

**The Relationship between the extent to which Physicians use key
Electronic Health Record (EHR) interoperability domains and their
performance on quality measures over time.**

By

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LIST OF ABBREVIATIONS

1. **PCPs**—Primary Care Practitioners
2. **EHRs**—Electronic Health Records
3. **PHRs**—Paper-Based Health Records
4. **ARRA**—American Recovery and Reinvestment Act
5. **HIT**—Health Information Technology
6. **HIMSS**—Healthcare Information and Management Systems Society
7. **HITECH ACT**—Health Information Technology for Economic and Clinical Health Act
8. **MU**—Meaningful Use
9. **CMS**—Centers for Medicare and Medicaid Service
10. **CHIP**—Children’s Health Insurance Program
11. **CHIPRA**—Children's Health Insurance Program Reauthorization Act
12. **SCHIP**—State Children's Health Insurance Program
13. **ONC**—Office of the National Coordinator for Health Information Technology
14. **HHS**—Department of “Health and Human Services”
15. **NSCH**—National Survey of Child Health
16. **CA**—Clinical Adoption Framework
17. **eHealth**—Electronic Health
18. **ICT**—Information and Communication Technology (ICT)
19. **NHIS**—National Health Interview Survey
20. **NEHRS**—National Electronic Health Record Survey

ABSTRACT

Despite the recent national analysis concerning the value of interoperability, which suggested that fully standardized interoperability could save the nation \$77.8 billion annually, the lack of compatibility between healthcare systems is still a national problem and a national priority. Studies indicate implementing approaches to ensure that Electronic Health Records (EHRs) can interoperate, is a high priority. Despite the urgencies there is still a lack of qualitative and quantitative evidence illustrating the use of the four key EHR interoperability domains related to Primary Care Practitioners' (PCPs) performance on quality measures in relation to the care adolescents between the ages of 12-19 years old receive over time.

In order to validate and provide answers to the research questions and hypotheses, the study established a baseline econometric model constructed as a multivariable linear regression equation. Performance to quality care within PCPs when providing quality access and availability of care to adolescents ages 12-19 years is the dependent variable while the four core EHR interoperability domains—find, send, receive, and integrate patient healthcare information are the predictors (independent variables) for this study.

The results on both econometric models constructed for this study shows that none of the variable coefficients as regards to the dependent variable is significant at $\alpha = 0.05\%$ and 0.01% . However, at both levels of α , all four EHR interoperability domains—electronically send, find, receive, and integrate patient clinical information (independent variables) show a positive relationship with the dependent variable (performance of quality measures). This means that as the usage of these four EHR interoperability domains increases (Independent variables), the net benefit of the access and availability

to care for adolescents between 12-19 years old in the United States increases (Dependent variable), which expresses a positive relationship.

Based on the magnitude of R values, the “Send patient information” domain has the highest R value which is .810. The second highest R value is the “Integrate patient information” domain which is .705. This implies that the "Send patient information" domain has more robust predictive capability on performance of quality measures. Furthermore, the analysis of the marginal impact equation shows that the interaction of the ICI domain and Usage produces the highest and positive marginal value. This result means that the Integrate Clinic Information (ICI) domain gives additional benefits on access and availability to care for adolescents between the ages of 12-19 years in the United States when continuously utilized.

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DEDICATION

I dedicate this dissertation journey to the lord God almighty. He has been a blessing in my life. Lord, thank you for your continuous wisdom, good health, and undaunted amount of determination throughout the entire process of my dissertation.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

The impetus to use information systems for leveraging technological advances to improve the quality of healthcare created the expectation that these systems would improve the quality of care, improve patients' safety, increase access or availability of care, increase productivity, and cut medical costs [1]. In 2009, the American Recovery and Reinvestment Act (ARRA) mandated hospitals, long-term care facilities, and office-based primary care practitioners (PCPs) switch from paper-based health records (PHRs) to electronic health records (EHRs). ARRA outlined expectations for a health information technology (HIT) exchange, defined as the ability to electronically exchange data between multiple systems that may reside outside of the host system [1,5]. The expectations were that these systems would communicate with each other to foster quality of care, enhance public health data, improve patient experience and privacy, and enhance the clinical decision-making processes [1].

1.1.1 What is interoperability?

Interoperability is the process where multiple healthcare information systems communicate with each other. According to the Healthcare Information and Management Systems Society (HIMSS), “Interoperability is the ability of different information systems, devices, and applications (i.e. 'systems') to access, exchange, integrate, and cooperatively use data in a coordinated manner—within and across organizational, regional, and national boundaries, to provide timely and seamless portability of information and optimize the health of individuals and populations globally.” [4]. After

enacting ARRA, interoperability continued to be a national priority and arguably one of the leading issues to the adoption of EHRs in the United States [8]. In order to advance the effort to increase interoperability between systems, the Health Information Technology for Economic and Clinical Health Act (HITECH ACT) was enacted to motivate and incentivize the implementation and supporting technology of EHRs in the United States. The HITECH ACT was enacted under ARRA in 2009 and included guidelines to provide incentive payments to physicians and hospitals who could actively demonstrate that they had implemented EHRs and "meaningfully use" this technology clearly to improve patient care [2].

1.1.2 What is Meaningful Use (MU)?

Meaningful Use (MU) is a federal incentive program introduced in 2009 to promote certified EHR technology among PCPs and other healthcare providers. MU in healthcare is critical because patient data must be accessible and easy to share between healthcare providers, insurers, and patients. MU is essential for advancing patient care, data security, and healthcare IT [1,107]. In 2010, physicians and hospitals that actively demonstrated adoption of an EHR within the four core interoperability domains and showed that they "meaningfully use" their EHR to impact patient care positively were qualified to receive cash through the HITECH ACT [1]. Payments were issued when the Federal Centers for Medicare and Medicaid Service (CMS) issued regulations for the three stages outlining MU and was administered within the joint program's guideline. The MU stages are listed as follows:

Stage 1—Stage 1 is the adoption and utilization of a certified EHR used in a meaningful way, **Stage 2**—Stage 2 is the adoption and utilization of a certified EHR

technology to electronically exchange health information to advance the quality of health care and certified EHR technology when submitting clinical quality materials and other measures. **Stage 3**—Stage 3 is the execution and implementation of meaningful use adopted approaches using a phased rollout approach [1, 6]. The MU framework and timeline are summarized in figure 1 below.

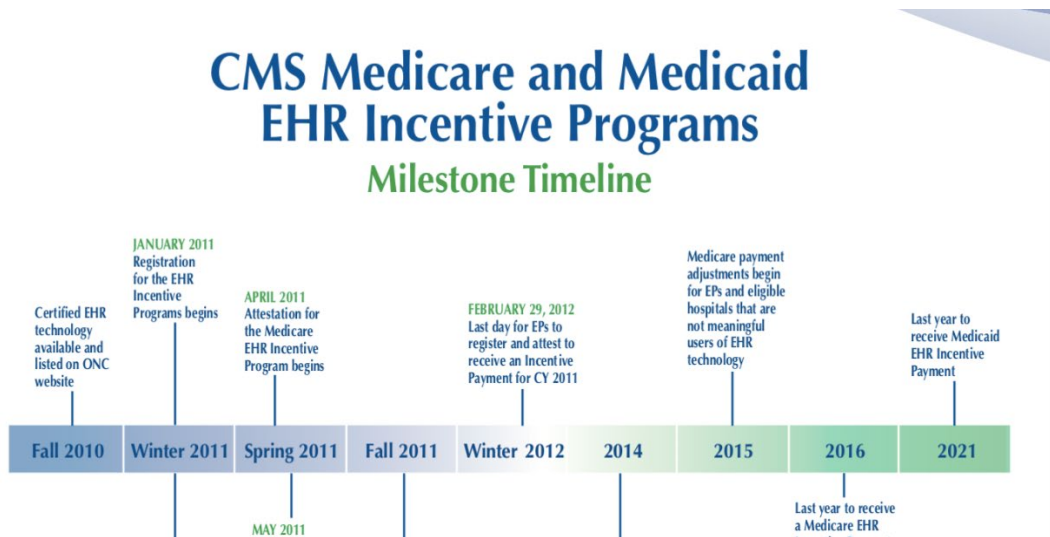


Figure 1: The MU Milestone Timeline (CMS, 2010).

In 2011, physicians were qualified to receive incentive payments for meeting the criteria for Stage one MU. The maximum cash payments PCPs could receive over the course of five years was \$43,720 under Medicare EHR incentive program guidelines. For PCPs in the Medicaid EHR incentive program, the maximum cumulative cash payments amounted to \$63,750. Those PCPs who failed to establish MU were penalized by a substantial reduction in their Medicare incentive payments, beginning with a 1% reduction in 2015 [2]. Furthermore, in December 2015, the federal government made \$13 billion in EHR cash payments to PCPs and other eligible healthcare professionals and organizations (plus an additional \$19 billion paid to eligible hospitals). Many of these

payments to PCPs correlated to MU stage 1—promotion of necessary EHR adoption and data gathering strategies [3].

The second stage of MU is the focal point of this study and emphasizes the care coordination and exchange (interoperability) of patient information. The EHR is a longitudinal electronic record of patient health information generated by one or more encounters in any care delivery setting [8]. Through healthcare information exchange and interoperability, clinicians can access a longitudinal health record, which is defined as a comprehensive clinical summary of a patient-based clinical experience, as opposed to the encounter-based or provider-based records of the past [108].

1.1.3 The Connecting Health and Care for the Nation:

The “Shared Nationwide Interoperability Roadmap” also referred to as “*The Roadmap*” describes the policies and technical actions needed to enable nationwide interoperability. “The Roadmap” also identified four key interoperability domains defined as: electronically sending, receiving, finding, and integrating or using critical clinical information. Interoperability is a fundamental requirement for the health care system to derive the societal benefits promised by adopting EHRs [9]. This study will examine the relationship between the four core domains of interoperability and the performance on quality measures. This correlation has not received in-depth analysis neither has it been the subject of research in past studies. The performance quality measure for this study focus on the access and availability of medical care for adolescents between the ages of 12-19 years who received care from their PCPs over time (specifically the years 2015 and 2017).

The relationship between the four core domains of interoperability and patient care remains an under-researched area despite the large incentives offered, high expectations, and the interest in EHRs and interoperability advancement in the US. Consequently, this research is relevant and timely. It is conceivable that access and availability to care, quality, safety benefits of interoperability, and EHR adoption and use may be time-dependent [109]. It could take years after implementation occurs before benefits are realized since practitioners and users need to become familiar with the different applications [19, 27].

As with other new technologies, there may be considerable delays in the widespread usage and adoption of the interoperability domains, hence the delay in realizing the benefits attributable to EHRs and the use of these domains [110]. Private office-based primary care facilities are widely available to adolescents. However, research indicates that these services are not available or accessible for uninsured or underinsured adolescents because these types of services depend significantly on fee-based reimbursements from insurance companies or other sources. [30].

Consequently, the underlying questions remain: How are these physicians currently using the four EHR domains to provide access/availability of care for adolescents? How are they sending, receiving, finding, and integrating clinical information to provide necessary access to care for this group (adolescents between the ages of 12-19 years)? How is the performance of quality measures—access or availability of care for adolescents—measured as it relates to the interoperability domains?

This study will focus on how PCPs use the key EHR interoperability domains and their performance of quality measures in adolescents with public insurance (such as

Medicaid, Children's Health Insurance Program (CHIP) etc.). This study will examine data from adolescent patients who received care from PCPs in 2015 and 2017.

Furthermore, according to recent studies, for those adolescents who see a PCP, a majority are covered by private insurance offered through family plans or through the parents' employers. Typically, adolescents in this category use private practices like a pediatrician or family practice. Adolescent youths with public insurance such as Medicaid or the State Children's Health Insurance Program (SCHIP) interact regularly with PCPs in the private or public areas where their insurance is accepted [30].

This dissertation aims to examine how the quality of care (defined as access and availability of PCPs for adolescents between the ages of 12-19 years) as delivered by private office-based practices and how it correlates with the extent to which they use key interoperability domains over time. The study will also analyze the marginal impact of each of the four key interoperability domains that are related to access and availability to care for adolescent youths in the age range of 12-19 years. Data analysis will be conducted for the years 2015 and 2017 owing to data limitations.

1.2 Background:

1.2.1 A review of the areas of research:

The background section focuses on the following areas to give a broad understanding of the different variable based on this research:

1.2.1.1 Interoperability and the Four Core Domains

1.2.1.2 MU and its Stages

1.2.1.3 Quality Measures- Definitions and Performance Measure Tools

1.2.1.4 Performance Quality Measure for this Research

1.2.1.1 Interoperability and the Four Core Domains:

1.2.1.1.1 Interoperability Definition:

According to the Office of the National Coordinator for Health Information Technology (ONC), and section 4003 of the 21st Century Cures Act [10], the term interoperability can be defined as any “health information technology that meets the following:

(A) Enables the secure exchange of electronic health information with, and use of electronic health information from, other health information technology without special effort on the user;

(B) allows for complete access, exchange, and use of all electronically accessible health information for authorized use under applicable State or Federal law; and

(C) does not constitute information blocking, as defined in section 3022(a)” [10] ONC is responsible for advancing connectivity and interoperability of health information technology (health IT).

According to ONC, EHR Interoperability is considered a national priority, which is the impetus for the ONC partnership with the Department of Health and Human Services (HHS) to focus on making interoperability one of the most critical requirements. Physicians and hospitals must meet these requirements as they prepare their systems (MU stage 1 requirement) for attestation in MU Stage (details of the MU stages reflect in detail below) [10].

1.2.1.1.2 Four (4) Core Domains of Interoperability:

The “**Shared Nationwide Interoperability Roadmap**” describes the technical actions needed to enable nationwide interoperability using the following criteria:

Electronically send patient health information, receive patient health information, find or query patient health information, and integrate or use critical clinical information [9,10].

- ❖ **Send patient health information:** Is the utilization of an EHR or a web-based portal to transmit patient data and records to other PCPs, most specialty healthcare providers, and other authorized outside organizations.
- ❖ **Receive patient health information:** Is the utilization of an EHR or web-based portal to receive patient information electronically from other PCPs, specialty healthcare providers, and other authorized outside organizations.
- ❖ **Find or Query patient health information:** Is the utilization and access of an EHR or web-based portals to pull information concerning a new or existing patient from outside sources and medical organizations.
- ❖ **Integrate patient health information:** Is the utilization, assessment, and integration of patient health information by the PCP. It is PCP’s ability to gather and integrate information from multiple EHR systems or web-based portal without any issues like manual data entries or scanning [11].

1.2.1.2 MU and its Stages:

1.2.1.2.1 Meaningful Use-Stages:

The HITECH Act was created to motivate the implementation and supporting technology of EHRs in the United States enacted under the ARRA act of 2009 (known as the Recovery Act). Incentive payments were made available to physicians and hospitals

who actively demonstrate meaningful use of an EHR or a certified EHR technology.

According to the act, there are three major components of meaningful use defined as:

Stage 1—Utilizing EHR in a strategic manner **Stage 2**—Utilizing an EHR for exchanging and submitting health information to improve patient care **Stage 3**—The execution and implementation of meaningful use and adapting to a phased approach method rolled out in three stages series. The first stage focuses on promoting necessary EHR adoption and data gathering; the second stage--the focal point of this study--emphasizes the care coordination and exchange of patient information; the last stage in the meaningful use series will focus on improving healthcare outcomes [12]. Figure 1 above outlines the MU Framework and timeline.

1.2.1.3 Quality Measures- Definition and Quality Performance Measure Tools

1.2.1.3.1 Quality Measures Definition:

Quality healthcare is a national priority for the President, HHS, and CMS. According to CMS—"Quality measures are tools that help us measure or quantify healthcare processes, outcomes, patient perceptions, organizational structure, and systems associated with the ability to provide high-quality health care. Quality measured is related to one or more quality goals for health care"[13]. "These goals include effective, access, safe, efficient, patient-centered, equitable, and timely care" [13]. CMS uses quality measures in its various quality initiatives that include quality improvement, pay for reporting, and public reporting [13].

1.2.1.4 Adolescents and Children's Quality Healthcare Measures:

"Quality measures seek to measure the degree to which evidence-based treatment guidelines are followed, indicated, and assess care results. The use of quality

measurement helps strengthen accountability and support performance improvement initiatives at numerous levels. These measures can be used to demonstrate a variety of activities and health care outcomes for specific populations such as the CHIP enrollees” [14]. In 2009, the Children's Health Insurance Program Reauthorization Act (CHIPRA) incorporated provisions to increase the quality of care and health outcomes provided to children in Medicaid and the Children's Health Insurance Program (CHIP). CMS quality care “Child Core Set” defines a variety of quality measures to include access and availability of care for adolescents between the ages of 12-19. The data set includes measures of physical and mental health of adolescents.

The data set is released annually by CMS and Mathematica. The data examines the progress made by states for reporting on the Child Core Set measures. Currently 25-45 states meet the standards of quality as laid out by these two groups [15]. This study incorporates data pulled from Medicaid.gov dealing with the access and availability to care for adolescents in the age range of 12-19 years who had access to a PCP between 2015 and 2017.

1.3 Statement of the Problem:

Burns and Grove (2017:144) define a research problem as an area in which there is a gap in nursing's knowledge base. This concept is ideal and applicable in other areas of healthcare areas.

In the HIT field, EHR interoperability is more popularly compared to the 2008 mortgage housing crisis because they both remain ongoing national crises despite national strategies to mitigate the crises. Interoperability continues to be a significant

barrier in adopting EHRs, which is why it was deemed the focus of discussion in the HIMSS 2020 conference [116]. The first mention of transitioning from paper medical records to electronic records came after the American Recovery and Reinvestment Act (ARRA) of 2009 [1]. The act was a fiscal stimulus signed by President Barack Obama on February 17, 2009. ARRA had seven components, but the "Expand Health Care" component of the act "subsidized the greater health care costs that the 2008 recession created" [1]. Consequently, ARRA initiated the computerization of medical records that facilitated the exchange of patient medical information (interoperability) among doctors, hospitals, and short/long care facilities [1].

Despite the recent national discussion concerning the value of interoperability, which suggested that fully standardized interoperability could save the nation \$77.8 billion annually [7], the lack of compatibility between healthcare systems is still a national problem and a national priority. Studies have shown that implementing approaches that ensure that EHRs can interoperate, is a high priority [8]. According to HHS, "interoperability in healthcare is the ability for various HIT to exchange, interpret and use data cohesively," [8]. Consequently, achieving interoperability for clinical information will be key to making EHR adoption a cornerstone of the practice. With clinical interchange, the record will become critical and a first stop when a clinician needs information about a patient's medical history would be the EHR [8].

Regardless of these findings and high expectations for system interoperability in the United States and the healthcare system in general, interoperability, quality of care, up-to-date information, and access/availability of care amongst children and adolescents remains a daunting challenge. Little or no research exists examining the relationship

between the extent to which physicians use key EHR interoperability domains related to their performance when providing access (quality of care) for children and adolescents over time. This research is timely and will help fill the knowledge gap that currently exists in the interoperability domains related to access or availability of care for children and adolescents.

