper expansion, FEV1 less than 80% of predicted value.

Table 1: Clinical and Laboratory Classification for Asthma Case Definition as defined by the National Center for Environmental Health.
(Health 2010)

The case definition established the NCEH has clear clinical criteria for case classification that will help establish the parameters in the SQL queries for extracting narrative unstructured data. For structured clinical data, business analysts for the State of Kansas indicated that any individuals who had a diagnosis code of 493.X for asthma within the past 12 to 18 months would be eligible for enrollment into a Health Home. Additionally, individuals who have received an asthma quick-relief medication within the past 12

months are also eligible. The following table indicates qualifying asthma quick-relief medications (National Heart 1997):

Asthma Quick-Relief Medications

Generic name	Brand name
Short-Acting Beta$_2$-Agonists: Inhaled	
albuterol	Airet® Proventil® Proventil HFA® Ventolin® Ventolin® Rotacaps
bitolterol pirbuterol terbutaline	Tornalate® Maxair® Brethaire® Brethine® (tablet only) Bricanyl® (tablet only)

Table 2: Asthma Quick-Relief Medications table that Qualify Individuals for Enrollment into a Health Home
(National Heart 1997)

Finally, any hospitalization related to asthma within the past 12 months also qualifies individuals for enrollment into a Health Home.

Population Definition

Figure 2 is a hierarchy diagram that represents the qualifying critieria for Chronic Care Health Homes as structured logic, and is used to guide the SQL queries. The population of interest for this particular study is individuals who are not classified with a severe mental illness, Medicaid beneficiaries, whom have been diagnosis with asthma within the past 12 to 18 months, and/or received an asthma quick-relief medication within

the past 12, and/or had a hospitalization within the past 12 months related to asthma complications, and are not already enrolled in a Health Home.

Figure 2: Hierarchical diagram for determining qualify individuals within a mental health electronic health record for enrollment into a Health Home.

SQL Queries for Structure Data Extract

Relevant clinical data needed to identify individuals who have asthma are held either as structured or unstructured data in various tables captured by the electronic

health record. Therefore, the SQL queries developed address the form of clinical data and the relative location of the data held within the database. All queries include a core set of attributes to be queried from the database. The core set of attributes includes policy id, patient's name, date of birth, insurance type and their assignment.

Joining tables within the database allows the query to pull related relevant data from several tables that have a common attribute. In this instance, the common attribute is the patient id and all relevant clinical data tables that tie to the patient table. For all queries, structured or unstructured, joins to patient coverage, insurance type, client assignment and main assignment are needed to filter and include only those individuals who have active Medicaid and not been assigned to a health home. We define these specific parameters in the where statement of the SQL queries in tables 3 through 8 and are shown in detail on figure 3.

```
SELECT

PC.Policy_Number as "Policy ID",
PT.First_Name | ' ' | Pt.Last_Name as "Client Name",
PT.DOB as "Client's DOB",
IT.Type as "Insurance Type",
MA.Unit as "Assignment",
ICD9.Code as "ICD-9 Code",
ICD9.Descrip as "ICD-9 Description"

FROM Patient PT

JOIN Patient_Coverage PC on PC.Patient_Pat_ID = PT.Pat_ID
JOIN Insurance_Type IT on IT.Insur_ID = PC.Insurance_Type_Insur_ID
JOIN Client_Assignments CA on CA.Patient_Pat_ID = PT.Pat_ID
JOIN Main_Assign MA on MA.Client_Assignments_CA_ID = CA.CA_ID
JOIN Patient_Services PS on PS.Patient_Pat_ID = PT.Pat_ID
JOIN Diagnosis DI on DI.Patient_Services_Enc_ID = PS.Enc_ID
JOIN AXIS_III A3 on A3.Diagnosis_Diag_ID = DI.Diag_ID
JOIN ICD9 on ICD9.ICD9_ID = A3.ICD9_ICD9_ID

WHERE

/*Search for Only Patients with Medicaid */
IT.Type = 'Medicaid'

/* Define time period of insurance effective to ensure they still have active Medicaid. */
/* ? will prompt user of the code to enter the effective end date and provides information of the format to input the date. */
AND PC.Effective_End >= ?End_Date_YYYYMMDD

/* Search for Patients not already enrolled in Health Homes. 500 Code stands for Health Homes. */
AND MA.Unit <> '500'

/* Search for Diagnosis Based on ICD9 Codes */
/* ICD-9 493.X is a Diagnosis Code for Asthma */
AND ICD9.ICD9_Code LIKE '493%'

/* Search Based on Begin Date for Diagnosis */
AND A3.Beg_Created >= ?Beg_Date_YYYYMMDD
```

Figure 3: Depiction of standard elements found in all SQL queries developed in this thesis

All codes extract policy ID, client's name, client's DOB, insurance type, and assignment attributes in the select statement. Additionally, all codes join tables to patient coverage, insurance type, client assignment and main assignment. Finally, specific codes are define to only search Medicaid beneficiaries from a certain date and are not already enrolled in a health home from the where statement.

For structured clinical data to further identify only individuals with asthma, the relevant tables include AXIS III and medical conditions data tables that capture ICD-9 codes, and medication, and pre-existing medication data tables that capture the medications related to the patient. Tables 3 and 4 provide the SQL queries to search for the specific ICD-9 code for asthma. As defined by the case definition, the specific ICD-9 codes for asthma are between 493.0 to 493.9. In order for SQL query to search for all codes between 493.0 and 493.9, the query is designed to utilize a wildcard character. A wildcard is used to substitute in other characters in the string. For these two queries, we used the wildcard "%" after 493. This allows the query to search for any ICD-9 codes that begin with 493 regardless of the numbers afterwards.

In addition to the Axis III and medical conditions table, relevant structured clinical data for identifying individuals with asthma are also held in the pre-existing medication and medication tables of the electronic health record. The queries developed for table 5 and 6 search for fast acting asthma medications that would identify an individual as having asthma. These particular medications may have multiple strengths, therefore, using the wildcard character is also useful. The wildcard would allow the query to search the related tables for the drug name and any strength related to the drug.

Furthermore, the SQL queries include a where clause to search within certain timeframes as well. Each query has an embedded clause to only include records where the effective end date of the patient's Medicaid is greater than a given time parameter. This code allows the user who runs the query to put in the appropriate date and only query for members whose effective end date is greater than the date provided. This effectively allows the query to only return members whose Medicaid has not ended. However, timeframe