There are many contributing factors for the lack of quality of care for adolescent's behavior and growth-related needs. For example, insurance reimbursements do not cover the full cost of healthcare awareness and disease preventative services. Time is also a factor in disease prevention; if visits are delayed or the adolescent does not have access to care, it increases the margin of death related issues [30, 111]. Furthermore, private office-based PCPs report that crucial information is missing from patient files in 14 % of the office visits [28]. Coupled with the barriers that include difficulties with technology, complementary changes and support, electronic data exchange, financial incentives, and physicians' attitudes, this lack of information about the patient can have critical ramifications of the level of care the patient receives [28]. Achieving the interoperability of clinical information is vital in making EHR use a cornerstone of practices nationwide [27]. With clinical interchange, the patient's record will become the single source of truth when a clinician needs information [8]. Regardless of the ongoing requirements of interoperability in the health industry, there is still a lack of qualitative and quantitative evidence on the extent to which office-based physicians use the four key EHR interoperability domains related to their performance on quality measures when providing access or availability of care for adolescents between the ages of 12-19 years old.

According to the World Health Organization (WHO), there are more adolescents now—1.2 billion—who account for one-sixth of the global population—unsurprisingly, this number is only expected to increase through 2050 [101]. Population growth in this segment will continue to rise, particularly in low-and middle-income countries where close to 90 percent of the children and adolescents aged 10-to 19- live [112]. Furthermore, this study is relevant and timely since an estimated 1.1 million adolescents die each year from preventable causes such as: depression, self- inflicting injuries, sexually transmitted diseases, suicide, and interpersonal violence, all of which can be mitigated from a routine visit with their PCPs [112].

This quantitative research aims to examine the relationship between the extent to which office-based PCPs use the four key EHR interoperability domains and their performance on quality measures. Quality measures in adolescent care can be defined as the access and availability of healthcare services for adolescents 12 -19 years of age who had a visit with a PCP over time.

Furthermore, the objectives of this research contribute to the existing body of knowledge to improve the area of life, practice, and net benefits of quality care. This study aims to: **1).** investigate the extent to which physicians use the four key interoperability domains (the extent to which they electronically--send, receive, find, and integrate clinical information) when providing access/availability of care (performance quality measures) for adolescents between the ages of 12- 19 years of age, **2).** Examine data to determine if a correlation exists between the four key EHR domains and quality measures (access or availability of care for adolescents between the ages of 12- 19. **3).** Determine if the four EHR interoperability domains are predictors of quality measures for

office-based PCPs providing access to care for adolescents ages 12-19 years of age in the United States 4). Determine if the integration of clinical information in the EHR accounts for a stronger relationship than the other three domains of interoperability and, 5).

Investigate the performance on access or availability of care for adolescents between the ages of 12-19 years of age and how PCPs use the four key EHR interoperability domains over time.

1.4 Significance of the study:

This study intends to establish and identify the relationship that exists between the extent to which physicians use the four key EHR interoperability domains related to their performance on quality measures for the access/availability of care for adolescents over time. The four key interoperability domains investigated in this study as the independent variables are the EHR system quality of electronically sending, receiving, finding, and integrating clinical information. Interoperability is still a significant problem in healthcare. It is considered a national priority because most EHR systems do not integrate well with other applications—including those applications within a hospital or practitioners' own network [8]. Recent studies have investigated and revealed that the EHR system can provide substantial benefits to physicians, clinical practices, and healthcare organizations and can facilitate workflow, access to care, improved quality of patient care, and safety [20].

However, there are no studies that have investigated the relationship between the EHR interoperability domains and performance quality care. Performance quality care for this study is the access and availability to care for adolescents ages 12-19 years receiving

care from their office-based PCPs. Access to PCPs is critical to children's and adolescents' health and well-being. Additionally, increased access was found to significantly reduce children's non-urgent ER visits, high screening time in hospitals, and appropriate treatment and preventative services [21].

Most adolescents are considered healthy as defined by the traditional medical measures of health status, including data points such as mortality rates, the incidence of disease, prevalence of chronic conditions, and the use of health services. According to the National Survey of Child Health (NSCH), approximately 83 percent of adolescents aged 12–19 years are in either excellent or perfect health. Data indicated that there was no difference between those that lived in rural areas compared to those that lived in urban or suburban areas [21,30].

Nevertheless, 70 percent of adolescent mortality is the result of behavioral or lifestyle choices. Subsequently, research indicated that behaviors such as unsafe sex, violence, abuse, drug and tobacco use, poor driving skills, lack of proper nutrition, and a sedentary lifestyle are all contributing factors driving adolescent mortality rates [22].

While the literature points to the need to measure access to care for adolescents and highlight the disparities in care, there is still a fundamental question of how PCPs use the EHR domains to access this population. Furthermore, there is still a lack of studies that have investigated the relationship between access of care to PCPs for adolescents as relates to the extent to which these PCPs use the four domains of interoperability as they provide care. This study will analyze and investigate any correlations between EHR interoperability domains and the performance of quality measures for children and young adults.

Additionally, visits to PCPs are a main source for routine care, nutritional evaluation, immunization and vaccinations, counseling, and assessments for the general and overall wellbeing of adolescents. Consequently, access to a PCP can be used as an essential measure for quality of care. Specifically, children ages 1-6 years should have had a visit within the past year and children ages 7-19 years should have visited a healthcare practitioner within the past two years [113]. How do we measure PCPs' performance to this essential performance measure? Is there a relationship to the effective use of the EHR interoperability domain? Can we predict that some of the benefits of system quality such as the EHR are effective to use, yield a net benefit to care quality, productivity, and access of care to PCPs for children and adolescents?

Findings from this study will provide recommendations and examine correlations between the key EHR interoperability domains and the performance of quality measures within PCPs. This study's recommendations will enhance societal, political, and economic trends, funding incentives, legislative policies and governance, and, most importantly, healthcare standards on the use of the EHR domains and access or availability of care for adolescents who are the nation's future.

The purpose of this study is to identify and establish which of these independent variables of the four key EHR interoperability domains (electronically...Send, Receive, Fine, and Integrate) predict the performance of quality measures—access or availability of care for adolescents between the ages of 12- 19 years over time. The study will also analyze the marginal impact of each of the four key interoperability domains related to PCPs when providing quality access and availability to care for adolescent youths between 12-19 years of age.

1.5 Research Questions and Hypothesis:

The central research question will be divided into four sections to answer the following questions and hypotheses:

1.5.1 Central Research question:

Which independent variables of the four key EHR interoperability domains, (electronically Send patient health information; Receive patient health information; Find patient health information; Integrate patient health information), has a more robust prediction on the performance of quality measures (dependent variable)—access and availability of care for adolescents ages of 12 and 19 years of age over time?

Which of the independent variables has the highest marginal impact related to PCPs when providing quality access and availability of care for adolescents between the ages of 12-19 years over?

Research Question 1: What is the relationship, if any, between quality access and availability of healthcare for adolescents between 12 -19 years as it relates to PCPs electronically **"Sending"** patient health information?

H1o: There is no statistical relationship between quality access and availability of healthcare for adolescents between 12 -19 years related to PCPs electronically **"Sending"** patient health information.

H1a: There is a statistical relationship between quality access and availability of healthcare for adolescents between 12 -19 years as it relates to PCPs electronically **"Sending"** patient health information.

Research Question 2: What is the relationship, if any, between quality access and availability of healthcare for adolescents between 12 -19 years as it relates to PCPs electronically **"Receiving"** patient health information?

H1o: There is no statistical relationship between quality access and availability of healthcare for adolescents between 12 -19 years related to PCPs electronically **"Receiving"** patient health information.

H1a: There is a statistical relationship between quality access and availability of healthcare for adolescents between 12 -19 years as it relates to PCPs electronically **"Receiving"** patient health information.

Research Question 3: What is the relationship, if any, between quality access and availability of healthcare for adolescents between 12 -19 years as it relates to PCPs electronically **"Finding"** patient health information?

H1o: There is no statistical relationship between quality access and availability of healthcare for adolescents between 12 -19 years related to PCPs electronically **"Finding"** patient health information.

H1a: There is a statistical relationship between quality access and availability of healthcare for adolescents between 12 -19 years related to PCPs electronically **"Find"** patient health information.

Research Question 4: What is the relationship, if any, between quality access and availability of healthcare for adolescents between 12 -19 years as it relates to PCPs electronically **"Integrating"** patient health information?

H1o: There is no statistical relationship between quality access and availability of healthcare for adolescents between 12 -19 years related to PCPs electronically

“Integrating” patient health information.

H1a: There is a statistical relationship between quality access and availability of healthcare for adolescent between 12 -19 years and when PCPs electronically

“Integrating” patient health information.

1.6 Theoretical Perspective

1.6.1 Clinical Adoption Model (CA):

The theory utilized for this research is the Clinical Adoption Framework (CA). It was first developed by the Canada Health Infoway in 2006 and was called the “Benefits Evaluation” (BE) framework. The BE model was modified from the Information System (IS) Success Model by DeLone and Mclean (as cited in Lau, Hagen, & Muttitt, 2007) [32]. It offered a theoretical framework for researchers to recognize system qualities, uses, and the overall “net benefits” of Electronic-Health (eHealth) execution in any healthcare organization. The CA framework is generally accepted by the healthcare community because of the “practicality” as a systematizing structure while defining and describing eHealth implementation and assessment [31].

Nevertheless, because the IS standards were established for the business environment, organizational and social contexts were excluded. In 2009, an extension to incorporate the meso-and macro-levels that could influence eHealth systems' performance metrics was introduced [32]. Neuman (2009) theories at three different levels: (a) the micro-level, (b) the meso-level, and (c) the macro-level.

The **Micro-level model** provides details limited to specific and measurable slices of time, numbers of people, and spaces. An example is, Goffman's model of face work, that clarifies how individuals participate in rituals during one-on-one interactions. **Meso-level models** connect the micro and macro levels--these are models of organizations, societal movements, or groups, as defined by Collin's model of control in organizations [32]. Lastly, the **Macro-level model** extrapolates and builds upon the other models to define larger groups, such as cultural systems, social institutions, and communities. An example is Lenski's macro-level theory of community stratification, which describes how the amount of surplus a society creates increases with society's development (Creswell, 2014:86).

These three dimensions/levels will be explained in detail within the literature review of this study. Furthermore, publications, graduate theses, and dissertations worldwide utilize the CA framework for research and publication. Examples of studies where the CA theory was used include but not limited to:

- ❖ “The meaningful use in primary care EMRs (Watt, 2014)
- ❖ A review of health information exchanges' success factors (Ng, 2012)
- ❖ Critical success factors for Malaysian public hospitals information systems (Abdullah, 2013)” [31]

Additionally, the CA framework indicates that when clinicians or healthcare organizations adopt eHealth, they must also address the three factors of the framework (micro-, meso- and macro-level factors) in order to achieve a successful eHealth implementation and adoption. To apply the CA framework, one needs different methods, tools, and matrices to evaluate whether the factors are associated with the extent of

adoption and impacts desired been achieved. As applied to this study, this theory performs as expected the independent variables- electronically send patient health information; receive patient health information; find patient health information; and integrate patient health information to influence or explain the dependent variable. The dependent variable is performance quality measure (access or availability to care for children and adolescents between the ages of 12 to 19 years over time.

CHAPTER II

LITERATURE REVIEW

The literature review will focus on details regarding this study's theory, the topic about the independent variables—EHR interoperability domains, the topic about the dependent variable—Performance quality measure on access and availability of care for adolescents, and Health Information Technology as it relates to Adolescents.

2.1 History and Introduction of Clinical Adoption Framework (CA):

The CA framework is widely accepted by the healthcare community because it is deemed reasonable and practical as an organizing structure when outlining eHealth (or HIT) adoption in healthcare organizations [31]. Neuman (2009) [32] reviewed theories at three levels: (a) micro-level, (b) meso-level, and (c) macro-level. Micro-level theories provide explanations limited to well defined incremental slices of time, space, or numbers of people [32]. Meso-level theories link the micro and macro levels-these are theories of organization, social movement, or communities. The macro-level theories explain larger aggregates, such as social institutions, cultural systems, and whole societies (Creswell, 2014:86). As earlier stated above, the CA framework is an extension of the BE framework. However, it includes organizational and contextual factors that influence the overall success of eHealth systems adoptions in a health setting [32]. The CA framework also comprises the micro, meso, and macro levels/dimension of clinical adoption built on models and theories from other disciplines.

These disciplines span information systems, organizational science, and health informatics. To conceptualize and create this framework, the following theories and models from these scholars were utilized:

- ❖ The information technology interaction by Silver, Markus, and Beath (1995).
- ❖ The unified theory of acceptance on using the technology model by Vaenkatesh, Morris, Davis, and Davis (2003).
- ❖ Earlier work in implementation by Cooper and Zumud (1990).
- ❖ Task-technology fit by Goodhue and Thompson (1995) and Ammenwerth, Iller, and Mahler (2006).
- ❖ Managing change and risks by Kotter and Schlesinger (1979) and Paré, Sicotte, Jaana, and Girouard (2008).
- ❖ The people and socio-organizational aspects of eHealth by Berg, Aarts, and van der Lei (2003), Kaplan, Brennan, Dowling, Friedman, and Peel (2001), Kaplan and Shaw (2004), and Stead and Lorenzi (1999)” [31].

The CA framework is the backbone of this study because it provides an overarching conceptual model for this research related to eHealth and its adoption by PCPs and clinicians.

2.1.1. What is eHealth?

“eHealth is an overarching term that refers to information and communication technology (ICT) in the healthcare sector [32]. Despite being a widely used term, there is no single universally agreed-upon definition of eHealth. An editorial on eHealth published in an online journal broadly defined the term as follows: eHealth is an emerging field in the interaction of medical informatics, public health, and business,

referring to health services and information delivered or enhanced through the internet and related technologies" [32].

2.1.2 Comparison of eHealth in the United States:

Since the term eHealth is widely used in other parts of the world, a firm definition for the term as it is used in the US is deemed necessary for this research. According to ONC, the term eHealth and health IT are tools and technologies utilized by clinicians, patients, and healthcare professionals to store, send, receive, find, integrate, and analyze health information [31]. The ONC is the federal entity charged with coordinating nationwide efforts to implement and use the advanced health information technology (HIT or eHealth in terms of this study) and the electronic exchange of health information [98].

The EHR and PHR systems are two significant areas of HIT that are coordinated by ONC. Both systems retrieve, store, and share patient information. ONC hosts a website that is designed to provide information to individuals promoting the use of eHealth (or HIT) benefits, as well as the features and benefits for users. Some examples of eHealth programs are the Meaningful Use Incentives, Blue Button, Share-care, and Innovation Challenges programs [32,99] (ONC, 2015). For this study's purpose, the term **"eHealth"** will be used instead of "Health IT."

Furthermore, adopters of the CA framework, which include eHealth organizations that manage or use any system electronically for patient care, are recommended to use specific levels of the framework. In most cases, all three levels of the framework are used depending on their system needs to achieve a successful eHealth implementation. Subsequently, as compared to Newman's review of theories in 2009, Lau and Kuziemky

(2016:60) [32] proposed that the CA framework for eHealth comprises the micro, meso, and macros levels of clinical adoption. The three conceptual views of eHealth adoption are further explained below [32].

2.1.2.1 Micro-level:

“The micro-level addresses the quality of the information, system, and service associated with an eHealth system, its use, and user satisfaction, and net benefits in care quality, productivity, and access. These are the same dimensions and categories that are defined in the BE Framework” [32].

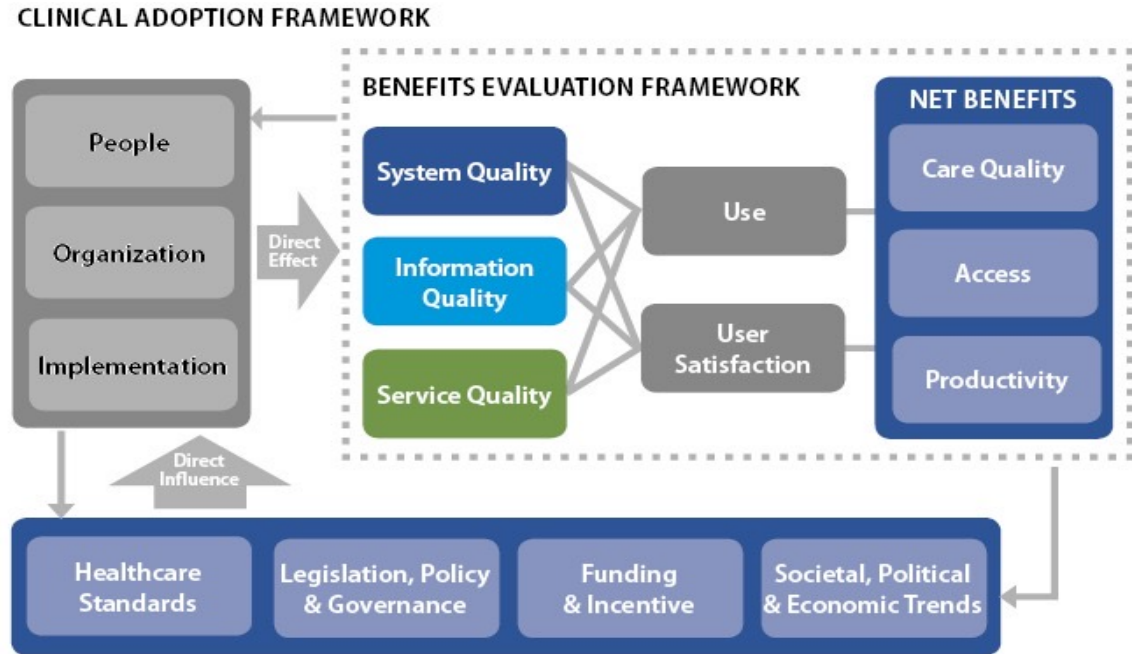
2.1.2.2 Meso-level:

“The meso level addresses the people, Organization, and implementation dimensions that directly affect the micro-level eHealth adoption by clinicians. The people dimension is drawn from the Unified Theory of Acceptance and Use of Technology (UTAUT) constructs, while the organization and implementation dimensions are from the ITIM, implementation research, and change management models described earlier” [32].

2.1.2.3 Macro-level:

“The macro-level addresses health care governance, standards, funding, and societal trends as the environmental factors that directly influence the extent to which the meso level can affect clinical adoption at the micro-level. These macro-level factors are based on the sociotechnical approaches that transcend organizations to include overall societal trends.” (Lau and Kuziemky, 2016:60) [32].

Figure 2-CA Framework:



Retrieved from: Handbook of eHealth Evaluation, An Evidence-based Approach

According to Figure 2, the different sections of the framework are further divided into factors and explained based on their individual micro, meso, and macro levels. According to Lau and Kuziemky (2016:61) [32], successful clinical adoption of an eHealth system at the micro-level correlates to the dependency HIT quality, usage quality, and net benefits as defined below.

2.1.3 Micro-Level Factors:

- ❖ **HIT Quality:** “refers to the accuracy, completeness, and availability of the clinical information content of an eHealth system; the features, performance, and security of the system; and responsiveness of the system's support services.”
- ❖ **Usage Quality:** “refers to eHealth system usage intention/pattern, and user satisfaction in terms of usefulness, ease-of-use, and competency.”