criteria are not limited to effective end date for Medicaid. The State of Kansas also has additional criteria for individuals who would qualify includes diagnosis of asthma within the past 18 months or used a fast acting asthma medication within the past 12 months. Therefore, additional codes for timeframe selection of asthma diagnosis or asthma medication utilization are included in the search criteria. The codes are also set to search for diagnosis or drug utilization greater than a certain period as specified by the individual running the query.

```
SELECT

PC.Policy_Number as "Policy ID",
PT.First_Name | ' ' | Pt.Last_Name as "Client Name",
PT.DOB as "Client's DOB",
IT.Type as "Insurance Type",
MA.Unit as "Assignment",
ICD9.Code as "ICD-9 Code",
ICD9.Descrip as "ICD-9 Description"

FROM Patient PT

JOIN Patient_Coverage PC on PC.Patient_Pat_ID = PT.Pat_ID
JOIN Insurance_Type IT on IT.Insur_ID = PC.Insurance_Type_Insur_ID
JOIN Client_Assignments CA on CA.Patient_Pat_ID = PT.Pat_ID
JOIN Main_Assign MA on MA.Client_Assignments_CA_ID = CA.CA_ID
JOIN Patient_Services PS on PS.Patient_Pat_ID = PT.Pat_ID
JOIN Diagnosis DI on DI.Patient_Services_Enc_ID = PS.Enc_ID
JOIN AXIS_III A3 on A3.Diagnosis_Diag_ID = DI.Diag_ID
JOIN ICD9 on ICD9.ICD9_ID = A3.ICD9_ICD9_ID

WHERE

/*Search for Only Patients with Medicaid */
IT.Type = 'Medicaid'

/* Define time period of insurance effective to ensure they still have active Medicaid. */
/* ? will prompt user of the code to enter the effective end date and provides information of the format to input the date. */
AND PC.Effective_End >= ?End_Date_YYYYMMDD

/* Search for Patients not already enrolled in Health Homes. 500 Code stands for Health Homes. */
AND MA.Unit <> '500'

/* Search for Diagnosis Based on ICD9 Codes */
/* ICD-9 493.X is a Diagnosis Code for Asthma */
AND ICD9.ICD9_Code LIKE '493%'

/* Search Based on Begin Date for Diagnosis */
AND A3.Beg_Created >= ?Beg_Date_YYYYMMDD
```

Table 3: SQL Code for structured data querying for asthma from AXIS III Table.

This code queries for individuals who may have been diagnosed with asthma and data capture of the diagnosis is in a structured data format of ICD-9 code in the AXIS III table. The query effectively joins tables to the AXIS III table where the code is held. A specific query for ICD-9 493.XX is indicated on the where statement to pull results for individuals with diagnosis with that code for asthma. Also, date diagnosis began parameter is added to search within a specific timeframe.

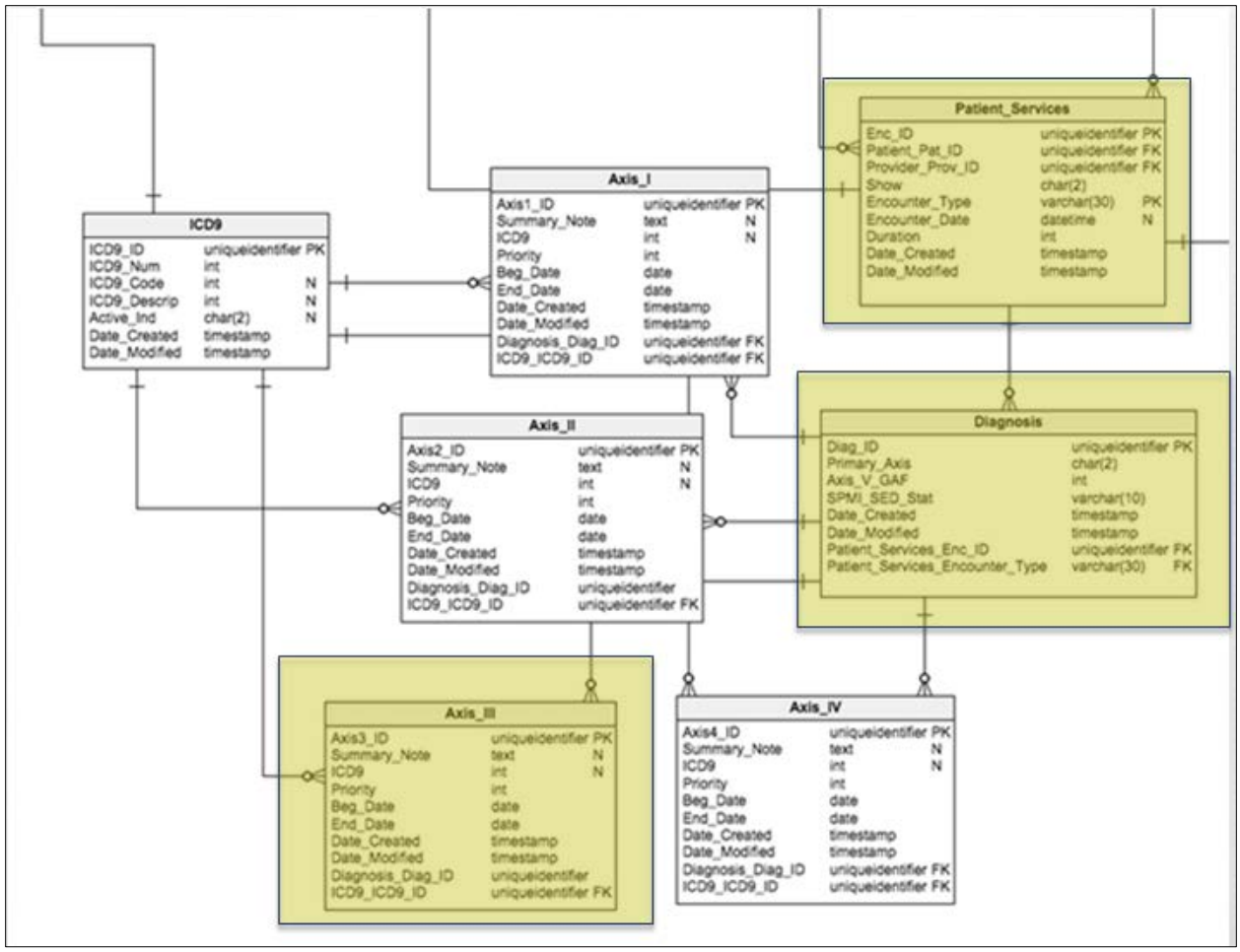


Figure 4: Table Reference for AXIS III

This figure should the reference tables and their relationship for the joins to query the data from the AXIS III table for ICD-9 codes.

```
SELECT

PC.Policy_Number as "Policy ID",
PT.First_Name | ' ' | Pt.Last_Name as "Client Name",
PT.DOB as "Client's DOB",
IT.Type as "Insurance Type",
MA.Unit as "Assignment",
ICD9.Code as "ICD-9 Code",
ICD9.Descrip as "ICD-9 Description"

FROM Patient PT

JOIN Patient_Coverage PC on PC.Patient_Pat_ID = PT.Pat_ID
JOIN Insurance_Type IT on IT.Insur_ID = PC.Insurance_Type_Insur_ID
JOIN Client_Assignments CA on CA.Patient_Pat_ID = PT.Pat_ID
JOIN Main_Assign MA on MA.Client_Assignments_CA_ID = CA.CA_ID
JOIN Patient_Services PS on PS.Patient_Pat_ID = PT.Pat_ID
JOIN Medical_Conditions MC on MC.Patient_Services_Enc_ID = PS.Enc_ID
JOIN Medical_Conditions_Diag MCD on MCD.Medical_Conditions_MC_ID = MC.MC_ID
JOIN ICD9 ICD9M on ICD9M.ICD9_ID = MCD.ICD9_ICD9_ID

WHERE

/*Search for Only Patients with Medicaid */
IT.Type = 'Medicaid'

/* Define time period of insurance effective to ensure they still have active Medicaid. */
/* ? will prompt user of the code to enter the effective end date and provides information of the format to input the date. */
AND PC.Effective_End >= ?End_Date_YYYYMMDD

/* Search for Patients not already enrolled in Health Homes. 500 Code stands for Health Homes. */
AND MA.Unit <> '500'

/* Search for Diagnosis Based on ICD9 Codes */
/* ICD-9 493.X is a Diagnosis Code for Asthma */
AND ICD9.ICD9_Code LIKE '493%'

/* Search Based on Created Date for Diagnosis */
AND MCD.Date_Created >= ?Created_Date_YYYYMMDD
```

Table 4: SQL code for structured data querying for asthma from medical conditions table.

This code queries for individuals who may have been diagnosed with asthma and data capture of the diagnosis is in a structured data format of ICD-9 code in the medical conditions table. The query effectively joins tables to the medical conditions table where the code is held. A specific query for ICD-9 493.XX is indicated on the where statement to pull results for individuals with diagnosis with that code for asthma. Also, date created parameter is added to search within a specific timeframe.

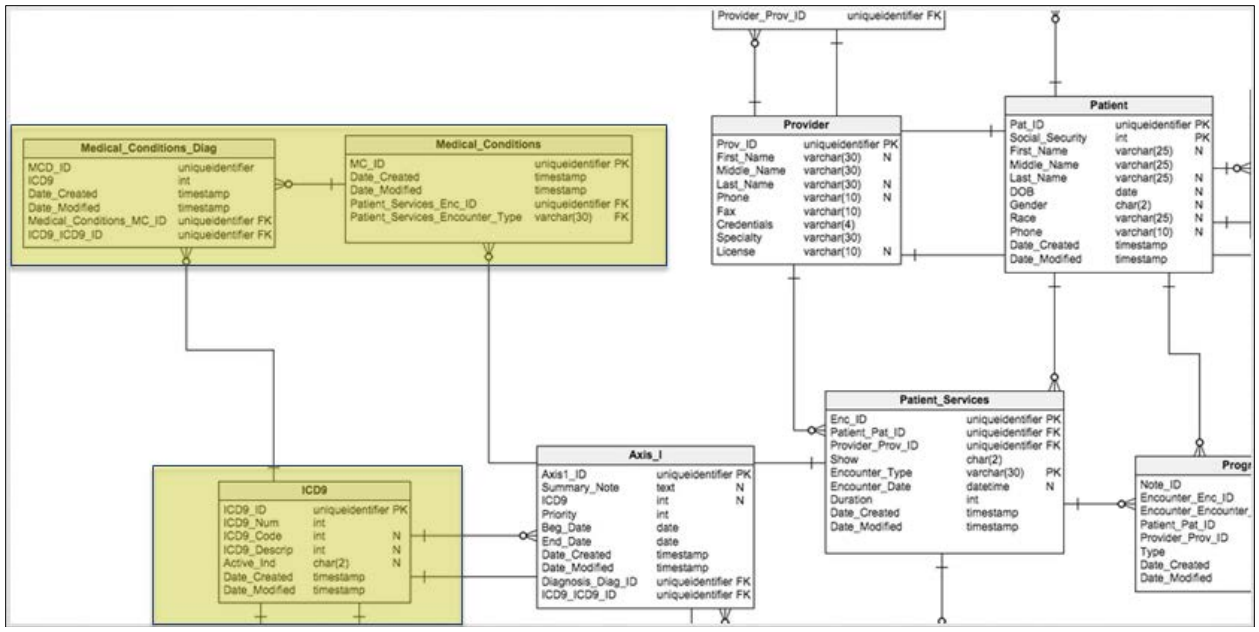


Figure 5: Table Reference for Medical Conditions

This figure should the reference tables and their relationship for the joins to query the data from the Medical Conditions table for ICD-9 codes.

```
SELECT

PC.Policy_Number as "Policy ID",
PT.First_Name | ' ' | Pt.Last_Name as "Client Name",
PT.DOB as "Client's DOB",
IT.Type as "Insurance Type",
MA.Unit as "Assignment",
PRE.Date_Prescriped as "Drug Date Prescribed",
PRE.Drug_Name as "Drug Name"

FROM Patient PT

JOIN Patient_Coverage PC on PC.Patient_PAt_ID = PT.Pat_ID
JOIN Insurance_Type IT on IT.Insur_ID = PC.Insurance_Type_Insur_ID
JOIN Client_Assignments CA on CA.Patient_Pat_ID = PT.Pat_ID
JOIN Main_Assign MA on MA.Client_Assignments_CA_ID = CA.CA_ID
JOIN Patient_Services PS on PS.Patient_Pat_ID = PT.Pat_ID
JOIN Medications_Profile MP on MP.Patient_Pat_ID = PT.Pat_ID
JOIN Pre_Existing_Medications PRE on PRE.Medications_Profile_RX_ID = MP.RX_ID

WHERE

/*Search for Only Patients with Medicaid */
IT.Type = 'Medicaid'

/* Define time period of insurance effective to ensure they still have active Medicaid. */
/* ? will prompt user of the code to enter the effective end date and provides information of the format to input the date. */
AND PC.Effective_End >= ?End_Date_YYYYMMDD

/* Search for Patients not already enrolled in Health Homes. 500 Code stands for Health Homes. */
AND MA.Unit <> '500'

/* Search for patients based on quick acting medications for Asthma */
AND (PRE.Drug_Name Like 'Alret%' OR PRE.Drug_Name Like 'Proventil%' OR PRE.Drug_Name Like 'Ventolin%' OR
     PRE.Drug_Name Like 'Tornalate%' OR PRE.Drug_Name Like 'Maxair%' OR PRE.Drug_Name Like 'Brethaire%' OR
     PRE.Drug_Name Like 'Brethine%' OR PRE.Drug_Name Like 'Bricanyl%')

/* Search date medication was prescribed. */
AND MS.Date_Prescribed >= ?Prescribed_Date_YYYYMMDD
```

Table 5: SQL code for structured data querying for asthma from pre-existing medications table.

This code queries for individuals who may have received a short acting asthma medication and data capture of the medication is in a structured data format found on the pre-existing medication's table. The query effectively joins tables to the pre-existing medication table where the code is held. A specific query for short acting medication is indicated on the where statement to pull results for individuals with diagnosis with that code for asthma. Also, date prescribed parameter is added to search within a specific timeframe.