- ❖ **Net Benefits:** “refer to changes in care quality, access and productivity as a result of eHealth adoption by clinicians”. “Care quality covers patient safety, appropriateness/effectiveness and health outcomes. Access covers provider/patient participation and availability/access to services. Productivity covers care coordination, efficiency and net cost” [32].

2.1.3.1 Author’s rationale of the micro-level:

Lau et al. explained that their rationale based on the micro-level is that "the better the quality of the eHealth system adopted, the more it will be embraced by satisfied clinicians, leading to greater tangible net benefits over time" [32].

2.1.3.2 Study rationale based on the micro-level:

The rationale based on the micro-level of the CA framework for this study is that “the more the quality of the EHR (HIT quality) system adopted, the more PCPs electronically sending, receiving, finding, and integrating clinical information (Usage Quality)” [32]. Consequently, better quality data can be more readily embraced by the PCP’s community while increasing satisfaction amongst users.

2.1.4 Meso Level Factors:

According to Lau and Kuziemky (2016:62) [32], successful clinical implementation of an eHealth system at the meso level depends on the groups, organization, and implementation process [32].

- ❖ **People:** “refers to all types of individuals or groups in the healthcare system having to do with eHealth in some way, their personal characteristics and expectations, as well as their roles and responsibilities within the eHealth system."

- ❖ **Organization:** "refers to how the system fits with the organization's strategy, culture, structure/processes, information infrastructure, and return on value."
- ❖ **Implementation:** "refers to the eHealth adoption stages, project management approaches, and the extent of eHealth-practice fit planned in the future and operating at present" [32].

2.1.4.1 Author's rationale of the meso-level:

Lau et al. (2016:62) [32] explained that their rationale based on the meso-level is "higher eHealth adoption can occur in the organization if clinicians have experience and clearly defined expectations for using the system. Moreover, the system will be adding value if it is designed to support organizational performance goals" [32]. "To do so, the implementation process must be carefully planned, executed, and managed throughout its life cycle. This ensures the eHealth system fits into the day-to-day work practices of clinicians. When these meso-level factors are aligned with those at the micro level, we can expect further magnified improvements in eHealth system quality, usage and net benefits" [32].

2.1.4.2 Study rationale based on the meso-level:

The meso level rationale of the CA framework used for this study predicts that "that higher eHealth (HIT) adoption can occur in the office-based practices **(Organization)** if the PCP **(People)** and clinicians in general have the experience and clear expectation of the EHR system usage. Additionally, the EHR system will be perceived as adding value if it is designed to support PCP's (access or availability of care for children and adolescents) performance goals." In order to achieve these goals **(Implementation)**, eHealth (HIT) must be well planned, well executed, and well

managed throughout the lifecycle process. The life cycles are electronically—Send—Receive—Find—and Integrate clinical information).

The well managed and well executed lifecycle will ensure that HIT systems are designed to fit the needs of the end user. Consequently, meso level factors must align with micro the level factors to ensure improvement in the quality, usage, and benefits of an EHR system.

2.1.5 Macro-Level Factors:

According to Lau and Kuziemky (2016:61), successful clinical adoption of an eHealth system at the macro level depends on the organizational context and standards, funding, and trends [32].

- ❖ **Governance refers:** “to the influence of governing bodies, legislative acts, and the regulations or policies covering such bodies as professional associations/colleges, advocacy groups and their attitudes toward eHealth.”
- ❖ **Standards refer:** “to the types of eHealth, organizational performance and professional practice standards in place.”
- ❖ **Funding refers:** “to the payment, remuneration, and incentive programs in place.”
- ❖ **Trends refer:** “to public expectations, and the overall socio-political and economic climates toward technologies, eHealth, and health care as a whole” [32].

2.1.5.1 Author’s rationale of the macro-level:

Lau et al. (2016:63) “explained that their rationale based on the macro-level is that higher eHealth adoption by clinicians can be achieved if the organization aligns its

effort with the macro-environmental factors that influence clinical adoption" [32]. “For instance, organizations should embrace eHealth systems that conform to industry-wide interoperability standards, help achieve external performance targets, and adapt to the changing scope of professional practice in care deliver” [32].

“Where feasible, organizations should take advantage of incentives that encourage clinical adoption such as subsidized eHealth system deployment and automated patient safety surveillance. Adhering to established health information protection legislations, policies, and practices with strong governance involving multiple stakeholders can further enhance clinical adoption through trust and relationship building” [32].

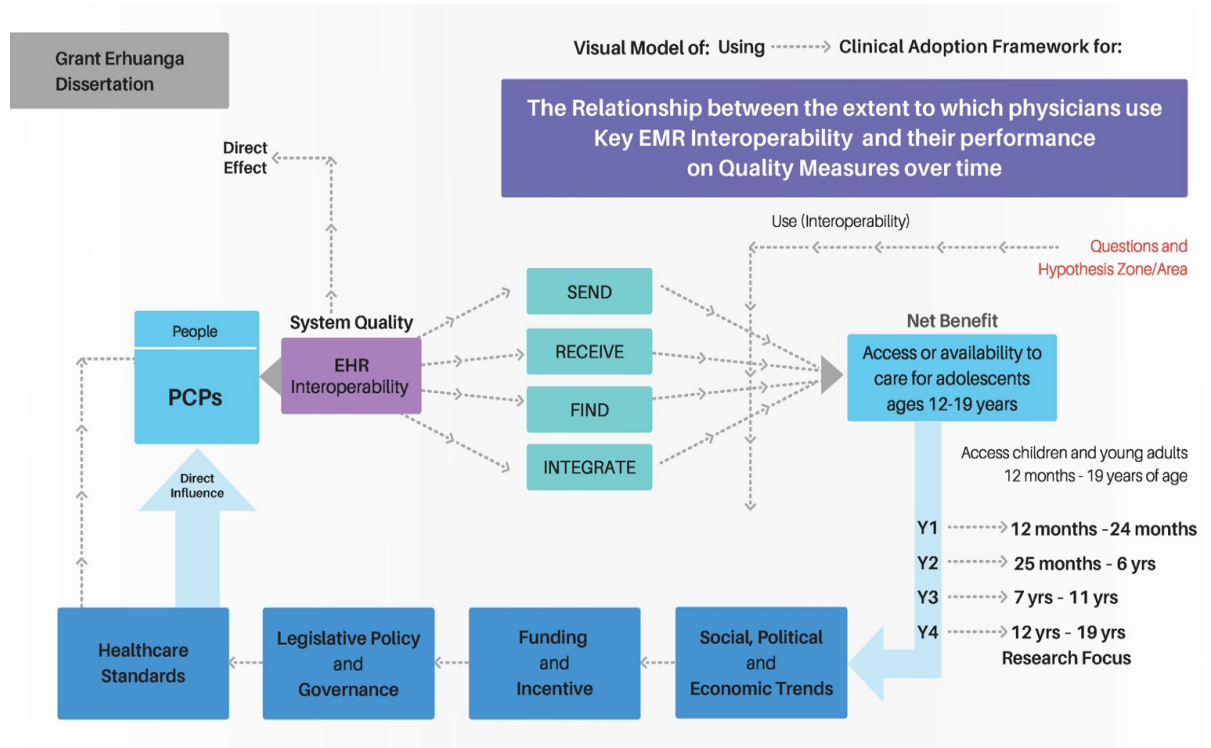
“Lastly, staying abreast of the sociopolitical and economic trends — such as encouraging citizens to better manage their own health using personal health records — allows the organization to be proactive in its eHealth planning and deployment efforts” [32].

2.1.5.2 Study rationale based on the macro-level:

The rationale based on the macro-level of the CA framework for this study is “that a greater emphasis or focus for eHealth (HIT) should be the implementation by PCPs or healthcare organizations which can be attained if the office-based PCP practices (Organization) align its implementation and adoption strategies with the macro-environmental factors that impacts clinical adoption” [32]. For instance, if the PCP’s practice (Organization) embraces an EHR (eHealth) system that adapts to industry-wide interoperability standards, their outward performance targets, and the modifications to the shifting scope of professional practice in healthcare delivery will improve dramatically.

Furthermore, the CA macro-level will encourage PCPs to take advantage of incentive programs and funding that elevates clinical adoption, system deployment, and automated patient safety programs.

Figure 3: Visual Study Model of the CA Framework:



2.2 Usage and Application of the Framework:

Based on the large number of factors involved in the clinical adoption process, it is recommended that a subset(s) of the framework be utilized to achieve a successful eHealth implementation [32]. For the CA framework to be applicable, a quantitative or qualitative method and a performance measurement tool are required to help evaluate the factors associated with the extent of adopting an eHealth system, possible impacts, and

desired outcomes. **Table 1** below shows some examples of studies that have used the framework. Below is a table showing the: framework used in past studies.

Table 1: Past Studies Where the CA Framework was Used:

Authors	Setting	eHealth system	Evaluation Focus	Design/Methods	Indicators/Measures	Results
Ahmadi et al. (2013) Malaysia	Eight primary care clinics	EMR systems	Identification of most influential meso-level factors – people, organization, implementation	Survey, modelling with fuzzy technique for order performance by similarity to ideal solution (TOPSIS), analytical hierarchy process (AHP)	Likert-scale surveys with 16 parameters under meso level – people, organization and implementation	Influential factors found were time investment, screen/room, hybrid system, planning, resource training, workflow and value
Bassi et al. (2012)	Physician offices	EMR systems	Perceived impact from surveys	Systematic review of published surveys, impact factors mapped to CA Framework, meta-analysis of selected impact areas	Seven impact areas with standardized positive-negative-mixed views by user/non-user	Mostly positive views regardless of user status, area with mostly mixed views is security and privacy
Hypponen et al. (2011)	All settings	Health information systems	Large-scale lessons of eHealth system implementation	Literature review, framework design and physician surveys	Dimensions, categories, measures of eHealth success	Evidence categories for eHealth success with baseline results
Lau et al. (2012)	Physician offices	EMR systems	Impacts, success factors and lessons	Systematic review of primary studies on EMR impact, organized by CA Framework	Six impact areas with proportions of positive-negative-neutral studies, factors that influence success, and common lessons	51% studies positive, 19% negative and 30% neutral; 48 factors influenced success. Five repeated lessons

Retrieved from “Handbook of eHealth Evaluation,” An Evidence-based Approach

2.2.1. Implications of the Framework:

“The current CA Framework requires more work to improve its validity, relevance, and utility. Some of the meso- and macro-level factors in the framework need to be refined as specific measures that can be applied and quantified in field settings. Additional methods and tools are also required to evaluate factors that are not currently addressed, especially in the areas of health outcomes at the micro level, return on value at the meso level, and governance, funding and standards at the macro level [32]. Despite the limitations, it is important to keep in mind that to make major strides forward with clinical adoption of eHealth systems, healthcare organizations need to share a

common vision of what constitutes eHealth success. The CA Framework provides a common ground by which eHealth adoption by clinicians can be described, measured, compared and aggregated as empirical evidence over time” [32] (Lau et al., 2016:68)

2.3. Introduction to the—Connecting Health and Care for the Nation A Shared Nationwide Interoperability Roadmap.:

In 2006, when the EHR system was described as a comprehensive system that provides "health information and data, results management, order entry and support, and decision support, EHR adoption rates by primary care physicians in the United States dropped to 4 percent in solo practices. Subsequently, the number also dropped to 21 percent in practices with 11 or physicians"[33]. After that, the ONC launched the "Connecting Health and Care for the Nation" initiative in 2014, which was ten years' vision to help the nation achieve an interoperability Health IT infrastructure (“A 10-Year Vision to Achieve an Interoperable Health IT Infrastructure”) [34].

The vision described improvements for health IT interoperability in three, six, and ten-year increments and laid out the “Roadmap” for a clear pathway for clinicians, health organizations, and stakeholders [34]. Furthermore, Congress declared interoperability amongst systems a national objective in order to achieve widespread health information exchange through interoperable certified EHR technology nationwide by December 31, 2018 and called it to action for commitments to be attained by 2017 [36]. The call to action outlined the steps, three high-level goals, roles, and actions IT professionals and stakeholders were to perform to make progress and significant impact concerning interoperability. Additionally, the call to action “Roadmap” identified three high-level

and short-term goals needed to achieve a learning health system by 2024 for IT interoperability [9, 34]. The high-level goals were to:

- ❖ "Send, Find, Receive, and Integrate or use priority data domains to improve healthcare quality and outcomes by **2015 and 2017.**"
- ❖ "Expand data sources and users in the interoperable health IT ecosystem to improve health and lower costs by **2018-2020.**"
- ❖ "Learn the health system, with the person at the center of a system that can continuously improve care, public health, and science through real-time data access by **2021-2024**" [34].

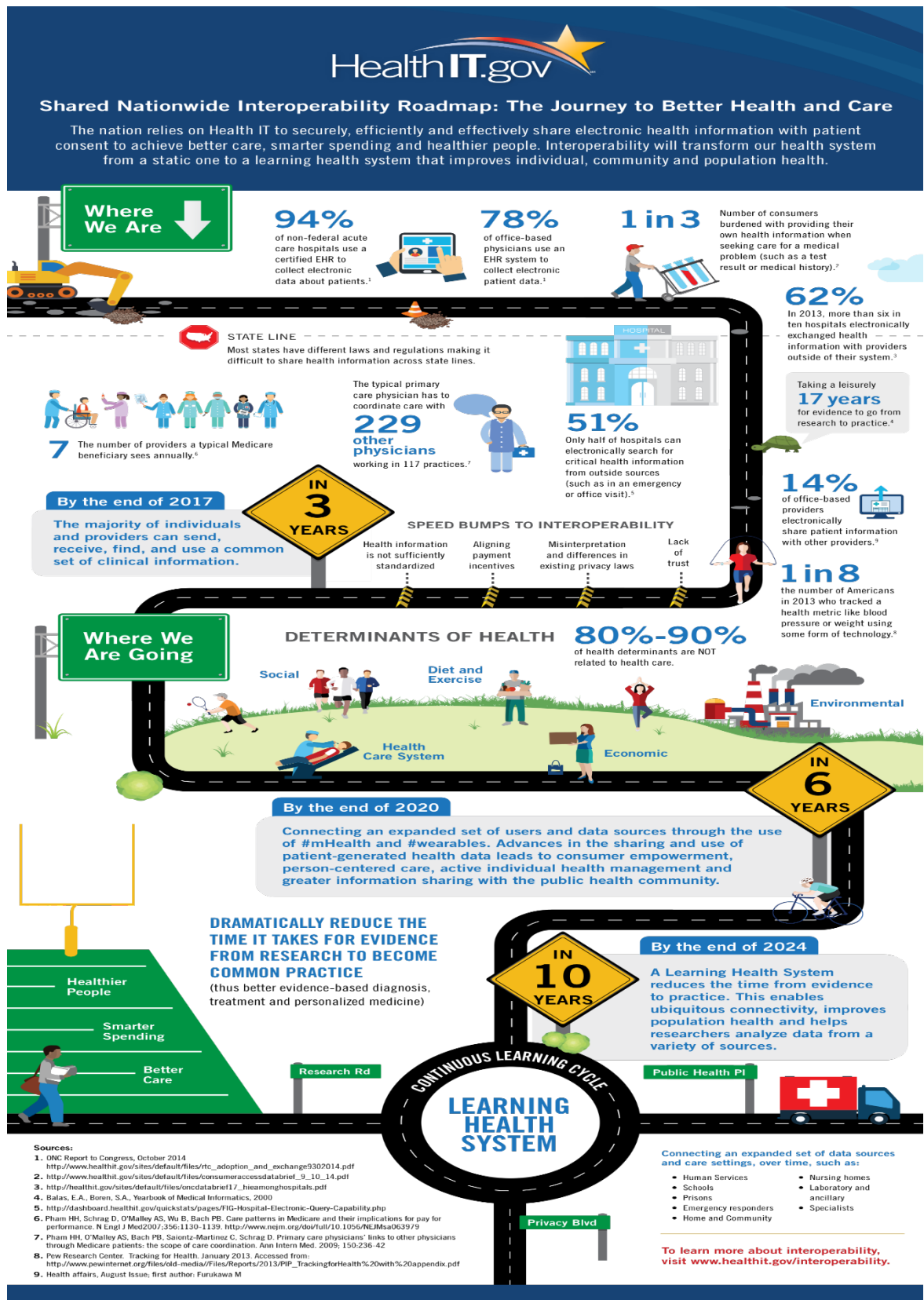
The first high-level goal was a priority to achieve nationwide interoperability. Consequently, this study will validate the improved health care quality and outcomes attained during 2015 and 2017 for PCP's use of EHRs for health exchange, patient engagement, and access and availability of care to PCPs for adolescents between the ages of 12-19 years. The office-based PCP's health information technology adoption and use data is made available from 2008-2017 by the CMS. Data from 2017 to date has not been made available to the public.

Lastly, to address future challenges and provide a foundation for long-term success by 2024, the "Roadmap" laid out three sections for clinicians, healthcare organizations, and IT stakeholders to prioritize. The first section addresses "drivers." These are the "mechanisms that can propel development of a supportive payment and regulatory environment that relies on and deepens interoperability"; the second section addresses the "Policy and Technical Components" [34].

These are "essential items stakeholders will need to implement in similar or compatible ways in order to enable interoperability, such as shared standards and expectations around privacy and security" [34]. The four interoperability domains fall under this section, as depicted in figure 3 below, retrieved from: ____

https://www.healthit.gov/sites/default/files/2017-08/shared_nationwide_interoperability_roadmap.pdf.

Figure 4: Shared National Interoperability Roadmap: The Journey to Better Healthcare



The third section addresses the "Outcomes." These are "metrics by which stakeholders will measure our collective progress on implementing the Roadmap" [34]. Each section includes specific milestones, call to action, and commitments that will support the development of a nationwide, interoperable health IT infrastructure. The literature reviewed for this study focused on the "Policy and Technical Components" and high-level priority goal of *"Send, Find, Receive, and Integrate or use priority data domains to improve health care quality and outcomes by 2015-2017."* According to the Institute of Electrical and Electronics Engineers (IEEE) and for the Roadmap, "interoperability is defined as the ability of a system to exchange electronic health information with and use electronic health information from other systems without special effort on the part of the user" [35]. "This means that all individuals, their families, and health care providers should be able to send, receive, find, and integrate or use electronic health information in a manner that is appropriate, secure, timely and reliable to support the health and wellness of individuals through informed, shared decision-making. With the right information available at the right time, individuals and caregivers can be active partners and participants in their health and quality of healthcare provided to them" [35].

2.3.1. The Four EHR Interoperability Domains:

The "Policy and Technical Components," as well as the high-level goal of the "Roadmap" for 2015-2017 --to send, find, receive, and integrate [9,34] or use priority data domains to improve health care quality and outcomes are the independent variables for this study. The independent variables are examined to see if there is any correlation with PCP's performance on access and availability of care for adolescents (dependent

variable) between the ages of 12-19 who utilized Medicaid and CHIP insurance in 2015 and 2017.