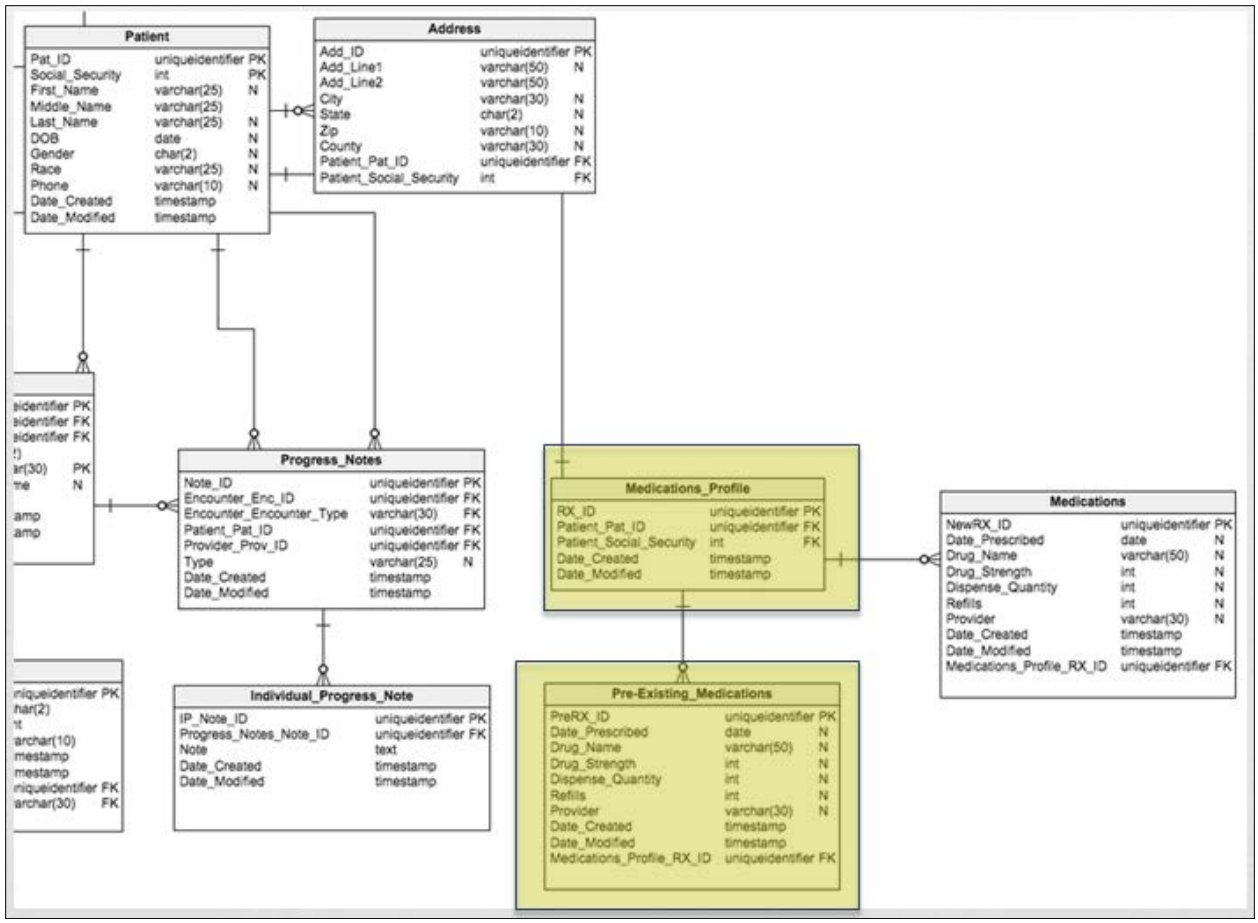


Figure 6: Table Reference for Pre-Existing Medications

This figure should the reference tables and their relationship for the joins to query the data from the Pre-Existing Medications table for asthma associated medications.

```
SELECT

PC.Policy_Number as "Policy ID",
PT.First_Name | ' ' | Pt.Last_Name as "Client Name",
PT.DOB as "Client's DOB",
IT.Type as "Insurance Type",
MA.Unit as "Assignment",
MS.Date_Prescriped as "Drug Date Prescribed",
MS.Drug_Name as "Drug Name"

FROM Patient PT

JOIN Patient_Coverage PC on PC.Patient_PAt_ID = PT.Pat_ID
JOIN Insurance_Type IT on IT.Insur_ID = PC.Insurance_Type_Insur_ID
JOIN Client_Assignments CA on CA.Patient_Pat_ID = PT.Pat_ID
JOIN Main_Assign MA on MA.Client_Assignments_CA_ID = CA.CA_ID
JOIN Patient_Services PS on PS.Patient_Pat_ID = PT.Pat_ID
JOIN Medications_Profile MP on MP.Patient_Pat_ID = PT.Pat_ID
JOIN Medications MS on MS.Medications_Profile_RX_ID = MP.RX_ID

WHERE

/*Search for Only Patients with Medicaid */
IT.Type = 'Medicaid'

/* Define time period of insurance effective to ensure they still have active Medicaid. */
/* ? will prompt user of the code to enter the effective end date and provides information of the format to input the date. */
AND PC.Effective_End >= ?End_Date_YYYYMMDD

/* Search for Patients not already enrolled in Health Homes. 500 Code stands for Health Homes. */
AND MA.Unit <> '500'

/* Search for patients based on quick acting medications for Asthma */
AND (MS.Drug_Name Like 'Alret%' OR MS.Drug_Name Like 'Proventil%' OR MS.Drug_Name Like 'Ventolin%' OR
     MS.Drug_Name Like 'Tornalate%' OR MS.Drug_Name Like 'Maxair%' OR MS.Drug_Name Like 'Brethaire%' OR
     MS.Drug_Name Like 'Brethine%' OR MS.Drug_Name Like 'Bricanyl%')

/* Search date medication was prescribed. */
AND MS.Date_Prescribed >= ?Prescribed_Date_YYYYMMDD
```

Table 6: SQL code for structured data querying for asthma from medications table.

This code queries for individuals who may have received a short acting asthma medication and data capture of the medication is in a structured data format found on the medications table. The query effectively joins tables to the medications table where the code is held. A specific query for short acting medication is indicated on the where statement to pull results for individuals with diagnosis with that code for asthma. Also, date prescribed parameter is added to search within a specific timeframe.