According to ONC's data brief in 2019 [37], interoperability among PCPs, specifically among office-based PCPs, remained constant in 2015 and 2017. The "finding domain"—patient healthcare information from external sources increased by 50 percent [37], but the other interoperability domains—send, receive, and integrate—remained constant between 2015 and 2017 [37]. Additionally, the brief stated that only one in ten PCPs engaged in all aspects of the four interoperability domains. In 2017, out of the 38 percent of PCPs who received patient health electronically, only three-quarters utilized such information at the point of care or to inform clinical decisions at any point in time [37]. Barriers identified were lack of data integration, missing or limited information, and poor workflows, and difficulty locating of information. Furthermore, findings from the data brief indicated that PCPs who participated in some type of value-based payment mode like the accountable care organization, Patient-Centered Medical Home, or the Pay-for-performance (P4P) Program had higher rates of engaging in all four interoperability domains [37].

Additionally, data indicated that access to EHR technology improved PCP's access to information when needed for a patient's care and had a positive net benefit the level of care and attention the patient received. [38]. Lastly, findings from the data brief suggested that PCPs who opted to participate in special programs such as CMS's Merit-Based Incentive Payment System (MIPS) or alternative payment models (APMs) used the four domains of interoperability to improve quality of care. Data pulled from the website <https://data.medicare.gov/Quality> which examined access to PCPs for adolescents

between the ages of 12-19 years under the Medicaid insurance program, will be utilized for this study [39].

2.3.1.1 Send Patient Health Information:

The utilization of an EHR or a web-based portal to transmit patient data and records to other PCPs, specialty healthcare providers, and other authorized outside organizations.

2.3.1.2 Receive Patient Health Information:

The utilization of an EHR or web-based portal to receive patient information electronically from other PCPs, specialty healthcare providers, and other authorized outside organizations.

2.3.1.3 Find Patient Health Information:

The utilization and access of an EHR or web-based portals to pull information concerning a new or existing patient from outside sources and medical organizations.

2.3.1.4 Integrate Patient Information:

The utilization, assessment, and integration of patient health information by the PCP. It is PCP's ability to gather and integrate information from multiple EHR systems or web-based portal [11]. **Figure 5** outlines PCP engagement in the four interoperability domains.

Figure 5: Percentage of PCPs engaged in all four interoperability domains in 2015 and 2017.



- ★ Physicians' engagement in electronically sending, receiving, and integrating information received from outside sources did not change between 2015 and 2017.
- ★ In both 2015 and 2017, about only 1 in 10 physicians engaged in all 4 domains of interoperability.

Retrieved from Healthit.gov at www.healthit.gov/sites [37]

2.3.2. EHR and PCPs:

In 2017, NCHS stated that 85.9% percent of office-based PCPs reported using some EHR system, while 79.7% of office-based PCPs had a certified system. Interoperability and sharing of patient health information, 43.0% received patient health information electronically, 32.1% integrated patient information electronically, and 56.1% searched for patient health information electronically [37] (NCHS, 2017). Additionally, past studies indicated that various barriers associated with implementing EHRs exist and categorized them as the following: financial barriers, organizational or behavioral barriers, and technical barriers.

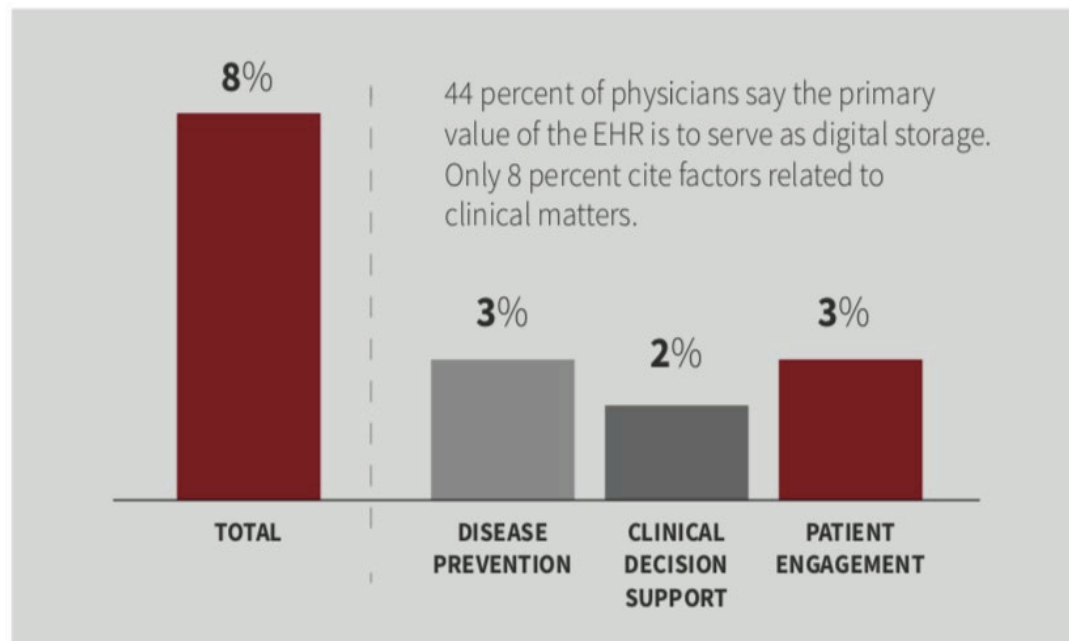
Financial barriers include a lack of the capital or financial resources needed to develop, acquire, implement, and support a healthcare information system.

Organizational and behavioral barriers related to a providers' use, acceptance, and perception of such an EHR system and lastly, technical barriers include everything from work needed to build system interface to a lack of adequate definitions and standards for data interchange [40] (Karen A. Wager 2009:137).

ARRA's implementation was painful and complicated for many PCPs, doctors, nurses, and health professionals across the country. ARRA necessitated investments in software and upskilling caregivers. Nearly 9 in 10 (86%) of office-based physicians had adopted an EHR in 2017, and almost 4 in 5 (80%) adopted a certified EHR. Since 2008, office-based physician adoption of EHRs has more than doubled, from 42% to 86% [37] (National Electronic Health Records Survey (NEHRS)-ONC:2019).

EHRs are implemented to foster and increase the quality of health and patient outcomes. Subsequently, the adoption and percentage rate of EHR Systems for office-based physicians and PCPs continues to be one of the major focus areas for the ONC. An online survey conducted by the Harris Poll for Stanford Medicine in 2018 gathered responses from over 521 PCPs across the United States. The survey results revealed that 44 percent of PCPs perceived data storage to be the primary value of an EHR, followed by disease prevention/management (3 percent), clinical decision support (3 percent), and patient engagement (2 percent). Only 8 % cited factors related to clinical matters (see chart from the Harris Poll below in Figure 6) [41].

Figure 6: How Doctors Feel About the EHR-The Harris Poll Survey-2018



Source: Stanford Medicine-The Harris Poll

Retrieved from: <http://med.stanford.edu/content/dam/sm/ehr/documents/EHR-White-Paper.pdf> [41].

The National Electronic Health Record Survey (NEHRS) conducted a survey of PCPs in 2015 and 2017 and found that 38 percent of physicians received patient information electronically. Out of that 38 percent, only one in five never used or rarely used the information. Lack of integration and lack of system availability played a key role in these findings [37] (NEHRS 2017).

2.4 Performance Quality Measures—Access and Availability of Care for Children and Adolescents under Medicare and CHIP:

Performance measurement is a powerful tool to drive improvements in the quality of care initiated at the provider, health plan, health system, or state levels. However,

several established measures of children's health care quality are defined differently and are more challenging to enact and interpret than those that measure adult care. Some metrics that are not taken into consideration are those that include the unique aspects of childhood: such as children's rapid growth and development, their higher likelihood of being in poverty, and dependence on their families [47]. Quality Measurement can inform and encourage improvement in child health care. However, most childcare measures currently gauge if care is received and provide no further information about the extent to which PCPs use the four interoperability domains--Send, Find, Receive, and Integrate clinical information--when providing access and availability of care for adolescents between 12-19 years of age.

One of the primary purposes of a PCP is to help adolescents grow and develop into healthy adults [30]. However, a significant concern is the availability of evidence to guide quality measurement, length of time since an adolescent last had contact with a PCP or a healthcare professional, and the health insurance coverages utilized to access care. According to the National Health Interview Survey (NHIS) results in 2015, 72.2 percent of adolescents between the ages of 12-17 years in the United States had contact with a PCP over the course of six months or less of which 77.5 percent had private insurance, and 78.9 percent had Medicaid or other public insurance which includes Medicare and CHIP [52].

The number of adolescents between the referenced ages above with contact to a PCP or a healthcare professional within six months or less rose to 73 percent in 2017, 78.8 percent had private insurance, and 79.7 percent had Medicaid and other public insurance [53]. The uninsured percentage was 50.6 percent in 2015 [52], and 50.9 [53]

percent in 2017. The CHIPRA Act of 2009 included provisions to strengthen the quality of care provided to and health outcomes of children in Medicaid and CHIP [48].

Medicaid and CHIP serve almost 74 million children and adults in the United States [47].

Studies indicate that children enrolled in Medicaid or CHIP receive the same level of care as those that are privately insured and receive better care than those that are uninsured [53, 53, 54]. Additionally, parents of adolescents and children enrolled in Medicaid or CHIP were more likely to express satisfaction than those parents of children who were uninsured [59]. Most of these adolescents are defined as physically fit and presumed healthy, however, there is still a considerable amount of premature death, illness, and injury among adolescents [101]. Furthermore, the conventional medical measures and status attributes that define most youths and adolescents as healthy--for example the incidence of disease, mortality rates, prevalence of chronic conditions, and health services --are the basis of this study's hypothesis.

Conversely, illnesses are another significant factor that prevent adolescents from growing and developing to their fullest potential [101]. According to the National Survey of Child Health, approximately 83 percent of adolescents aged 12–17 years are in either excellent or excellent health as reported by their parents, regardless of whether they live in urban or rural areas [11,3]. Additionally, in 2016, approximately 1.1 million adolescents 10-19 years of age died according to WHO. Over 3000 adolescents died daily from avoidable or preventable causes [101]. Another area of concern was the statistics regarding mental health – according to WHO one half of all mental health illnesses and issues begin during the adolescent phase, specifically by age 14, and these issues and

illnesses will continue throughout the life of the adolescent and carry into adulthood. Most of these cases are left undetected or untreated [101].

According to the National Center for Injury Prevention and Control, most adolescents' deaths are the result of sudden injuries like car crashes or deliberate injuries like suicide, sexual transmitted diseases, homicide, or chronic health disorders [114]. Furthermore, in 2016, highway traffic injuries were the major cause of death among youths and adolescents. Other major causes of death among adolescents include social violence, HIV/AIDS, diarrheal relates illnesses, and suicide. Adolescence marks a critical milestone as children transition to adulthood and this time is optimal to create healthy choices and well-being to promote health later in life [114].

Many adolescents engage in risky behaviors and live in communities or areas that affect their physical and mental health, which significantly impacts their lives and health as adults [114]. Medicaid and CHIP offer adolescent youths' access to PCPs, well-child visits, and other preventive health care services. These services include immunizations, screenings, and counseling to support healthy living. Availability and quality access to consistent primary care services can prevent disease and other physical and mental health disorders. Access to primary care services can help individuals live longer, enjoy healthier and happy lifestyles, and improve the health population's health as a whole [103].

2.4.1 Primary Care Services:

Access to primary care is vital for the health and well-being of children and adolescents. High-quality primary care services have been found to significantly reduce children's non-urgent ER visits [39] consistent source of primary care can fill the need for

screening, appropriate treatment, and preventative services for children and adolescents. Sadly, the United States faces a shortage of primary care physicians to meet the nation's healthcare needs for children and adolescents [39]. PCPs offer direct patient care PCP is the patient's first contact with the health care system. PCPs provide critical preventative care, disease management, and referrals to patients who need to engage with more specialized health care professionals. [39]. In 2015, the number of active PCPs (including general practice, family practice, obstetrics and gynecology, pediatrics, geriatrics, and internal medicine) in the United States per 100,000 people was 127.7 [39].

The number increased to 149.7 in 2017 and had a little spike in 2019, bringing the current US value of PCPs per 100,000 populations to 159.6 [39]. Furthermore, PCPs offering provider-based services offers them in private office-based care practices (such as pediatrics and family medicine offices).

2.4.1.1 Private Office Base-Care:

Primary care services are the first point of contact in the healthcare system. Private office base-care serves as the firsthand contact or "front door" to access care to adolescents [118]. Recent studies show that although private office-based primary care services are accessible to most adolescents, those services depend significantly on fee-based reimbursement; thus, they are not accessible to adolescents who are uninsured or underinsured [30]. Research indicates that adolescents are an underserved group who typically have a low rate of PCP usage. In fact, adolescents have the lowest rate of PCP usage out of any age category [30]. Recent studies indicate that that one-third of adolescents had no preventive care visits from ages 13 to 17 years and only 40% had a single visit [88]. PCP's practices often cover the following:

1). Routine health care visits or yearly physicals or well-care visits which are often monitored and controlled by community school boards. necessary diagnostic tests (such as height, weight, and blood pressure), vision and hearing screening, and brief consultation on health concerns or health promotion [30].

2). Scheduled vaccinations also drive the volume of annual office visits, depending on the school's requirements, state programs for free vaccines, insurance coverage, and reimbursement practices [30]. Results from one study indicated that that 38 % (out of the 8,464 adolescents surveyed) had regular follow up and preventive care visit in the last twelve months. This study measured routine preventive care visits provided by PCPs to adolescent patients [66]. According to the study, uninsured adolescents and low-income status had a higher risk of not seeing a PCP throughout the year [66]. Generally, adolescents will schedule a follow-up visit with their PCPs if they are assured that any information shared during the visit will be kept confidential and not shared with their parents or guardians. This type of reassurance and commitment to patient privacy resulted in a greater rate of routine follow-up visits [68-70]. Adolescents are among those least likely to have access to preventive health care [30]. They historically have the lowest rate of primary care use of any age group in the United States [30].

Adolescents report that patient privacy is a great concern for them. Research indicates that adolescents will see providers if the provider can assure them that all information pertaining to the visit is kept confidential. These assurances result in adolescent patients more likely to return for a follow-up visit [30,70]. There are many barriers to confidential care for adolescents. Adolescents have a serious knowledge gap

regarding consent laws and pediatricians and providers are encouraged to remind adolescents of relevant privacy laws [68].

2.4.1.2 Safety-Net Primary Care Services:

Safety-net primary care practices, as defined by the Institute of Medicine (IOM), are "those providers that delivers and organizes a significant level of health care services to uninsured Medicaid and vulnerable patients" [73]. Research indicates that there is a gap between uninsured adolescents and visits to a medical professional. Those that are uninsured or underinsured are less likely to receive primary care services. Additionally, many adolescents in this category do not have an established relationship with a health care professional [30]. According to the IOM, "core safety net providers are providers that operate on an open door" policy to patients regardless of the ability to pay. These patients are uninsured, Medicaid, and other vulnerable patients [73]. These core providers include some service providers such as community teaching and community hospitals, school-based health programs, and private physicians who care for predominantly uninsured or Medicare patients [73].

A study conducted in 2016 on the public use of safety-net clinics for primary care among adults with non-Medicaid insurance in the United States showed that more than one-third (35.0%) of all primary care safety-net clinic visits were among adolescent adults with non-Medicaid primary insurance, representing 6,642,000 annual visits nationally [77]. The study concluded that safety net clinics are important primary care delivery sites for non-Medicaid insured minority and low-income populations with a high chronic illness [77].

2.4.1.3 Community Health Centers:

Community-based health centers are a fundamental component to the safety-net primary care system [30]. These centers offer a broad array of primary care services for their communities that may not have access to traditional health care services [30]. According to the Health Resources and Services Administration (HRSA), these care services reduce health disparities by emphasizing the care management of patients with multiple health care needs and critical quality improvement practices, including health information technology [105]. Many of these community health centers receive Health Center Program federal grant funding to improve underserved and vulnerable populations [75]. Furthermore, most of their operating funds come from Medicare, Medicare, private insurance, patient fees, and other resources [75].

In 2016, federally-funded local health centers served 25.9 million children, adolescents, and adults or --more than 1 in 12 patients --in over 10,400 cities and rural areas [80]. Additionally, local and state authorities fund and support over 58 municipal health centers which account for over 738,000 patients [80].

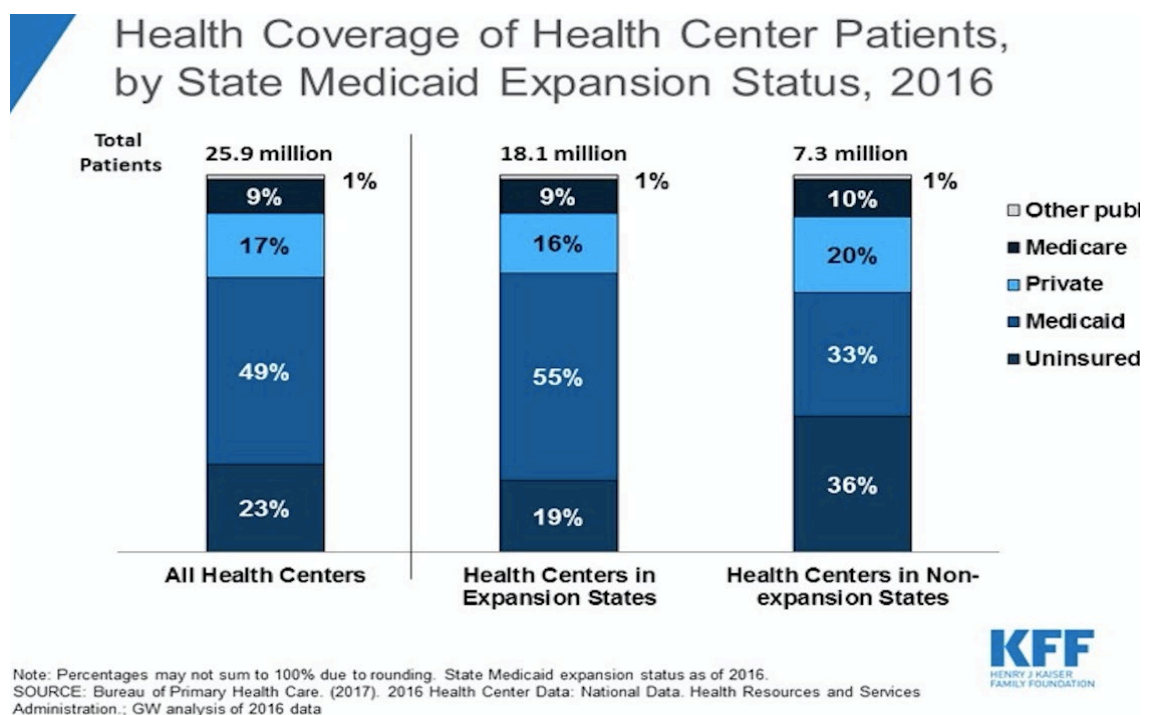
2.4.1.4 Hospital-affiliated Primary Care Services:

Over the past three decades, more and more PCPs have allowed hospitals to assume their patients who require emergency services, need intensive care, or require hospitalization [78]. Several success stories include those hospitals that have created adolescent focused centers to serve adolescents specific needs [30]. The Mount Sinai Hospital in New York City, Denver Health in Colorado, and the Arkansas Children's Hospital and Adolescent Center in Little Rock are some of the hospitals with primary care centers [30]. A study of more than 560,000 Medicare admissions found that patients

who were cared for by their PCP in the hospital were 14% more likely to be discharged home, 6% less likely to die within 30 days, and had 12% longer lengths of stay compared to those cared for by hospitalist [79].

Medicare provides coverage for approximately half of the health center's patient; 49% of patients were covered by Medicaid in 2016 according to **Figure 7** below.

Figure 7: Medicaid Coverage—Health Center Patients Status in 2016.



Lastly, according to figure 7 above, 17% of adolescents had private insurance which includes marketplace coverage, with Medicare covering 9%. Due to the increases in health coverage from the Affordable Care Act (ACA), health center patients were insured by 23% in 2016 as shown in figure 7 above [80].

2.4.1.5 School-Based Health Centers:

School-Based Health Centers (SBHCs) provide critical and developmentally appropriate services to adolescents [83]. SBHCs have provided a variety of comprehensive services to adolescents for more than forty years [83]. Recent studies have shown that adolescents who use SBHCs for medical care have significantly increased attendance rates than students who do not use them [82]. Additionally, students who frequently use SBHC services for mental health issues showed an increase in their grade point averages compared to those who did not use it [82]. Research indicates that adolescents are an underserved population and have unique mental and physical health care needs. Few adolescents receive regular preventive health care, while teens from disadvantaged families are at the highest risk for lack of access to preventive care [83]. SBHCs are distinctively designed to fill adolescents' unmet healthcare needs [81].

2.4.2. Adolescents' Use of Health Services:

It is critical to understand adolescent's use of health care services. Understanding adolescent's use of health services and clarifying the variations in their unmet need can improve the quality of care available to adolescents [30].

2.4.2.1 Visits with Health Care Providers-for adolescents ages 12-17 years:

A considerable number of adolescents visit a PCP during the year. However, the proportion decreases with age, especially in later adolescence as young people transition to adulthood. The greatest decrease occurs at age 18, as adolescents age out of free insurance [30]. According to the NHIS, in 2015, 76 percent of adolescents aged 12-17 years stated to have seen a PCP or other health care provider in the past year [52]. Subsequently, in 2017, that number rose to 89 percent of adolescents [53]. Adolescents

often rely on emergency room visits for all their health-related concerns. Their rates of emergency room use for non-urgent care is higher than any other age group [30]. Private insurance adolescent insurance holders are more likely to receive health services in a private provider's or managed care office and in contrast, adolescents with public insurance are more likely to see PCPs in a local clinic or health center [30].

2.5 Health Information Technology and Adolescent access to care:

Information Technology (IT) in health care is vital for providing quality care and access to care for adolescents. The HITECH act enacted in 2009 reinvigorated the widespread adoption of health information technology (HIT) [2]. HIT offers PCPs, healthcare providers, and patients' new ways to access and use health information. The delivery of health care through HIT requires that the PCPs and adolescents possess the ability integrate complex information from diverse sources [70]. Most adolescents between the ages of 12-17 years of age are technologically savvy. Their comfort level with technology far surpasses that of their parents and other older family members. The internet, social networking sites, mobile phones, and text messaging are some of the preferred forms of communication for adolescents [30]. Sadly, health institutions and the health industry cannot meet the technological needs of adolescents and cannot leverage existing technology to improve delivery and reduce unhealthy habits for this group [30].

The advancement of HIT globally is essential for optimized delivery of health care for adolescents. HIT is deemed to provide real-time and demand decision support for patients and clinicians while educating adolescents and their families. HIT is the frontier for a better health care system; it will encourage the diffusion of health services from the

office to the communities and assist in the tracking and coordinating care across regions and providers [70].

CHAPTER III:

METHODS

3.1. Introduction:

This study explored the correlative relationship between the core interoperability domains and the access/availability (performance of quality of care) of care for adolescents between the ages of 12-19 years utilizing two data sources of health care providers. The preceding chapters discussed the literature review pertinent to the research which included a discussion of the study purposes and research inquiries. This chapter consists of discussions on: **(3.2)** data sources for this study; **(3.3)** research questions and hypotheses; **(3.4)** research design; **(3.5)** appropriateness of design; (3.6) procedures; (3.7) data collection and instrumentation, **(3.8)** data analysis, **(3.9)** study variables.

This chapter also discusses the benefits to the field of health IT specifically focusing on access and availability of care for adolescents aged 12-19 years in the United States. Additionally, this chapter discusses approaches used by researchers in numerous research studies and a combination of alternatives research methods, which led to the selection of the quantitative correlational design in this study. This design approach fosters the aims and goals of the research to understand the correlation between quality access and availability of care for adolescents and the four core interoperability domains of an EHR system.

3.2. Data Sources:

The study decision involved two data sources, (a) National Electronic Health Record Survey (NEHRS) for the years 2015 and 2017 and the Medicaid.gov yearly reporting on the quality of care for adolescents in Medicaid and CHIP in 2015 and 2017.

3.2.1 National Electronic Health Record Survey (NEHRS):

The Centers for Disease Control and Prevention's National Center for Health Statistics has been conducting the mail survey—the National Electronic Health Records Survey (NEHRS)—of office-based physicians since 2008. ONC funds this supplemental survey to [96] track office-based physician's adoption and use of EHRs for health information exchange and patient engagement. The data set in this survey estimates measures nationally and individually for each state and the District of Columbia beginning in 2010. For this study, data from 2015 and 2017 was downloaded from the website data.gov using IBM SPSS. Appendices A and B contain the detailed Data Elements File for both the 2015 and 2017 datasets.

3.2.2. Yearly Reporting on the Quality of Care for Adolescents in Medicaid and CHIP:

CMS compiles and publishes information on state's progress reporting the “Child Core Set” measures. This study includes assessment data of state-specific performance measures as reported by 28 out of 45 states. These data sets meet internal standards of data quality and are compiled each year. Furthermore, the CHIPRA act of 2009 included requirements to strengthen the quality of care offered to adolescents and health outcomes of adolescent who participate s in the Medicaid CHIP programs [92]. The core data set includes a range quality measures which include physical and mental health of

adolescents ages 12-19 [92]. For this study, the yearly reporting for data sets focused on the quality of care for adolescents in Medicaid and CHIP programs for 2015 and 2017 will be utilized.

These datasets were downloaded for free using IBM SPSS at <https://data.medicaid.gov/Quality/2015-Child-Health-Care-Quality-Measures/59ee-bj4v> and <https://data.medicaid.gov/Quality/2017-Child-Health-Care-Quality-Measures/t8ub-nmh7> respectively.

3.3 Research Questions and Hypotheses:

1). Which independent variables of the four key EHR interoperability domains, electronically-- Send patient health information; Receive patient health information; Find patient health information; Integrate patient health information—have the highest correlation coefficient (R) in relation to the performance of quality measures (dependent variable) the quality access and availability of care for adolescents 12 and 19 years of age over time?

2). Which of the independent variables have the highest marginal impact related to PCPs when providing quality access and availability of care for adolescents between the ages of 12-19 years?

3.3.1. Research Question 1:

What is the relationship, if any, between quality access and availability of healthcare for adolescents between 12 -19 years as it relates to PCPs electronically "Sending" patient health information?

H1o: There is no statistical relationship between quality access and availability of healthcare for adolescents between 12 -19 years related to PCPs electronically "Sending" patient health information

H1a: There is a statistical relationship between quality access and availability of healthcare for adolescents between 12 -19 years as it relates to PCPs electronically "Sending" patient health information.

3.3.2. Research Question 2:

What is the relationship, if any, between quality access and availability of healthcare for adolescents between 12 -19 years as it relates to PCPs electronically "Receiving" patient health information?

H1o: There is no statistical relationship between quality access and availability of healthcare for adolescents between 12 -19 years related to PCPs electronically "Receiving" patient health information

H1a: There is a statistical relationship between quality access and availability of healthcare for adolescents between 12 -19 years as it relates to PCPs electronically "Receiving" patient health information.

3.3.3. Research Question 3:

What is the relationship, if any, between quality access and availability of healthcare for adolescents between 12 -19 years as it relates to PCPs electronically "Finding" patient health information?

H1o: There is no statistical relationship between quality access and availability of healthcare for adolescents between 12 -19 years related to PCPs electronically "Finding" patient health information

H1a: There is a statistical relationship between quality access and availability of healthcare for adolescents between 12 -19 years related to PCPs electronically "Find" patient health information

3.3.4. Research Question 4:

What is the relationship, if any, between quality access and availability of healthcare for adolescents between 12 -19 years as it relates to PCPs electronically "Integrating patient health information?"

H1o: There is no statistical relationship between quality access and availability of healthcare for adolescents between 12 -19 years related to PCPs electronically "Integrating" patient health information

H1a: There is a statistical relationship between quality access and availability of healthcare for adolescent between 12 -19 years and when PCPs electronically "Integrating" patient health information

3.4. Research design:

Research design in quantitative research refers to the researcher's way of answering a question by taking several considerations into account, including the number of subject groups, the timing of data collection, and research interventions, if any [97]. Quantitative research can be interventional or noninterventional. Interventional designs test the effect of intentional action, called an intervention, on a measured result. I am not examining the impact of an intervention or an intentional action, so this design category will not be used. Noninterventional design counts and measures characteristics about the phenomenon of interest and the study variables as they exist naturally, without intentional

interventions [97]. This research examines variables as they exist naturally, without intentional interventions; hence it is considered a noninterventional design.

Furthermore, noninterventional research can be divided into two designs—descriptive design and correctional design. The descriptive analysis describes the variables within a study, but correlational research focuses on describing relationships between and among variables [97]. A quantitative correctional design is used for this study. This study's scope includes quantitative, empirical, and longitudinal correlational methods/designs because its purpose is to describe the relationships between and among variables over time. Furthermore, it is considered a longitudinal correlational study because one group (PCPs) is utilized for this study. The data-collection periods, during which each subject is measured, are two or more.

This study focuses on describing the relationship between access/ availability of care for adolescents as it relates to the extent to which PCPs use the four EHR interoperability domains to provide care for them over time. This study aims to determine if the use of EHR interoperability core domains are associated (net benefits) with PCPs when providing access and availability of the quality of care to adolescents ages 12-19 years. Therefore, a correctional design is considered suitable for this study.

3.5. Appropriateness of Design:

Correlational research was conducted to determine the direction and the strength of relationships between or among variables as they exist naturally. The outcome of correctional research maybe **1)** the description of relationships between or among variables **2)** the ability to predict values of one variable based on the values of the other,

or 3) the confirmation of the individual relationships within a proposed theoretical model [97]. Correlational analysis was chosen as the foundation to hone the focus for which variables to utilize in a possible casual analysis. Furthermore, the need to illustrate and examine the correlation between the core EHR interoperability domains and the quality of care for adolescents aged 12-19 is deemed timely and needed.

A correlational design which is quantitative in nature matches the type of data collected for this quantitative study. Hence, a quantitative and correlational design was deemed suitable for investigating the correlation between quality access and availability of care to PCPs for adolescents related to the extent to which these PCPs use the four core EHR interoperability domains.

3.6. Procedures:

Both the data.gov and data.Medicaid.gov databases are intended for public access and use in research; however, statistics software may be required to extract the necessary dataset for analysis.

3.6.1. Data.gov:

The procedures to pull data from these databases is outlined below. The first step is to review the website's datasets and available information to determine data availability, data values and data reliability. The next step is to review the dataset that correlates to this study and review the data for the study years. For this study, data for 2015 and 2017 are examined and verified. This dataset is federally funded and published by the Office of the National Coordinator for Health Information Technology. Therefore, it is intended for public access and use. Users of this database do not need to complete

any type of training or provide license information before accessing the datasets. For this study, "office-based-physician-health-it-adoption-and-use" datasets are used for the years 2015 and 2017. The database contains datasets from 2008-2017 and can be downloaded at https://dashboard.healthit.gov/datadashboard/data/NEHRS_2008-2017.csv for free using statistical software. The website also contains information on the following:

- ❖ Access and Use information—Public Use and no license required
- ❖ Download and Resources— <https://catalog.data.gov/dataset/office-based-physician-health-it-adoption-and-use>
- ❖ Publisher—Office of the National Coordinator for Health Information Technology (ONC)
- ❖ References-- <https://dashboard.healthit.gov/quickstats/pages/physician-ehr-adoption-trends.php>
- ❖ <https://dashboard.healthit.gov/apps/physician-health-it-adoption.php>
- ❖ Metadata Updated Date—June 2020

3.6.2 Data.Medicaid.gov:

CHIPRA contained provisions to foster and improve the quality of care provided to and health outcomes of children participating in Medicaid and the CHIP. Annual information and reporting on the progress of each state regarding the Child Core Set measures and state-specific performance measures are released by CMS for at least 25 states that meet internal standards of data quality [92]. The Data.Medicaid.gov database for quality of care and performance measures for the 2015 and 2017 Child Core datasets is accessible at <https://www.medicaid.gov/medicaid/quality-of-care/index.html>. The database contains yearly reporting on the quality of care—access and availability of care

for adolescents 12-19 years who participate in programs provided by Medicaid and CHIP.

To extract data from this website, users would use the link listed above and proceed to their study's required performance measurement. For this study, the performance measurement for the "Child Core" datasets are used.

The CMS promotes and collects the "Child Core" Sets to support federal and state efforts to collect, report, and use a standardized set of measures to drive improvement in the quality of care available to Medicaid and CHIP beneficiaries. On the "Child Core" Set web page, the dataset for the "Child Health Quality Measures Dataset" can be extracted for the intended year or years relevant to the time frame that is being researched. For this research, datasets for the Child Health Quality Measures datasets for FFY 2015 can be extracted from <https://data.medicaid.gov/Quality/2015-Child-Health-Care-Quality-Measures/59ee-bj4v> and Datasets for 2017 at <https://data.medicaid.gov/Quality/2017-Child-Health-Care-Quality-Measures/t8ub-nmh7> respectively. Data limitations prevented the inclusion of the 2016 data set since specific files needed for this study were unavailable. Consequently, this study will not include analysis for 2016. This database downloads also include descriptions and the list of data elements.

- ❖ Access and Use information—Public Use and no license required
- ❖ Download and Resources— <https://www.medicaid.gov/medicaid/quality-of-care/performance-measurement/adult-and-child-health-care-quality-measures/childrens-health-care-quality-measures/index.html>
- ❖ Publisher—Center for Medicare and Medicaid (CMS)

3.7. Data collection and Instruments:

The data collection process played a critical role for this this research. The nature, accessibility, and availability of data collected solidified the basis of this study and was used as the foundation for the conclusions I provided. A retrospective data collection approach is used in the data collection for this study. Retrospective in healthcare means looking backward, usually in a relationship, to time [97]. As indicated in the "research design" section of this chapter (Section 3.4), this study is noninterventional research design. Much of noninterventional research in health care uses retrospective data analysis, which is primarily drawn from health records achieved in electronic databases [97]. Data for this study was drawn from health records archived in electronic databases that are accessible to the general public. Furthermore, in retrospective studies, data is obtained from existent records or other previously collected data, predating the occurrence of the event [97]. Using this type of data instrument, as a researcher, I can establish possible causal relationships for further investigations.

Both the data.gov and data.Medicaid.gov databases required statistical software for downloads. However, each database's datasets were downloaded as a Microsoft Access database with Excel files provided as data dictionaries. The specific files and datasets needed from both databases were extracted, manipulated, and uploaded to SPSS for analysis.

3.8 Data analysis:

In research, data analysis involves data categorization, data ordering, data manipulation, and data summarization. All of which are critical in the analysis and for

drawing conclusions in useful and meaningful terms [95]. This study is quantitative in nature and uses statistical strategies and software during data analysis. All statistical tests were conducted at the 95% confidence level ($\alpha = .05$) throughout this study, and data analysis was performed in numerous steps. First, I entered the data from the extracted excel data files into SPSS and conducted the various statistical analyses as outlined in the following paragraphs. frequency tables and percentages were used to calculate nominal data in this study. Standard deviation and means were utilized to calculate the independent variables—electronically send, receive, find, and integrate patient health information at the point of care over time.

Secondly, emphasis was placed on the analysis of the relationship between quality measures—access and availability of care for adolescents in Medicaid and CHIP (dependent variable). Each one of the interoperability domains (independent variables) mentioned above was measured separately and was entered in a different hypothesis/correlation analysis. The following is an example of the analysis done for each one of the study hypotheses. Hypothesis one—I examined the relationship between the quality measures—quality access and availability of care for adolescents between 12-19 years in Medicaid and CHIP and electronically "Send patient health information."

A Pearson correlation analysis was used to analyze and examine the hypothesis; a Pearson correlation analysis series measures the relationship between quality of care (access and availability of care for adolescents) and electronically Send patient health information. According to Pallant, [95], a Pearson correlation is deemed suitable when the study's outcomes are to assess the correlation among two variables with one being an ordinal variable. The letter r denotes the Pearson correlation coefficient (statistic), and the

value is always between -1.00 and +1.00. A value of zero indicates no relationship between the two variables. A positive correlation suggests that higher values of x are associated with higher values y , and lower values of x are associated with lower values of y . A general multiple regression equation can be written as: $y = b_1x_1 + b_2x_2 + \dots + b_nx_n + c$.

Where the b 's, that is ($i=1, 2 \dots n$) are the regression coefficients. They represent the value of the criterion variable when the predictor variable changes. A multiple regression equation will be derived for this study in the next chapter.

Furthermore, a negative coefficient indicates an inverse relationship. Coefficients from 0.00 to 0.29 are considered weak but positively associate; those 0.00 to -0.29 are also weak but are deemed to have a negative association. 0.30 to 0.49 are moderate and positively associated, and -0.49 to -0.30 are also regarded as moderate but negatively associated.

Lastly, a strong correlation in data variables is defined as 0.50 to 1.00 and is considered to have a positive association; those from -1.00 to -0.50 are also strong but negatively associated [97]. The hypothesis related to the individual study questions and methods are listed below:

3.9. Study Variables:

3.9.1. Dependent Variable:

Quality Measures-Access and availability of care for adolescents between the ages of 12-19 years in Medicaid and CHIP are the dependent variables for this study.

3.9.2. Independent Variables:

3.9.2.1. Send Patient Health Information:

The utilization of an EHR or a web-based portal to transmit patient data and records to other PCPs, specialty healthcare providers, and other authorized outside organizations.

3.9.2.2. Receive Patient Health Information:

The utilization of an EHR or web-based portal to receive patient information electronically from other PCPs, specialty healthcare providers, and other authorized outside organizations.

3.9.2.3. Find Patient Health Information:

The utilization and accessing of an EHR or web-based portals to pull information concerning a new or existing patient from outside sources and medical organizations.

3.9.2.4. Integrate Patient Information:

The utilization, assessment, and integration of patient health information by the PCP. It is PCP's ability to gather and integrate information from multiple EHR systems or web-based portal [11].