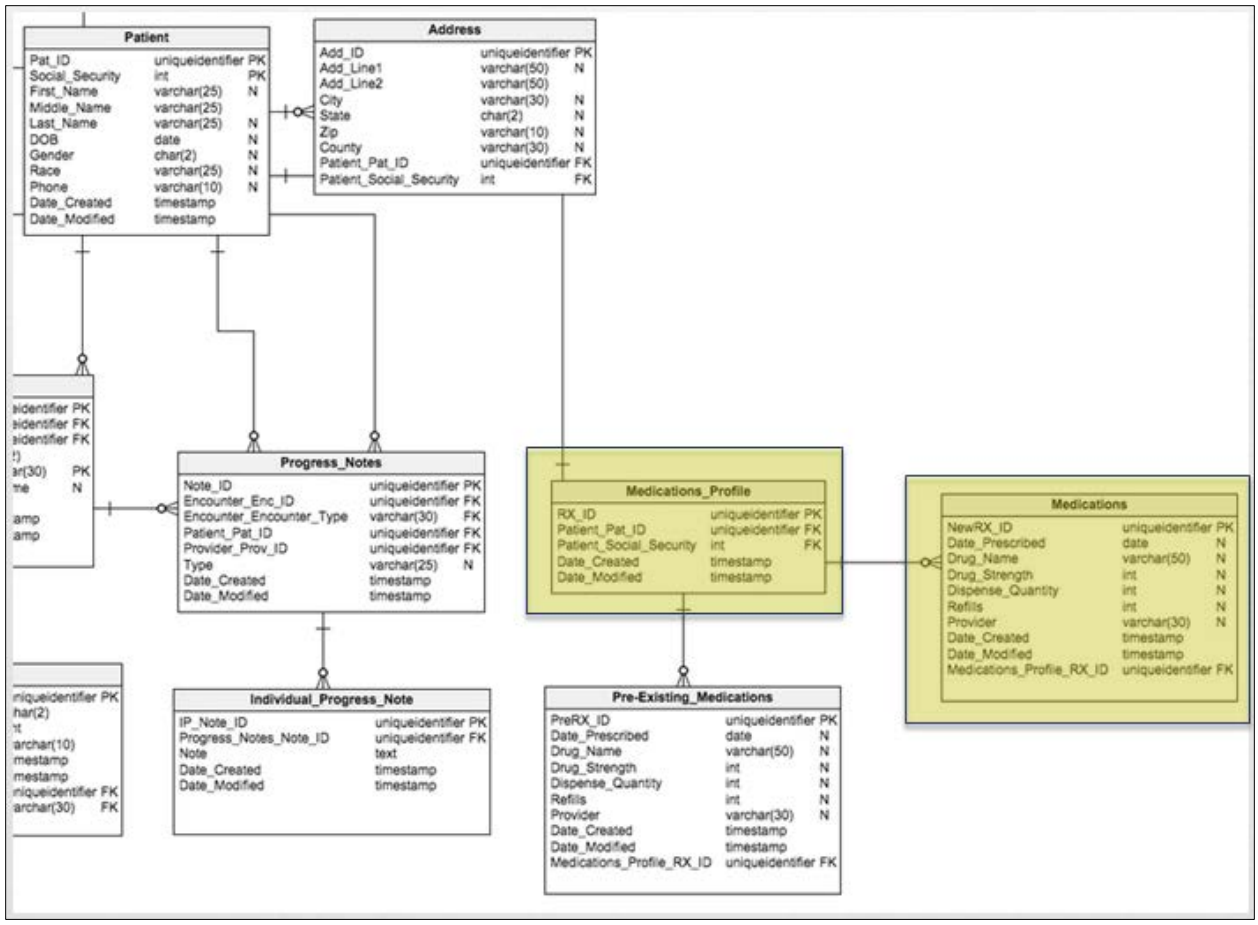


Figure 7: Table Reference for Medications

This figure should the reference tables and their relationship for the joins to query the data from the Medications table for asthma associated medications.

SQL Queries for Unstructured Data Extract

Unstructured data queries follow many of the same schema as the structured clinical data queries. However, the query is based on searching for free text held within the electronic health record system. Relevant free text clinical data are captured in the individual progress notes and the summary note of the Axis III. Therefore, to search for free

text from those tables, the query has to join tables that link the patient to the relevant tables.

The free text query searches for text that matches the clinical criteria for asthma as defined by the case definition for asthma surveillance. The terms being searched include wheezing, chronic cough, dyspnea, FEV, pulmonary function test, asthma, bronchodilation and shortness of breath. The query will return results with any records that have those terms in the free text.

However, querying free text only pulls records with the defined terms specified in the query. As mentioned earlier, unstructured data requires more involvement to interrupt the results. This query only allows for the early stage of data discover for unstructured clinical data and cannot be used definitively to identify individuals with asthma. In order to confirm an individual has asthma, further analysis of the records pulled from this query is required, and beyond the scope of this study.

```
SELECT

PC.Policy_Number as "Policy ID",
PT.First_Name | ' ' | Pt.Last_Name as "Client Name",
PT.DOB as "Client's DOB",
IT.Type as "Insurance Type",
MA.Unit as "Assignment",
IPN.Note as "Individual Progress Note"

FROM Patient PT

JOIN Patient_Coverage PC on PC.Patient_PAt_ID = PT.Pat_ID
JOIN Insurance_Type IT on IT.Insur_ID = PC.Insurance_Type_Insur_ID
JOIN Client_Assignments CA on CA.Patient_Pat_ID = PT.Pat_ID
JOIN Main_Assign MA on MA.Client_Assignments_CA_ID = CA.CA_ID
JOIN Patient_Services PS on PS.Patient_Pat_ID = PT.Pat_ID
JOIN Progress_Notes PN on PN.Encounter_ID = PS.Enc_ID
JOIN Individual_Progress_Note IPN on IPN.Progress_Notes_Note_ID = PN.Note_ID

WHERE

/*Search for Only Patients with Medicaid */
IT.Type = 'Medicaid'

/* Define time period of insurance effective to ensure they still have active Medicaid. */
/* ? will prompt user of the code to enter the effective end date and provides information of the format to input the date. */
AND PC.Effective_End >= ?End_Date_YYYYMMDD

/* Search for Patients not already enrolled in Health Homes. 500 Code stands for Health Homes. */
AND MA.Unit <> '500'

/* Search for Free-Text Embedded in the individual progress note that matches clinical criteria for asthma. */
AND (IPN.Note Like '%wheezing%' OR IPN.Note Like '%chronic cough%' OR IPN.Note Like '%dyspnea%' OR
     IPN.Note Like '%FEV%' OR IPN.Note Like '%pulmonary function test%' OR IPN.Note Like '%asthma%'
    IPN.Note Like '%bronchodilation%' OR IPN.Note Like '%shortness of breath%')

/* Search date note was created. */
AND IPN.Date_Created >= ?Created_Date_YYYYMMDD
```

Table 7: SQL code for unstructured data querying for asthma based on clinical criteria from individual progress note table.

This code queries for free text embedded in the individual progress notes. This query searches for terms that match the clinical criteria set by the case definition for determining individuals with asthma. Essential joins of relevant tables to the individual progress notes is shown in the code. Searching for free text requires utilization of wildcard character to be able to extract the data properly. Date created parameter is added to search within a specific timeframe.