CHAPTER IV:

RESULTS

The aim of this quantitative correlational study was to investigate the potential relationship between the four EHR interoperability domains and the performance on quality of care by PCPs when providing quality access and availability of care for adolescents ages 12-19 years. Additionally, this study analyzed the marginal impact of each of the interoperability domains (Find, Send, Receive, and Integrate patient health information) and its impact on PCP's performance on quality of care (access and availability of care) for adolescents between the ages of 12-19 years. The analysis and results for this study was reported in the order below:

4.1 Procedures and Methods of Estimation

4.2 Research Equations, Definitions, and Study Variables

4.3 Marginal Impact Equations and Descriptions

4.4 Data analysis and Results

4.5 Multiple linear Regression Results-Central Question and Answer

4.1. Procedures and Methods of Estimation:

In order to validate and provide answers to the research questions and hypotheses, the study established a baseline econometric model constructed as a multivariable linear regression equation. Performance to quality care within PCPs when providing quality access and availability of care to adolescents ages 12-19 years is the dependent variable while the four core EHR interoperability domains —are the predictors (independent

variables) for this study. The years of study are 2015 and 2017. Study period is limited to two years because of the availability of the necessary data.

4.2 Research Equations, Definitions, and Study Variable:

The study equations, definitions, and study variables are depicted as follows:

4.2.1 Equation 1: Equation 1 Is the general equation without interaction:

In equation 1 below, the mathematical values of the coefficients are used in this study to determine the degree or strength of the relationship between variables (dependent and independent) of the study. A positive coefficient implies positive R. This means that a positive change in the predictor variable conveys a positive impact on the dependent variable. Also, a negative change in the predictor variable conveys a negative change in the dependent variable.

$$AACA_t = \beta_0 + \beta_1 FCI_t + \beta_2 SCI_t + \beta_3 RCI_t + \beta_4 ICI_t + \varepsilon_t$$

4.2.2 Equation 1: Definitions:

- ❖ **AACA_t**—Is the “Access and Availability to Care for Adolescents (AACA) ages 12-19 years within their PCP practices captured by Medicaid and CHIP over time (t).
- ❖ **FCI_t** (Find Patient Health Information)—Is the utilization and accessing of an EHR or web-based portal to pull information concerning a new or existing patient from outside sources and medical organizations.
- ❖ **SCI_t** (Send Patient Health Information)—Is the utilization of an EHR or a web-based portal to transmit patient data and records to other PCPs, specialty healthcare providers, and other authorized outside organizations.

- ❖ **RCI_t** (Receive Patient Health Information)—Is the utilization of an EHR or web-based portal to receive patient information electronically from other PCPs, specialty healthcare providers, and other authorized outside organizations.
- ❖ **ICI_t** (Integrate Patient Information)—Is the utilization, assessment, and integration of patient health information by the PCP. It is PCP's ability to gather and integrate information from multiple EHR systems or web-based portal.

4.3 Marginal Impact Equations and Descriptions:

4.3.1 Equation 2: Equation two is the equation with interaction:

In equation 2 below, the study derives the marginal impact of the interaction of usage time and each domain on the quality of healthcare. It is calculated by first establishing the interaction variables as shown below in the model (eq. 2). Then proceeds to take partial derivative of equation (2) with respect to each of the four domains. This produces four equations as stated below and solves for the marginal quantity. The domain with the highest value is said to have the highest marginal impact. This means it is the best domain for quality access and availability of care for adolescents between 12-19 years.

Equation 2:

$$\begin{aligned} \text{❖ } \text{AACA}_t = & \beta_0 + \beta_1 \text{FCI}_t + \beta_2 \text{SCI}_t + \beta_3 \text{RCI}_t + \beta_4 \text{ICI}_t + \beta_5 \text{FCI}_t * \text{Usage}_t + \beta_6 \text{SCI}_t \\ & * \text{Usage}_t + \beta_7 \text{RCI}_t * \text{Usage}_t + \beta_8 \text{ICI}_t * \text{Usage}_t + \varepsilon_t \end{aligned}$$

4.3.2 Equation 2: Definitions:

Under this equation “Usage” is defined as number of times each domain is used by PCPs. The percentage is dependence on each domain to quality access and availability

of care for adolescents over the years (2015 and 2017). The equation definitions are explained below:

- ❖ $FCI_t * Usage_t$ —Is the interaction of “Find” domain and usage time.
- ❖ $SCI_t * Usage_t$ —Is the interaction of “Send” domain and usage time.
- ❖ $RCI_t * Usage_t$ —Is the interaction of “Receive” domain and usage time.
- ❖ $ICI_t * Usage_t$ —Is stands for the interaction of “Integrate” domain and usage time.
- ❖ β_0 —Is the intercept coefficient (constant) of linear regression.
- ❖ ε_t —Is the statistical error term.

Furthermore, with respect to each of the four EHR interoperability domains and after solving for the marginal quantity, the results are the four-marginal impact (Usage) equations below.

Equation 3:

$$\frac{\partial AACA_t^*}{\partial FCI_t} = \beta_1 + \beta_5 Usage_t$$

Equation 4:

$$\frac{\partial AACA_t^*}{\partial SCI_t} = \beta_2 + \beta_6 Usage_t$$

Equation 5:

$$\frac{\partial AACA_t^*}{\partial RCI_t} = \beta_3 + \beta_7 Usage_t$$

Equation 6:

$$\frac{\partial AACA_t^*}{\partial ICI_t} = \beta_4 + \beta_8 Usage_t$$

Where AACA* is the health industry quality access to care as shown in the first baseline econometric model.

4.4 Data analysis and Results:

4.4.1 Data Analysis:

The data used in the econometric models I & 2 was sourced from NEHRS and Medicaid & CHIP for 2015 and 2017, respectively. The available data retrieved from NEHRS and Medicaid & CHIP covers 45 states in the United States. However, there are missing values (in some of the interoperability domains) for the years 2015 and 2017 in 17 states. Of the 45 states, only 28 states have complete data and it is decided to analyze the 28 states.

The justification for this decision is that 28 states is 62 percent of 45. The complete datasets for the 28 states are far more than half of the observed states (45 states). Therefore, 28 state is significant and can be concluded that these complete sets of data can be applied to other states (17), all things being equal. The complete data, tables and other relevant graphs are attached in the appendix for clarity of work and further explanatory functions.

4.4.2 Results:

Table 2: Descriptive Statistics 1:

Table 2- Descriptive Statistics

	N	Mean		Std. Deviation		Variance		<u>Skewness</u>		Kurtosis	
	Statistic	Statistic	Std. Error	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error	Statistic	Std. Error
Medicaid and CHIP	54	88.172	.8844	6.4993	42.241	-1.901	.325	3.731	.639		
Find Clinical Information	54	45.397	1.8999	13.9611	194.911	.368	.325	-.501	.639		
Send Clinical Information	54	38.506	1.1072	8.1364	66.201	.045	.325	-.243	.639		
Receive Clinical Information	54	38.322	1.2310	9.0463	81.836	.757	.325	.581	.639		
Integrate Clinical Information	54	30.084	1.0716	7.8744	62.006	.768	.325	-.168	.639		

Table 3: Descriptive Statistics 2:**Table 3- Descriptive Statistic 2**

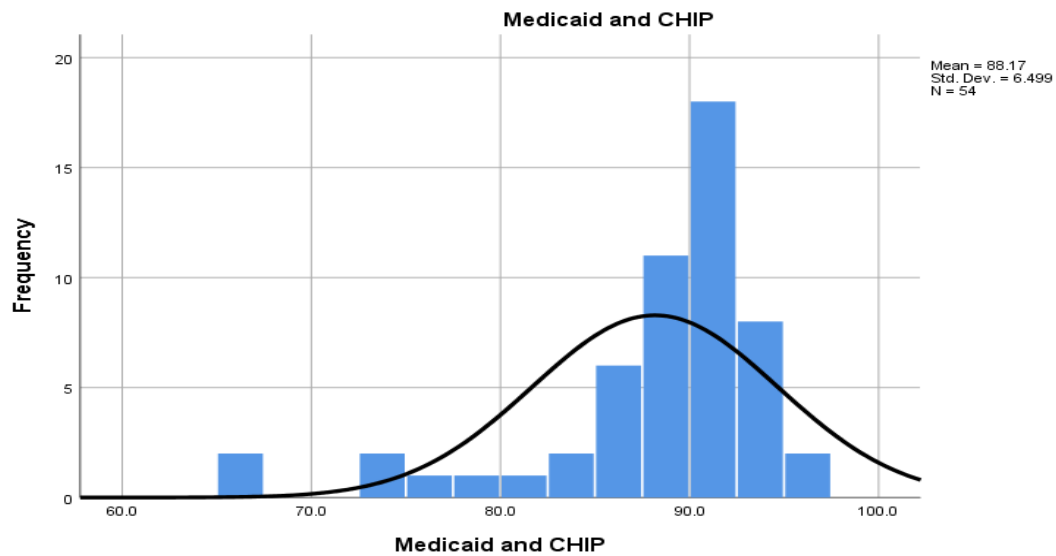
		Medicaid and CHIP	Find Clinical Information	Send Clinical Information	Receive Clinical Information	Integrate Clinical Information
N	Valid	54	54	54	54	54
	Missing	0	0	0	0	0
Mean		88.172	45.397	38.506	38.322	30.084
Median		90.000	41.444	38.132	38.648	28.447
Mode		91.2 ^a	19.8 ^a	20.5 ^a	23.7 ^a	18.0 ^a
Std. Deviation		6.4993	13.9611	8.1364	9.0463	7.8744
Variance		42.241	194.911	66.201	81.836	62.006
Skewness		-1.901	.368	.045	.757	.768
Std. Error of Skewness		.325	.325	.325	.325	.325
Kurtosis		3.731	-.501	-.243	.581	-.168
Std. Error of Kurtosis		.639	.639	.639	.639	.639

a. Multiple modes exist. The smallest value is shown

Table 2 and 3 above show the descriptive statistics for the dependent variable (access and availability to care for adolescents ages 12-19 years using Medicaid and CHIP when visiting their PCPs) and the independent variables, electronically—find clinical information (FCI), send clinical information (SCI), receive clinical information (RCI), and integrate patient information (ICI). The number of observations is represented by N = 54. A sample size less than 30 ($n < 30$) is statistically considered a small sample. The study sample is 54, therefore, it is deemed a relatively large sample. The descriptive statistics reflected above are mean, median, mode, standard deviation, variance, skewness, standard error of skewness, kurtosis, and standard error of kurtosis.

The results of the statistical analysis indicate that all have positive values except for the Medicaid and CHIP skewedness which can be considered having a negative skew. A skew to the left is when the mean is less than the median as shown in table 3.

Figure 8: Medicaid and CHIP Histogram (Dependent Variable):



In figure 8 (Medicaid and CHIP bar) the estimated value of the mean is 88.17 with a Median of 90.0, and a standard deviation of 6.5. The sample size as shown in the bar is 54. The normality test shows the bar slightly skewed to the left.

Figure 9: “Find” Interoperability Domain Histogram:

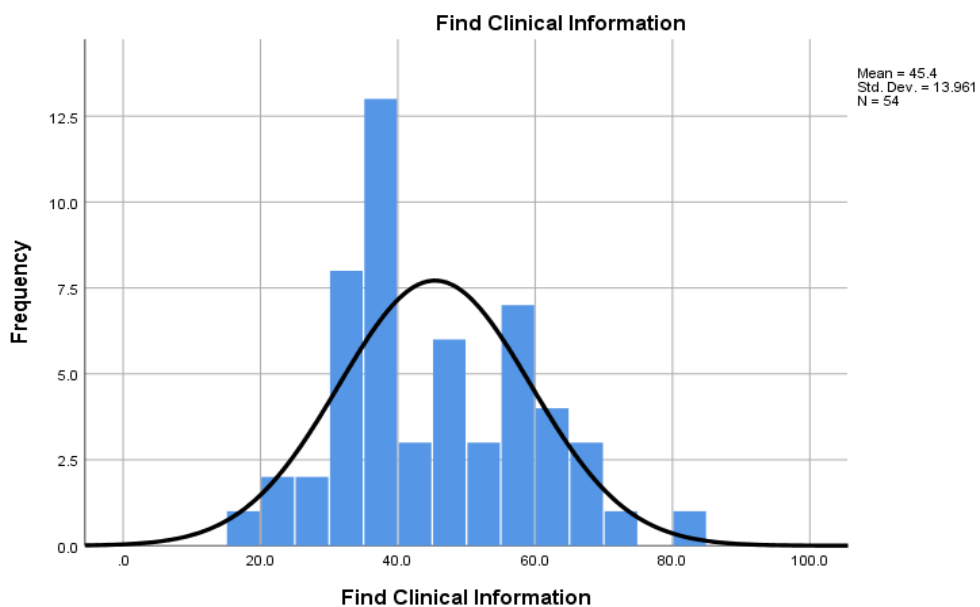


Figure 9 is a bar representation of the “find” clinical information (FCI) domain observation. The normality test is almost considered a normal distribution; however, it shows a slight departure from the symmetry (positive skewness). The distribution has a mean of 45.4, a median of 41.1, and a standard deviation of 13.981. The sample size is 54 which is considered a relatively large sample.

Figure 10: “Send” Interoperability Domain Histogram:

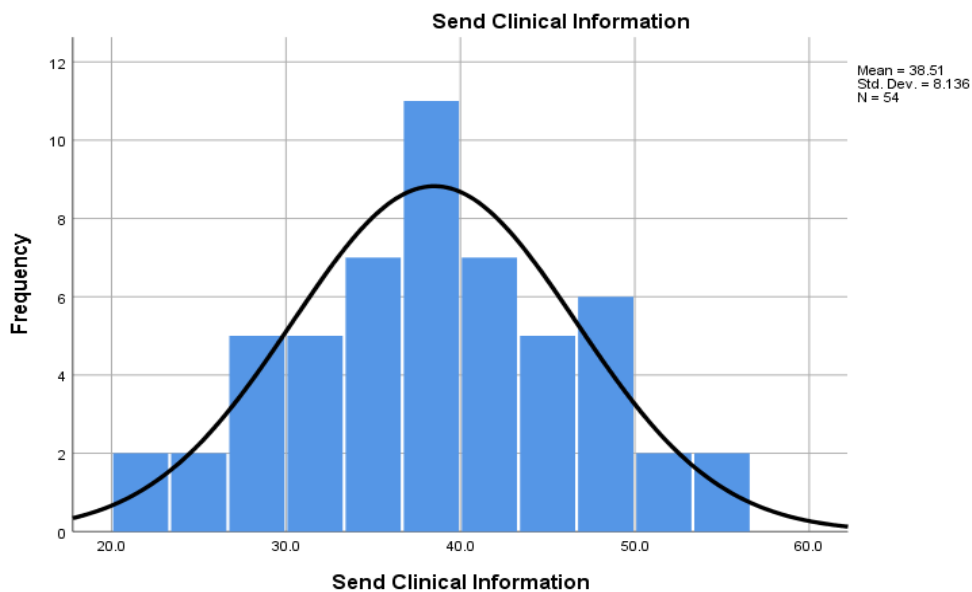


Figure 10 is a bar representation of the observations of the “send” clinical information (SCI) variable. It reflects a small departure from the symmetry (positive skewness) but the normality test shows a practically normal distribution. The distribution result shows a mean of 38. 51, a median of 38.1, and a standard deviation of 8.136. It is also considered a relatively large sample with a sample size of 54.

Figure 11: “Receive” Interoperability Domain Histogram:

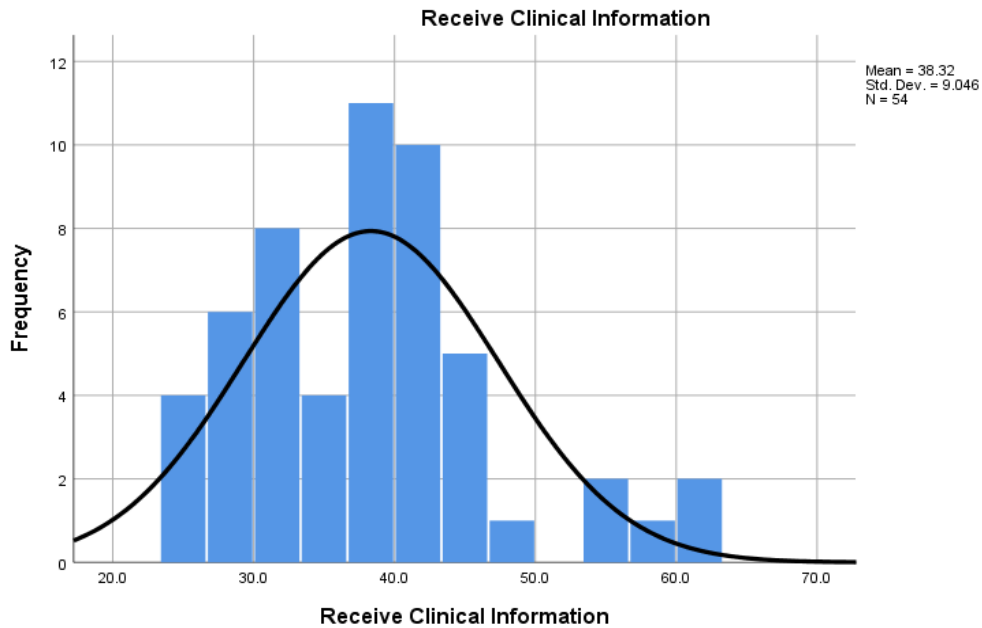


Figure 11 is a bar representation of the observation variables receive clinical information (RCI). It also shows a negligible departure from the symmetry (positive skewness), however, the normality test reflects a practically normal distribution. The distribution result has a mean of 38.32, a median of 38.64, and a standard deviation of 9.046. It has a relatively large sample of 54 as well.

Figure 12: “Integrate” Interoperability Domain Histogram:

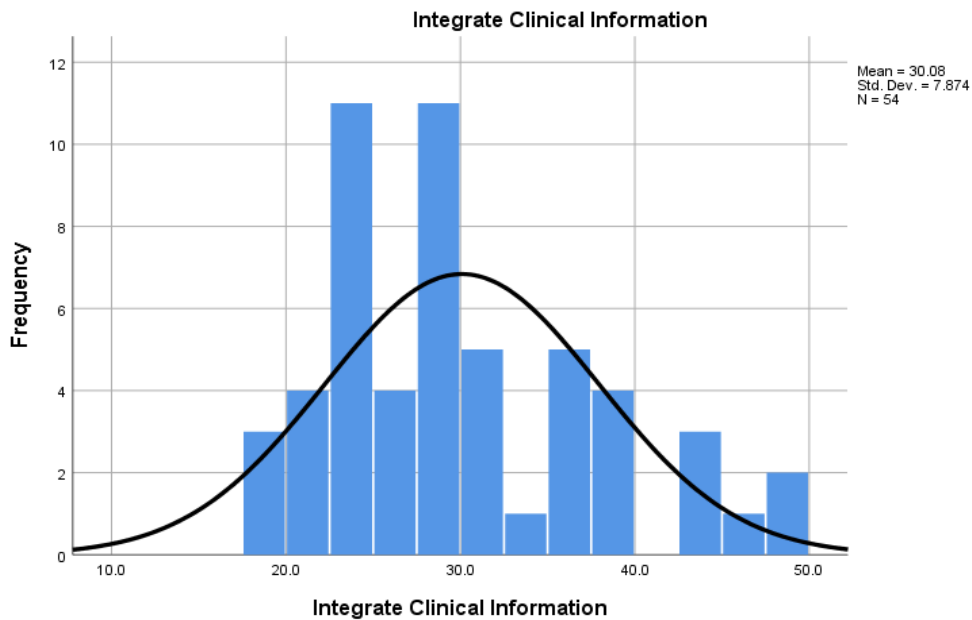


Figure 12 reflects a bar representation of the integrate clinical information (ICI) observation variables. The distribution is almost zero which means or indicates a non-existence skewness, that is, no departure from the center. The distribution has a mean of 30.08, a median of 28.44, and a standard deviation of 7.874. The simple size is considered large with N=54.