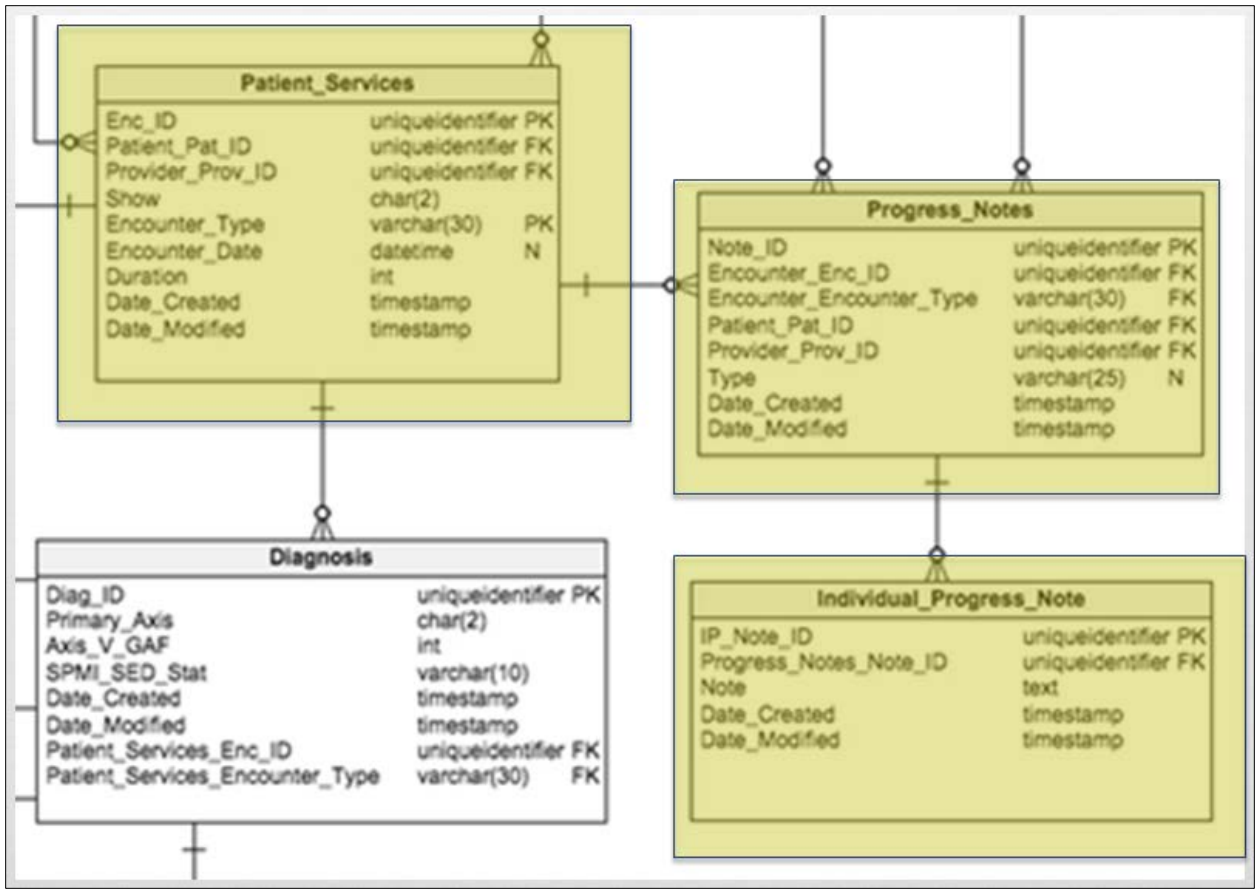


Figure 8: Table Reference for Individual Progress Note

This figure should the reference tables and their relationship for the joins to query the data from the individual progress note table for asthma associated clinical terms embedded as free-text.

```sql
SELECT

PC.Policy_Number as "Policy ID",
PT.First_Name | ' ' | Pt.Last_Name as "Client Name",
PT.DOB as "Client's DOB",
IT.Type as "Insurance Type",
MA.Unit as "Assignment",
A3.Summary_Note as "Axis III Summary Note"

FROM Patient PT

JOIN Patient_Coverage PC on PC.Patient_PAt_ID = PT.Pat_ID
JOIN Insurance_Type IT on IT.Insur_ID = PC.Insurance_Type_Insur_ID
JOIN Client_Assignments CA on CA.Patient_Pat_ID = PT.Pat_ID
JOIN Main_Assign MA on MA.Client_Assignments_CA_ID = CA.CA_ID
JOIN Patient_Services PS on PS.Patient_Pat_ID = PT.Pat_ID
JOIN Diagnosis DI on DI.Patient_Services_Enc_ID = PS.Enc_ID
JOIN AXIS_III A3 on A3.Diagnosis_Diag_ID = DI.Diag_ID

WHERE

/*Search for Only Patients with Medicaid */
IT.Type = 'Medicaid'

/* Define time period of insurance effective to ensure they still have active Medicaid. */
/* ? will prompt user of the code to enter the effective end date and provides information of the format to input the date. */
AND PC.Effective_End >= ?End_Date_YYYYMMDD

/* Search for Patients not already enrolled in Health Homes. 500 Code stands for Health Homes. */
AND MA.Unit <> '500'

/* Search for Free-Text Embedded in the summary note of Axis III that matches clinical criteria for asthma. */
AND (A3.Note Like '%wheezing%' OR A3.Note Like '%chronic cough%' OR A3.Note Like '%dyspnea%' OR
     A3.Note Like '%FEV%' OR A3.Note Like '%pulmonary function test%' OR A3.Note Like '%asthma%'
    A3.Note Like '%bronchodilation%' OR A3.Note Like '%shortness of breath%')

/* Search date note was created. */
AND A3.Date_Created >= ?Created_Date_YYYYMMDD
```

Table 8: SQL code for unstructured data querying for asthma based on clinical criteria from Axis III summary note table.

This code queries for free text embedded in the AXIS III summary notes. This query searches for terms that match the clinical criteria set by the case definition for determining individuals with asthma. Essential joins of relevant tables to the summary notes is shown in the code. Searching for free text requires utilization of wildcard character to be able to extract the data properly. Date created parameter is added to search within a specific timeframe.