Table 4: Correlation Without Usage:**Table 4- Correlations without Usage**

		Medicaid and CHIP	Find Clinical Information	Send Clinical Information	Receive Clinical Information	Integrate Clinical Information
Medicaid and CHIP	Pearson Correlation	1	.113	.033	.060	.053
	Sig. (2-tailed)		.415	.810	.669	.705
	N	54	54	54	54	54
Find Clinical Information	Pearson Correlation	.113	1	.296*	.536**	.289*
	Sig. (2-tailed)	.415		.030	.000	.034
	N	54	54	54	54	54
Send Clinical Information	Pearson Correlation	.033	.296*	1	.712**	.478**
	Sig. (2-tailed)	.810	.030		.000	.000
	N	54	54	54	54	54
Receive Clinical Information	Pearson Correlation	.060	.536**	.712**	1	.509**
	Sig. (2-tailed)	.669	.000	.000		.000
	N	54	54	54	54	54
Integrate Clinical Information	Pearson Correlation	.053	.289*	.478**	.509**	1
	Sig. (2-tailed)	.705	.034	.000	.000	
	N	54	54	54	54	54

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Table 4 is a correlation distribution of the study variables without the usage interaction variables at 0.01 and 0.05 levels of alpha. It is a correlation distribution from equation 1. The R values for the variables are all positive at 0.01 and 0.05 levels of significance. Furthermore, table 4 also reflects the significance when the respective variables correlates with each other. For example, the RCI and FCI has a correlation value of (.536**) and the SCI and RCI with a correlation value of (.712**). The interpretation of these results indicates that when these domains are combined, they produce a maximum or high predictive capability of access and availability to care for adolescents ages 12-19 years.

Table 5: Correlation with Usage Interaction:

		Medicaid and CHIP	Find Clinical Information	Send Clinical Information	Receive Clinical Information	Integrate Clinical Information	Find Clinical Information with Usage	Send Clinical Information with Usage	Receive Clinical Information with Usage	Integrate Clinical Information with Usage
Medicaid and CHIP	Pearson	1	0.113	0.033	0.060	0.053	0.105	0.030	0.060	0.040
	Correlation									
	Sig. (2- tailed)		0.415	0.810	0.669	0.705	0.449	0.827	0.667	0.771
Find Clinical Information	N	54	54	54	54	54	54	54	54	54
	Pearson	0.113	1	.296*	.536**	.289*	.929**	0.219	.536**	0.166
	Correlation									
Send Clinical Information	Sig. (2- tailed)	0.415		0.030	0.000	0.034	0.000	0.111	0.000	0.230
	N	54	54	54	54	54	54	54	54	54
	Pearson	0.033	.296*	1	.712**	.478**	0.238	.991**	.711**	.445**
Receive Clinical Information	Correlation									
	Sig. (2- tailed)	0.810	0.030		0.000	0.000	0.083	0.000	0.000	0.001
	N	54	54	54	54	54	54	54	54	54
Integrate Clinical Information	Pearson	0.060	.536**	.712**	1	.509**	.408**	.696**	1.000**	.468**
	Correlation									
	Sig. (2- tailed)	0.669	0.000	0.000		0.000	0.002	0.000	0.000	0.000
Find Clinical Information with Usage	N	54	54	54	54	54	54	54	54	54
	Pearson	0.053	.289*	.478**	.509**	1	0.175	.482**	.509**	.981**
	Correlation									
Send Clinical Information with Usage	Sig. (2- tailed)	0.705	0.034	0.000	0.000		0.206	0.000	0.000	0.000
	N	54	54	54	54	54	54	54	54	54
	Pearson	0.105	.929**	0.238	.408**	0.175	1	0.130	.408**	0.008
Receive Clinical Information with Usage	Correlation									
	Sig. (2- tailed)	0.449	0.000	0.083	0.002	0.206		0.350	0.002	0.956
	N	54	54	54	54	54	54	54	54	54
Integrate Clinical Information with Usage	Pearson	0.030	0.219	.991**	.696**	.482**	0.130	1	.696**	.474**
	Correlation									
	Sig. (2- tailed)	0.827	0.111	0.000	0.000	0.000	0.350		0.000	0.000
Find Clinical Information with Usage	N	54	54	54	54	54	54	54	54	54
	Pearson	0.060	.536**	.711**	1.000**	.509**	.408**	.696**	1	.468**
	Correlation									
Send Clinical Information with Usage	Sig. (2- tailed)	0.667	0.000	0.000	0.000	0.000	0.002	0.000		0.000
	N	54	54	54	54	54	54	54	54	54
	Pearson	0.040	0.166	.445**	.468**	.981**	0.008	.474**	.468**	1
Receive Clinical Information with Usage	Correlation									
	Sig. (2- tailed)	0.771	0.230	0.001	0.000	0.000	0.956	0.000	0.000	
	N	54	54	54	54	54	54	54	54	54

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Table 5 shows the correlation distribution variables with the usage variable at 0.01 and 0.05 levels of alpha. This table is a correlation distribution from equation 2. The R values for the variables are all positive at a significance level of 0.01 and 0.05, respectively. Furthermore, the table reflects significance when each variable interacts

with usage in the two-tail test. For example, the RCI and the SCI have correlation value of (.712**), SCI and RCI*Usage correlates at (.696**). The interpretation of these results indicates that when these domains are combined, they produce a maximum or high predictive capability of access and availability to care for adolescents ages 12-19 years.

Table 6: Regression without Usage Interaction:

Table 6: Regression without usage interaction

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
	B	Std. Error	Beta			Lower Bound	Upper Bound
(Constant)	85.563	4.988		17.153	0	75.539	95.587
Find Clinical Information	0.052	0.079	0.113	0.663	0.51	-0.107	0.212
Send Clinical Information	-0.004	0.166	-0.005	-0.026	0.98	-0.338	0.33
Receive Clinical Information	-0.008	0.17	-0.012	-0.049	0.961	-0.35	0.333
Integrate Clinical Information	0.024	0.139	0.029	0.17	0.866	-0.255	0.303

Table 6 analyzes the relationship between the mean of AACA captured by Medicaid and CHIP values and the interoperability domains, that is, the predictive values (FCI, SCI, RCI, and ICI). The relative impact of these predictors variables reflects a negative relationship in RCI and SCI but ICI and FCI are positive which indicates a positive impact on the dependent variable AACA.

Table 7: Regression with Usage Interaction:**Table 7 Regression with usage interaction**

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
	B	Std. Error				Lower Bound	Upper Bound
(Constant)	85.313	5.309		16.070	0.000	74.626	95.999
Find Clinical Information	-0.260	0.438	-0.557	-0.593	0.556	-1.141	0.622
Send Clinical Information	-5.001	4.154	-6.260	-1.204	0.235	-13.363	3.362
Integrate Clinical Information	1.376	2.759	1.667	0.499	0.620	-4.177	6.929
Find Clinical Information with Usage	0.007	0.009	1.033	0.775	0.442	-0.011	0.025
Send Clinical Information with Usage	0.135	0.112	6.216	1.203	0.235	-0.091	0.360
Receive Clinical Information with Usage	0.000	0.005	-0.006	-0.025	0.980	-0.010	0.009
Integrate Clinical Information with Usage	-0.045	0.093	-1.669	-0.489	0.627	-0.231	0.141

a. Dependent Variable: Medicaid and CHIP

Table 7 analyzes the relationship between the mean of AACA captured by Medicaid and CHIP values and the interoperability domains - predictive variables (RCI, SCI, FCI and ICI) with the Usage variable interaction. In this table, the relative impact of these predictors on AACA are quantified. Both unstandardized and standardized coefficients of the predictor variables show positive relationship in FCI and SCI. However, ICI and RCI are negative coefficients showing negative impact on AACA. Hence the justification of the marginal impact analysis. This will show, however, if these negative signs of the coefficients depict negative impact when a domain is continuously utilized.

Table 8: Marginal Impact Table (Unstandardized Marginal Quantity Results):

Table 8: Marginal Impact Table

Marginal Impact Analysis					
Usage(2015+2017)	Domain	β_i	B_i	$\beta_i + \beta_i Usage_t.$	Marginal quantity
.34+.53	FCI	B_1	B_5	$\beta_1 + \beta_5 Usage_t.$	-0.25391
.36+.38	SCI	B_2	β_6	$\beta_2 + \beta_6 usage_t.$	-4.9011
.38+.38	RCI	β_3	B_7	$\beta_3 + \beta_7 Usage_t.$	0.000
.31+.28	ICI	B_4	B_8	$\beta_4 + \beta_8 usage_t.$	1.34945*

Table 8 shows the marginal analysis and the magnitude of the positive values on the interaction values which is used to offset the negative signs. The marginal impact value of the unstandardized and standardized integrate clinical information (ICI) coefficients is positive and has the highest values at (1.34945) and (0.682) respectively. This implies that the ICI domain produces highest marginal impact on AACA. The other domains have a small, negative, or zero values. The values of the unstandardized and standardized Marginal Impact are shown below.

Unstandardized Marginal Impact Values:

FCI: -0.25391

SCI: -4.9011

! RCI:0.000

ICI: 1.34945*

Standardized Marginal Impact Values:

FCI: 0.341

SCI: -1.660

! RCI: 0.000

ICI: 0.682*

! The yearly usage rates for 2017 and 2015 are the same. This effected the coefficient and it was omitted.

*(ICI) has the highest marginal impact. The “Integrate Clinical Information” interoperability domain has the highest marginal impact and it is positive. Others are negative or zero.

4.5 Central Question and Answer:

Central Research question:

1). Which independent variables of the four key EHR interoperability domains,--electronically--Send patient health information; Receive patient health information; Find patient health information; Integrate patient health information --has the highest correlation coefficient (R) in relation to the performance of quality measures (dependent variable) the quality access and availability of care for adolescents 12 and 19 years of age over time?

2). Which of the independent variables has the highest marginal impact related to PCPs when providing access and availability of care for adolescents between the ages of 12-19 years?

Answer: In both econometric models 1 & 2, none of the variable coefficients as regards to the dependent variable is significant at $\alpha = 0.05\%$ and 0.01% (when a correlation is significant, it is denoted with the * sign—see table 4 and 5 above).

However, at both levels of α , they all show a positive relationship with the dependent variable (performance of quality measures). Based on the magnitude of R values, the “Send patient information” domain has the highest R value which is .810. The second highest R value is the “Integrate patient information” domain which is .705. This implies that the "Send patient information" domain has more robust predictive capability on performance of quality measures. The correlation used together for example SCI and FCI is .296* and FCI and RCI is .536* at .01% and .05% α levels. This can be interpreted to mean that when two domains are combined, it will produce a better robust prediction on the performance of quality measures on the access and availability of care for adolescent ages of 12 and 19 years of age.

Model 2 is an interaction baseline econometric equation estimated to compute the marginal impact of the predictors on the dependent variable. Therefore, based on the result on Table 5; the ICI domain has a strong and positive correlation value of 0.705 and the highest marginal impact value per table 8 of 1.34945. This result of the analysis of this data supports the description and functions of the Integrate Clinical Information domain. The marginal impact value is 1.34945. Based on the marginal impact result, we can confidently say that even though the magnitude of the R value for predictor “SCI” is highest, the “ICI” domain has the highest additional effect when it is continuously used to predict performance of quality measures (quality access and availability of care for adolescents 12-19 years). Note that other domains have negative marginal impacts to the performance of quality measures mentioned above. Receive patient health information is excluded because the usage value remained constant over the two years of study.

CHAPTER VI:

DISCUSSION

This chapter will focus on the discussion of results as well as the interpretation of results on the study research questions and hypothesis.

5.1. Discussion of Study Results:

5.2. Results on Research Questions:

Results on Research Question 1 and Hypothesis 1

Results on Research Question 2 and Hypothesis 2

Results on Research Question 3 and Hypothesis 3

Results on Research Question 4 and Hypothesis

5.1. Discussion of Results:

Tables 2 and 3 as well as Figures 8-12 are distributions of the descriptive statistics. They represent all the variables which include the dependent and independent variables. The means, mode, variances, standard deviations, standard error, Kurtosis, Standard error of kurtosis and skewness values are derived by SPSS and they tend towards normality as shown in the bar charts. Apart from slight skewness as shown in Figure 2, others are symmetric with respect to the origin. The implication of this is that the data is normally distributed. There is no major outlier.

The correlation matrices are normal. They show various values that are significant at $\alpha = 0.05\%$ or 0.01% . In Table 4 & 5, the (correlation coefficients) R values of the variables of both dependent and independent are high and positive which depicts that there is a strong and positive relationship between the four EHR interoperability domains

and quality access and availability of care to adolescents as it relates to their PCPs as defined in the body of this study. Table 4 shows the correlation coefficients (R) table without Usage factors; however, Table 5 shows the correlation coefficients (R) table with Usage factor. In the linear regression estimation table above (Table 6 and 7), the coefficients (β) for the variables SCI (Send Clinical Information) and RCI (Receive Clinical Information) are negative while FCI (Find Clinical Information) and ICI (Integrate Clinical Information) are both positive when the regression was ran without interaction variables/effects. Nonetheless, when the regression was running with interaction variables, only the ICI (Integrate Clinical Information) had a positive coefficient (β).

This result indicates that there is a strong influence between the ICI (Integrate Clinical Information) interoperability domain and quality access and availability of care to adolescents ages 12-19 years receiving care from their PCPs. Furthermore, the marginal impact value of the ICI (Integrate Clinical Information) interoperability domain is positive and shows the highest among the other domains as shown in Table 8 above. Therefore, this domain yields the highest positive marginal impact when other covariates are held constant. Additionally, for the purpose of this study, if the P- value is less than or equal to α , the null hypothesis will be rejected, and the alternative will be accepted.

5.2. Results on Research Questions:

Research Question 1: What is the relationship, if any, between quality access and availability of healthcare for adolescents between 12 -19 years as it relates to PCPs electronically "Sending" patient health information?

H1o: There is no statistical relationship between quality access and availability of healthcare for adolescents between 12 -19 years related to PCPs electronically

"Sending" patient health information

H1a: There is a statistical relationship between quality access and availability of healthcare for adolescents between 12 -19 years as it relates to PCPs electronically

"Sending" patient health information.

5.2.1. Result:

At α level of 0.05% and 0.01%, a strong positive or a positive, strong relationship exists as shown in tables 4 & 5. The correlation coefficient is .810 for both equation 1&2. Using the p-values: the conditions for acceptance and rejection is if the p-value is lower than the significance levels or level that are or is chosen, the null hypothesis is rejected otherwise do not reject if $p > \alpha$. Here, we have a case of two tail tests and the resultant p-value is less than or equal to α , therefore, null hypothesis is rejected and alternative accepted. It can be concluded that there is a statistical relationship between quality access and availability of healthcare for adolescents between 12 -19 years as it relates to PCPs electronically "Sending" patient health information.

Research Question 2: What is the relationship, if any, between quality access and availability of healthcare for adolescents between 12 -19 years as it relates to PCPs electronically "Receiving" patient health information?

H1o: There is no statistical relationship between quality access and availability of healthcare for adolescents between 12 -19 years related to PCPs electronically

"Receiving" patient health information.

H1a: There is a statistical relationship between quality access and availability of healthcare for adolescents between 12 -19 years as it relates to PCPs electronically "Receiving" patient health information.

5.2.2. Result:

At α level of 0.05% and 0.01%, a positive and strong relationship exists as shown in tables 4 & 5. The correlation coefficient is .669 for both equation 1&2. Using the p-values: the conditions for acceptance and rejection is if the p-value is lower than the significance levels or level that are or is chosen, the null hypothesis is rejected otherwise do not reject if $p > \alpha$. Here, we have a case of two tail tests and the resultant p-value is less than or equal to α , therefore, null hypothesis is rejected and alternative accepted. It can be concluded that There is a statistical relationship between quality access and availability of healthcare for adolescents between 12 -19 years as it relates to PCPs electronically "Receiving" patient health information.

Research Question 3: What is the relationship, if any, between quality access and availability of healthcare for adolescents between 12 -19 years as it relates to PCPs electronically "Finding" patient health information?

H1o: There is no statistical relationship between quality access and availability of healthcare for adolescents between 12 -19 years related to PCPs electronically "Finding" patient health information.

H1a: There is a statistical relationship between quality access and availability of healthcare for adolescents between 12 -19 years related to PCPs electronically "Finding" patient health information.

5.2.3. Result:

At α level of 0.05% and 0.01%, a positive but weak relationship exists as shown in tables 4 & 5. The correlation coefficient is .415 for both equation 1 & 2. Using the p-values: the conditions for acceptance and rejection is if the p-value is lower than the significance levels or level that are or is chosen, the null hypothesis is rejected otherwise do not reject if $p > \alpha$. Here, we have a case of two tail tests and the resultant p-value is less than or equal to α , therefore, null hypothesis is rejected and alternative accepted. It can be concluded that There is a statistical relationship between quality access and availability of healthcare for adolescents between 12 -19 years as it relates to PCPs electronically "Finding" patient health information.

Research Question 4: What is the relationship, if any, between quality access and availability of healthcare for adolescents between 12 -19 years as it relates to PCPs electronically "Integrate" patient health information?

H1o: There is no statistical relationship between quality access and availability of healthcare for adolescents between 12 -19 years related to PCPs electronically "Integrate" patient health information.

H1a: There is a statistical relationship between quality access and availability of healthcare for adolescents between 12 -19 years related to PCPs electronically "Integrate" patient health information.

5.2.4. Result:

At α level of 0.05% and 0.01%, a positive and strong relationship exists as shown in tables 4 & 5. The correlation coefficient is .705 for both equation 1 & 2. Using the p-values: the conditions for acceptance and rejection is if the p-value is lower than the

significance levels or level that are or is chosen, the null hypothesis is rejected otherwise do not reject if $p > \alpha$. Here, we have a case of two tail tests and the resultant p-value is less than or equal to α , therefore, null hypothesis is rejected and alternative accepted. It can be concluded that there is a statistical relationship between quality access and availability of healthcare for adolescents between 12-19 years as it relates to PCPs electronically "integrate" patient health information.

CHAPTER VI:

LIMITATIONS AND FUTURE SCOPE OF THE STUDY

This chapter contains discussion concerning the limitations of the study, recommendations for action, recommendations for future study, summary, and conclusion.