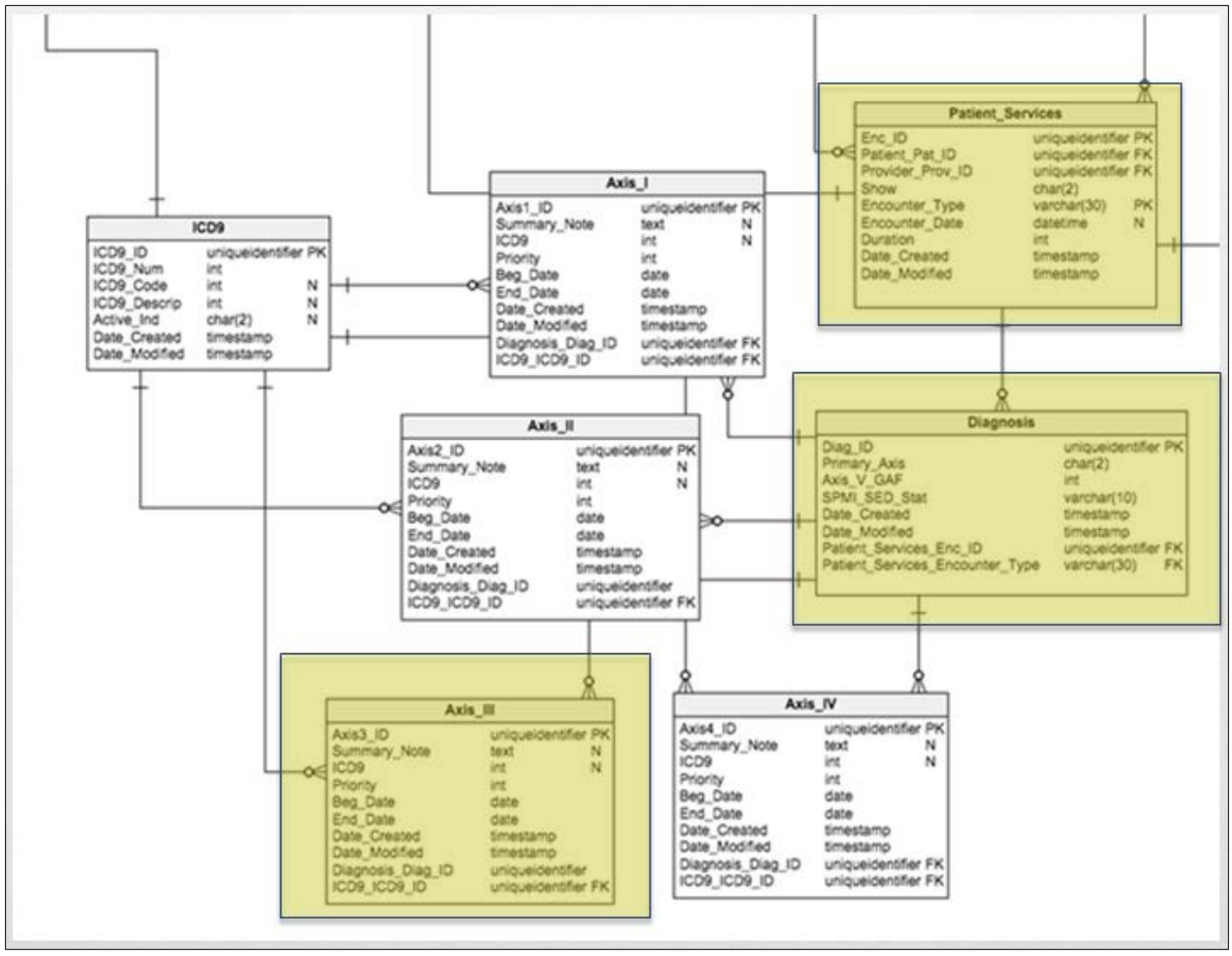


Figure 9: Table Reference for AXIS III Summary Note

This figure should the reference tables and their relationship for the joins to query the data from the AXIS III summary note table for asthma associated clinical terms embedded as free-text.

Chapter 5: Conclusions, Limitations and Recommendations

Introduction

Mental health centers are an integral part in providing patient care to the community. Section 2703 of the Affordable Care Act of 2010 allows for Medicaid State Plans to establish Health Homes with community health centers to coordinate care for Medicaid beneficiaries who have chronic conditions. The coordinated care for individuals intends to improve the health outcomes of members and lower healthcare costs through better care utilization. Therefore, it is pertinent to identify individuals not already be enrolled in a Health Home who would qualify for the service. .

Barriers and Limitations

One of the barriers in developing the process for identifying individuals with chronic conditions using clinical data held within the mental health electronic health records includes the time and effort needed to learn the full extent of the system. Another barrier was gaining access to the database system to determine the full model of the database. This barrier led to the development of a data model based on observations on how the data is currently captured within the graphical user interface of the electronic mental health record system rather than getting the data model directly from the developers. Finally, the lack of access to the database meant the SQL queries could not be run against data in the database.

This study had several additional limitations. First, the SQL queries only focused on one chronic condition. However, the intended narrow focus of the code provides a concept and methodology that can be extended to include additional conditions.. Second, the SQL query was developed based on the data flow analysis of the Kansas Mental Health EHR. Therefore the SQL queries may only apply to the Kansas Mental Health EHR. Third, the SQL queries only address patients with asthma as a chronic condition and do not identify risk to develop a second chronic condition, the second criteria for enrollment into the Health Home. Fourth, the database does not currently hold hospitalization data in a structured data form. Hospitalization may be mentioned in free text and captured as unstructured data. However, the State requires hospitalization to be related to asthma, which would require a separate case definition beyond what is currently defined.

Lastly, the unstructured data query only means to initiative the search the database for free text that matched the defined terms. These search results are not definitive for a diagnosis of asthma. Further analyses of the records that are return from the query based on the terms defined by the clinical criteria are needed to determine if those individuals have asthma.

Recommendations

Recommendations address the limitations encountered during this study and enhance the methodologies for extracting relevant data from electronic health records. This thesis focuses on utilizing SQL queries to extract the data from an electronic health record, but the SQL is quite basic. Future studies could define advanced coding that

package and maximizes the query method for identifying candidate patients for Chronic Care Health Homes from the EHR.

Further, the SQL queries were not able to be ran against the clinical data held within the mental health electronic health record. Future studies would benefit from running the codes against the data to determine the feasibility of the SQL queries and determine the most effective methods in identifying candidates. The codes could be readjusted to query both structured and unstructured at the time and allow for the evolution of the query as providers change from unstructured to structured clinical data entry.

Furthermore, community health centers that have the capacity to support a data warehouse would benefit from using the methodology discussed in this thesis. The query logic can be rewritten to run against the data warehouse using a business intelligence tool, such as Oracle Business Intelligence. This logic can also be further developed into the rules executed by a clinical decision support system to determine a patient's eligibility during the point of care. Identified candidates can be set to alert providers of the mental health electronic record system that further investigation of the patient's candidacy for a chronic care health home is needed.

Additionally, it was mention this thesis does not address all criteria needed for enrollment into a Health Home. Individuals who are at risk for second chronic conditions are not defined in this thesis. However, with the advancement of data analytics, criteria for risk can be defined and which can be used to develop a CASE WHEN statement in SQL to better identify these individuals within the electronic health record.

Also, the thesis was not able to develop a query method to locate individuals who may have an asthma-related hospitalization due to the current limitation of the Mental

Health Electronic Health Record system. However, Kansas does operate a Health Information Exchange that connects to several electronic health record systems including the mental health system. Therefore, future research can define the process and leverage the capabilities of the two systems in identifying individuals with chronic conditions.

It was previously mentioned that the method to utilize unstructured data to pull relevant records is only considered the first step in utilizing that data to identify individuals with a chronic condition. Further analysis is required to ensure that the queries extracted the appropriate records and this verification could be a manual review or use emerging solutions such as natural language processing. Further studies focusing on natural language processing can help determine the value of the query on unstructured data for secondary utilization.

Conclusion

The developed SQL queries in this thesis directly link to the relevant tables that hold the clinical data, structured or unstructured data, within the Kansas Mental Health Electronic Health Record. The relevant tables were established after a data flow analysis was conducted on the system and the SQL queries developed reflects that analysis. The SQL queries for structured data should be able to directly extract the required information for qualifying members into a Health Home with the chronic condition of asthma, which can be applicable to additional chronic conditions, based on the process defined through this research. However, the SQL query results for unstructured data require further analysis to determine if the data extracted meets the correct criteria for members to be enrolled into a Health Home. All queries developed require testing against actual data to verify anticipated

results. Given the complexity of how clinical data is currently being captured, structured or unstructured data, it may be best to utilize both data concurrently to qualify individuals for Health Homes.

Appendix

Surveillance Case Definition For Asthma

I. MORTALITY AND HOSPITAL DISCHARGE CLASSIFICATION

Case classification

Confirmed:

There is no confirmed case classification for mortality and hospital discharge data. Health departments are encouraged to evaluate the accuracy of these sources.

Probable:

death certificates/records listing the asthma diagnostic code (ICD-9 Code: 493; or ICD-10 Codes: J45, J46) as the underlying cause of death.

hospital records listing the asthma diagnostic code (ICD-9-CM Codes: 493.0- 493.9; ICD-10-CM Codes: J45.0-J45.9) as the primary diagnosis.

Possible:

death certificates/records listing the asthma diagnostic code (ICD-9 Code: 493; or ICD-10 Codes: J45, J46) as a contributing cause of death.

hospital records listing the asthma diagnostic code (ICD-9-CM Codes: 493.0- 493.9;ICD-10-CM Codes: J45.0-J45.9) as a secondary diagnosis.

466(acute bronchitis and bronchiolitis), *** in children < 12 years***

491.20 and 491.21 (chronic bronchitis), *** in children < 12 years***

COMMENT:

Additional ICD-9 codes that may be used to evaluate administrative data for misdiagnoses and to evaluate possible changes in diagnoses that could explain changes in asthma trends may include:

492 (emphysema),

495 (extrinsic allergic alveolitis),

496 (chronic airway obstruction, not elsewhere classified),

508 (respiratory conditions due to other/unspecified external agents),

506.3 Other acute/subacute respiratory conditions due to fumes/vapors

506.9 unspecified respiratory conditions due to fumes and vapors

786 (symptoms involving respiratory system/other chest symptoms)

II. PREVALENCE CLASSIFICATION

Case classification

Confirmed:

There is no confirmed case classification for self-report. Health departments are encouraged to validate the accuracy of survey self-response data.

Probable:

A positive response to the survey question, "Did a doctor (or other health professional) ever tell you (or any household member) that you (they) had asthma?"

AND

A positive response to any of the following survey questions:

a) "Do you (or the household member) still have asthma?"

OR

b) "Have you (or any household member) taken prescription medications for asthma (such as albuterol, inhaled steroids, cromolyn, theophylline, etc) during the past year?"

OR

c) "Have you had a wheeze episode in the past year?"

Possible: A suspect case meets any of the following:

A positive response to survey question "Have you (or any household member) used over-the-counter medications for asthma during the past year?",

Positive response to survey question, "Have you (or any household member) experienced episodes of wheezing during the past year?

III. CLINICAL AND LABORATORY CLASSIFICATION

Clinical Criteria

presence of wheezing lasting 2 or more consecutive days,

chronic cough that responds to bronchodilation that persists 3-6 weeks in the absence of allergic rhinitis or sinusitis,

nocturnal awakening with dyspnea, cough and/or wheezing in the absence of other medical conditions known to cause these symptoms (see Comments below).

Definitive Laboratory CriteriaPulmonary function testing (spirometry: FEV_1, FVC) demonstrating a 12% increment after the patient inhales a short-acting bronchodilator;

a 20% decrement in FEV1 after a challenge by histamine, methacholine, exercise or cold air

20% diurnal variation in peak expiratory flow over 1 to 2 weeks

Case classification

Confirmed:

A confirmed case met any of the clinical symptoms at least 3 times during the past year AND at least one of the laboratory criteria.

Probable:

A probable case meets any of the following:

In the absence of supporting laboratory criteria, presence of any of the clinical symptoms which have been reversed by physician treatment with asthma medications and have occurred at least 3 times during the past year.

In the absence of supporting clinical criteria, met at least one of the laboratory criteria during the past year.

In the absence of supporting laboratory or clinical criteria, taken medications in the past year that were prescribed by a physician for asthma.

Possible: A suspect case meets any of the following:

the presence of any of the following during the past year:

shortness of breath on exertion,

presence of wheezing or chronic cough in the absence of obvious respiratory infection

presence of increased nasal secretion, mucosal swelling, nasal polyps, or chronic sinusitis

hyper expansion of the thorax,

sounds of wheezing during normal breathing

prolonged phase of forced exhalation,

chest x ray showing hyper expansion,

FEV1 less than 80% of predicted value

COMMENT: This surveillance case definition may not be as useful in young children as in adults because it is more difficult to diagnose asthma in young children and there may be a reluctance to stigmatize young children with the diagnosis of asthma.

Recurrent episodes of cough and wheezing are frequently due to asthma. However, other causes of airway obstruction leading to wheeze exist (NIHNAEP 1997), such as:

In infants and children:

Upper airway diseases (allergic rhinitis and sinusitis); Obstructions involving small airways (foreign body in the trachea or bronchus, vocal cord dysfunction, vascular rings or laryngeal webs, laryngotracheomalacia, tracheal stenosis, or bronchostenosis, or enlarged lymph nodes or tumor); Obstructions involving small airways (viral bronchiolitis or obliterative bronchiolitis, cystic fibrosis, bronchopulmonary dysplasia, heart disease); Other causes (recurrent cough not due to asthma, aspiration from swallowing mechanism dysfunction or gastroesophageal reflux)

In adults:

Chronic obstructive pulmonary disease (chronic bronchitis or emphysema); Congestive heart failure; Pulmonary embolism; Laryngeal dysfunction; Mechanism obstruction of the airways (benign and malignant tumors); Pulmonary infiltration with eosinophilia; Cough secondary to drugs; Vocal cord dysfunction.

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Comment

It is recommend to combine the confirmed and probable cases for asthma case count.

Asthma Medications

Asthma Medicines: Brand and Generic Names, 1997*

Asthma Long-Term-Control Medications

Generic name	Brand name
Steroids: Inhaled	
beclomethasone	Beclovent®
	Vanceril®, Vanceril®—Double Strength
budesonide	Pulmicort Turbuhaler®
flunisolide	AeroBid®, AeroBid-M®
fluticasone	Flovent®
triamcinolone	Azmacort®
Cromolyn and Nedocromil: Inhaled	
cromolyn sodium	Intal®
nedocromil sodium	Tilade®
Leukotriene Modifiers: Tablets	
zafirlukast	Accolate®
zileuton	Zyflo®
Long-Acting Beta$_2$-Agonists	
salmeterol (inhaled)	Serevent®
albuterol (extended release tablet)	Volmax® Proventil Repetabs®
Theophylline: Tablets or liquid	
	Aerolate® III Aerolate® JR Aerolate® SR Choledyl® SA Elixophyllin® Quibron®-T Quibron®-T/SR Slo-bid® Slo-Phyllin® Theo-24® Theochron® Theo-Dur® Theolair® Theolair®-SR T-Phyl® Uni-Dur® Uniphyl®

Asthma Quick-Relief Medications

Generic name	Brand name
Short-Acting Beta$_2$-Agonists: Inhaled	
albuterol	Airet® Proventil® Proventil HFA® Ventolin® Ventolin® Rotacaps
bitolterol	Tornalate®
pirbuterol	Maxair®
terbutaline	Brethaire® Brethine® (tablet only) Bricanyl® (tablet only)
Anticholinergics: Inhaled	
ipratropium bromide	Atrovent®
Steroids: Tablets or liquids	
methylprednisolone	Medrol®
prednisone	Prednisone Deltasone® Orasone® Liquid Pred® Prednisone Intensol®
prednisolone	Prelone® Pediapred®

* This glossary is a complete list of brand names associated with the appropriate generic names of asthma medications, as listed in the United States Pharmacopeial Convention, Inc., *Approved Drug Products and Legal Requirements*, Volume III, 17th edition, 1997, and the USP DI *Drug Information for Health Care Professionals*, Volume I, 17th edition, 1997. **This list does not constitute an endorsement of these products by the National Heart, Lung, and Blood Institute.**

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