6.1. Limitations:

One of the main limitations of this study was the unavailability of some datasets related to the four EHR interoperability domains. Of the 45 states that reported on the four interoperability domains, 17 states were missing data on one or more of the domains. Twenty-eight (28) states reported on all four of the interoperability domains, hence, this study utilized that number (28) for analysis. The study results could reflect a stronger relationship if additional data on more states were available and if the outliers are accounted for when collecting and conducting data analysis.

Another limitation of this study was the method chosen to answer the research questions and hypothesis. Though the study result shows a positive and strong correlation (except on the “Find” interoperability domain which was positive but weak at 0.415) on all four EHR interoperability domains (independent variables) and the performance on quality of care—quality access and availability to care for adolescents 12 – 19 years (dependent variable), a direct cause and effect association between the dependent and independent variables was not examined. Furthermore, this study contains only data for the quality access and availability of care (dependent variables) for adolescents ages 12-19 years using Medicaid and CHIP insurance coverages. For general purposes, data on

both public (Medicaid and CHIP) and private insurance coverages showing access and availability of care for adolescent should be examined.

Lastly, this study is a longitudinal-correlational study, but because of data limitations, a period of two years' data (2015 and 2017) was used for analysis. For future analysis, researchers can increase the amount of years when data becomes available.

6.2 Summary:

6.2.1 Recommendations for Action:

The results from this study reflect positive and strong correlations between the electronically—EHR interoperability domains (send, receive, and integration clinical information) and the quality access and availability to care for adolescents 12-19 years. This indicates that there is a statistically significant relationship when PCPs utilizes the interoperability domains consistently when providing access and availability to healthcare for adolescents or anyone in general. The EHR core functions improve the system quality and uses becomes more efficient, which yields an increase in the net benefit over time.

Furthermore, based on the marginal impact results of this study (Interaction Usage), PCPs should use the “Integrate Clinical Information” domain of any EHR system in order to maximize the full potential, usage, net benefits, and capabilities of an EHR. According to the results of this study, there is a positive but weak correlation when PCPs use the EHR to “Find” clinical information. PCPs should utilize this interoperability domain more frequency at a point of care. The “Find” Interoperability domain can add value to the PCP and data indicates that when the “Find” feature is fully utilized and

leveraged then the data trove received is rich and is valuable to PCPs when finding possible cause of illness or providing access to care for adolescent using the EHR system.

As with any “find” or “query” feature, this is highly dependent on the user’s level of comfort with the system and their ability to develop strong queries to return appropriate data. When any new system is deployed and implement there is always a significant learning curve that users must overcome before they can fully leverage the software. This is also a prevalent issue for the medical community who may not have had to create complex reporting queries or been required to learn how to fully harness reporting software. The “Find” requirement could be challenging for these types of users since “find” implies that some sort of query, even a basic query, must be used to gather the information the physician requires.

As users are introduced to systems, the query feature can be particularly frustrating and overwhelming. A recommendation would be for EHR systems to have prebuilt query functions that are user friendly. When a system is being considered for implementation, reporting requirements and queries should be part of the discussion and these requirements should have end user input before the system is deployed. Additionally, training should be made available to end users that covers basic queries and reporting. These recommendations would assist practitioners in implementing MU guidelines especially in relations to “find”.

6.2.2 Recommendations for Further Study:

The results of this study, although limited, represent the first steps towards examining the uses of the four core EHR interoperability domains (electronically--send, receive, find, and integrate patient clinical information) domains and net benefits (access

and availability to care for adolescent ages 12-19 years). The results are promising with regards to the usage and benefits of an interoperable EHR system in the United States and the added benefits these types of systems have and the incredible impact these systems have for healthcare in the United States. Future studies can use the other age categories of access and availability to care for children between the age of 25 months-6 years to determine if a positive correlation exist as well.

Additional studies can also expand the access and availability to care for adolescents with private insurance to see if the relationships are as strong as the adolescents using public insurance coverages like Medicaid and CHIP. Lastly, future researchers can examine the relationship between the core EHR functions as defined by the Institute of Medicine (IOM) as they relate to performance to quality of care (access and availability to care for children and adolescents).

6.3. Conclusion:

Despite the recent national analysis concerning the value of interoperability, which suggested that fully standardized interoperability could save the United States \$77.8 billion annually [7], the lack of compatibility between healthcare systems is still a national problem and a national priority. Jim Bloedau, the CEO of Information Advantage Group stated “It is useful to think of interoperability as a philosophy instead of just a standards-based interaction between computer systems” [117]. This research contributed to the body of knowledge in the HIT and biomedical informatics field. Results from this study will help inform PCPs, providers, hospitals, policy makers, healthcare research funding entities, and the healthcare industry. Interoperability is

deemed important in order to achieve the grandiose promise of the EHR which is meant to lower healthcare costs, foster the patient experience and healthcare services, improve quality of care and lead to better coordinated care.

The study problem statement resulted in the exploration of how the core EHR interoperability domains are used as in relation to when PCPs are providing quality access and availability to care to adolescents between 12-19 years. The absence of quality standards when PCP's send, find, receive, and integrate patient clinical information between health systems are the top priority of the ONC.

According to the ONC "connecting systems together requires an agreed-upon method." Guidance from ONC states that "Standards may pertain to security, data transport, data format or structure, or the meanings of codes or terms" [116]. The results from this study will shed light on health information exchange standards and policies; it will help enhance and enforce predictive analytics EHR systems; and some of the information exchange efforts currently ongoing in the United States as of the date of this study. Recommendations are based on the study's Clinical Adoption (CA) framework as outlined in figure 3 in the literature review. The results of this study are summarized based on the levels of the study: micro, meso, and macro levels.

Based on the results of the study, including those results at the micro level, it is confident to say, that the more the quality of the system, the more PCPs will electronically engage in all four interoperability domains of the EHR. Study results shows that the "Find" interoperability domain has a weak but positive correlation (0.415 as compared to the other three domains which had a strong and positive correlations) as it relates to PCP's performance on quality care when providing access and availability to

care for adolescents. This result confirms that when better quality data exists, PCPs will embrace the use of an EHR frequently to find information when providing care to adolescents and their patients in general.

Furthermore, based on the meso-level of the study, providers, especially PCPs can see that there is a strong correlation to when the EHR send, receive, and integrate clinical information are used. This result will help them understand that the EHR system is and can be used as a clinical tool for diagnostics rather than a digital storage for patient records. Based on the study results, emphasis or focus for eHealth (HIT) implementation should be a top priority for PCPs. This can be attained if the office-based PCP practices (Organization) align its implementation and adoption strategies with the macro-environmental factors that impacts clinical adoption. Another recommendation would be for end users, PCPs, or hospitals to consider smarter systems that leverage technology such as AI and better reporting features. Software systems should be designed with the unique needs of the medical community in mind rather than deploying cookie cutter systems that are designed to meet a wide market demand from investing to HR – medical needs are truly unique and require unique system requirements that cannot be met with an ‘off the shelf’ solution.

Before any EHR system is implemented, it should be vetted by end users and medical practitioners, additionally, hospitals and PCPs should have access to use cases, success stories, or strategic roadmaps/blueprints that would help guide them through the daunting process of implementing an EHR system. Lastly, the results from the marginal impact analysis shows that an additional value is added when the PCP aligns its adoption

strategies and integrates clinical information when providing access and availability of care.

In conclusion, the data analysis indicates that quality access and availability to care for adolescents between 12-19 years will improve if PCPs leverage the core EHR interoperability domains when providing care. Data governance bodies should utilize the findings of this study to establish interoperability standards while providing funding and incentive programs/payments for PCPs and other healthcare practitioners when they demonstrate “meaningful use” with regards to the EHR interoperability domains at the point of care for adolescents.

This correlational/longitudinal study provided evidence of the existing relationships between the four EHR interoperability domains and performance to quality of care—quality access and availability to care for adolescents ages 12-19. It also provided evidence of an instantaneous effect when PCP’s use the EHR to integrate patient clinical information consistently over time.

REFERENCES

1. Centers for Medicare and Medicaid Services, Medicare and Medicaid Programs, Electronic Health Record Incentive Program Final Rule. Federal Register, 75 (144) (2010), pp. 44314-44358 (July 28).
<http://www.gpo.gov/fdsys/pkg/FR-2010-07-28/pdf/2010-17207.pdf>
2. Centers for Medicare and Medicaid Services. Medicare and Medicaid EHR Incentive Program Basics (2016) (accessed 8.05.16)
<https://www.cms.gov/Regulations-and-Guidance/Legislation/EHRIncentivePrograms/Basics.html> Google Scholar
3. Centers for Medicare and Medicaid Services. EHR Incentive Program: December 2015 (2015) https://www.cms.gov/Regulations-and-Guidance/Legislation/EHRIncentivePrograms/Downloads/December2015_SummaryReport.pdf Google Scholar
4. HIMSS Redefines Interoperability-<http://www.himss.org/resources-news/himss-redefines-interoperability>
5. Robert H. Miller, et al. The value of electronic health records in solo or small group practices Health Aff. (Millwood), 24 (5) (2005), pp. 1127-1137
CrossRefView Record in ScopusGoogle Scholar
6. Public Health and Promoting Interoperability Programs:
<https://www.cdc.gov/ehrmeaningfuluse/introduction.html>
7. Walker et al., 2005: “The Value of Health Care Information.”
8. Bates, D.W. (2005). Physicians and ambulatory electronic health records. US Physicians are ready to make the transition to EHRs-which is clearly overdue, given the rest of the world’s experience. Health Affairs (Millwood), 24 (5),1180-1189.
9. Connecting Health and Care for the Nation: A Shared Nationwide Interoperability Roadmap Version 1.0. <https://www.healthit.gov/policy-researchers-implementers/interoperability> 3. Patel V., Henry J., Pylypchuk Y., & Searcy T. (May 2016).
10. HealthIT.gov-Interoperability- <https://www.healthit.gov/topic/interoperability>
11. The Office of the National Coordinator for Health Information Technology-
<https://www.healthit.gov/sites/default/files/page/2019-05/ONC-Data-Brief-47-Interoperability-among-Office-Based-Physicians-in-2015-and-2017.pdf>

12. Center for Medicare and Medicaid Services-Promoting Interoperability Programs-
<https://www.cms.gov/Regulations-and-Guidance/Legislation/EHRincentivePrograms>
13. Center for Medicare and Medicaid Services-Quality Measures:
<https://www.cms.gov/Medicare/Quality-Initiatives-Patient-Assessment-Instruments/QualityMeasures>
14. Quality of Care Performance Measures-
<https://www.medicaid.gov/medicaid/quality-of-care/quality-of-care-performance-measurement/index.html>
15. Initial Core Set of Children's Health Care Quality Measures:
<https://www.medicaid.gov/medicaid/quality-of-care/performance-measurement/adult-and-child-health-care-quality-measures/childrens-health-care-quality-measures/index.html>
16. Healthcare Effectiveness Data and Information Set (HEDIS):
<https://www.ncqa.org/hedis/measures/>
17. Interoperability among U.S. Non-federal Acute Care Hospitals in 2015. ONC Data Brief, no.36. Office of the National Coordinator for Health Information Technology: Washington DC. <http://dashboard.healthit.gov/evaluations/data-briefs/non-federal-acute-care-hospital-interoperability-2015.php>
18. Burwell SM. Setting value-based payment goals--HHS efforts to improve U.S. health care. *N Engl J Med*. 2015 Mar 5;372(10):897-9. 4.
19. Miller RH, West CE. The value of electronic health records in community health centers: Policy implications; *Health Aff* 2007 Jan–Febr;26(1):206–14.
20. Wang SJ, Middleton B, Prosser LA, et al. A cost benefits analysis of electronic medical records in primary care. *Am J Med*. 2003; 114 (5):397-409
21. Maternal and Child Health Bureau. (2005. a). *The Health and Well-Being of Children: A Portrait of States and the Nation, 2005*. Rockville, MD: U.S. Department of Health and Human Services, Health Resources and Services Administration.
22. National Research Council. (1989). *Recommended Dietary Allowances*. 10th ed. Washington, DC: National Academy Press.
23. Medicare Access and CHIP Reauthorization Act of 2015 (MACRA). (Pub. L. No. 114–10, enacted April 16, 2015).
<https://www.gpo.gov/fdsys/pkg/PLA114publ10/html/PLAW114publ10.htm>

24. Tyler, K. A., Whitbeck, L. B., Hoyt, D. R., and Johnson, K. D. (2003). Self-mutilation and homeless youth: The role of family abuse, street experiences, and mental disorders. *Journal of Research on Adolescence*, 13(4), 457–474.
25. Tyler, K. A., Cauce, A. M., and Whitbeck, L. (2004). Family risk factors and prevalence of dissociative symptoms among homeless and runaway youth. *Child Abuse and Neglect*, 28(3), 355–366. [PubMed]
26. Tyler, K. A., Whitbeck, L. B., Chen, X., and Johnson, K. (2007). Sexual health of homeless youth: Prevalence and correlates of sexually transmissible infections. *Sexual Health*, 4(1), 57–61. [PubMed]
27. Miller RH, Sim I. Physicians' use of electronic medical records: Barriers and solutions; *Health Aff* 2004 Mar–Apr;23(2):116–26.
28. Smith PC, Araya-Guerra R, Bublitz C, et al. Missing clinical information during primary care visits. *JAMA*. 2005; 293:565-571
29. Frigola-Capell, E., Pareja-Rossell, C., Gens-Barber, M., Oliva-Oliva, G., Alava-Cano, F., Wensing, M., & Davins-Miralles, J. (2015). Quality indicators for patient safety in primary care. A review and Delphi-survey by the LINNEAUS collaboration on patient safety in primary care. *The European journal of general practice*, 21 Suppl(sup1), 31–34. <https://doi.org/10.3109/13814788.2015.1043730> For quality measure definition
30. National Research Council (US) and Institute of Medicine (US) Committee on Adolescent Health Care Services and Models of Care for Treatment, Prevention, and Healthy Development; Lawrence RS, Appleton Gootman J, Sim LJ, editors. *Adolescent Health Services: Missing Opportunities*. Washington (DC): National Academies Press (US); 2009. 3, Current Adolescent Health Services, Settings, and Providers. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK215423/>
31. Lau F., Price M., Keshavjee K. From benefits evaluation to clinical adoption: Making sense of health information system success in Canada. *Healthcare Quarterly*. 2011;14(1):39–45. [PubMed] [Reference list]
32. Lau F, Price M. Chapter 3 Clinical Adoption Framework. In: Lau F, Kuziemy C, editors. *Handbook of eHealth Evaluation: An Evidence-based Approach* [Internet]. Victoria (BC): University of Victoria; 2017 Feb 27. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK481588/>
33. David Blumenthal and John P. Glaser, “Information Technology Comes to Medicine” *The New England Journal of Medicine* (2007)

34. A 10-Year Vision to Achieve an Interoperable Health IT Infrastructure:
<http://www.healthit.gov/sites/default/files/ONC10yearInteroperabilityConceptPaper.pdf>
35. Derived from the Institute of Electrical and Electronics Engineers (IEEE) definition of interoperability. http://www.ieee.org/education/careers/education/standards/standards_glossary.html
36. Medicare Access and CHIP Reauthorization Act of 2015 (MACRA) (P.L. 114-10 Sec 106)
37. Interoperability among Office-Based Physicians in 2015 and 2017:
<https://www.healthit.gov/sites/default/files/page/2019-05/ONC-Data-Brief-47-Interoperability-among-Office-Based-Physicians-in-2015-and-2017.pdf>
38. U.S. Department of Health and Human Services. (October 2015). 2015 Edition Health Information Technology (Health IT) Certification Criteria, 2015 Edition Base Electronic Health Record (EHR) Definition, and ONC Health IT Certification Program Modifications. Federal Register.
<https://www.federalregister.gov/documents/2015/10/16/2015-25597/2015-edition-health-information-technology-health-it-certification-criteria-2015-edition-base>
39. Children's Health Care Quality Measures:
<https://www.medicaid.gov/medicaid/quality-of-care/performance-measurement/adult-and-child-health-care-quality-measures/childrens-health-care-quality-measures/index.html>
40. Wager, Karen A., 1961-Health care information systems: a practical approach for health care management /Karen A. Wager, Frances Wickham Lee, John P. Glaser: Foreword by Lawton Robert Burns. -2nd ed. 2009:137
41. How Doctors Feel About Electronic Health Records-A National Physicians Poll by The Harris Poll:
<http://www.med.stanford.edu/content/dam/sm/ehr/documents/EHR-Poll-Presentation.pdf>
42. Health Information Technology in the United States: The Information Base for Progress. Robert Wood Johnson Foundation, George Washington University Medical Center, and Institute for Health Policy. 1January2006.
43. Key Capabilities of an Electronic Health Record System: Letter Report. Committee on Data Standards for Patient Safety, Board on Health Care Services, Institute of Medicine of the National Academies, Washington, DC: National Academies Press, 2003

44. CMS.gov-<https://www.cms.gov/Medicare/Quality-Initiatives-Patient-Assessment-Instruments/Value-Based-Programs/MACRA-MIPS-and-APMs/MACRA-MIPS-and-APMs>
45. The Medicare Access and CHIP Reauthorization Act of 2015 (MACRA), (Pub. L. No. 114 - 10, enacted April 16, 2015), Section 106(b)(1).
<https://www.gpo.gov/fdsys/pkg/PLAW-114publ10/html/PLAW-114publ10.htm>.
46. Connecting Health and Care for the Nation: A Shared Nationwide Interoperability Roadmap Version 1.0. <https://www.healthit.gov/policy-researchers-implementers/interoperability>.
47. May 2018 Medicaid and CHIP Enrollment Data Highlights are available at <https://www.medicaid.gov/medicaid/programinformation/medicaid-and-chip-enrollment-data/reporthighlights/index.html>. Numbers reflect Medicaid and CHIP enrollment data as of May 2018, as reported by 50 states and the District of Columbia.
48. Children's Health Care Quality Measures at <https://www.medicaid.gov/medicaid/quality-of-care/performance-measurement/adult-and-child-health-care-quality-measures/childrens-health-care-quality-measures/index.html>
49. Beal AC, et al. Quality Measures for Children's Health Care. Pediatrics 2004; 113: 199-209.
50. Schor EL. Rethinking Well Child Care. Pediatrics 2004; 114: 210-216.
51. Kuo, AA, et al. Rethinking Well-Child Care in the United States: An International
52. Summary Health Statistics: National Health Interview Survey, 2015 at https://ftp.cdc.gov/pub/Health_Statistics/NCHS/NHIS/SHS/2015_SHS_Table_C-8.pdf
53. Summary Health Statistics: National Health Interview Survey, 2017 at https://ftp.cdc.gov/pub/Health_Statistics/NCHS/NHIS/SHS/2017_SHS_Table_C-8.pdf
54. Summary Health Statistics: National Health Interview Survey, 2018 at https://ftp.cdc.gov/pub/Health_Statistics/NCHS/NHIS/SHS/2018_SHS_Table_C-8.pdf
55. See CHIPRA Mandated Evaluation of the Children's Health Insurance Program: Final Findings, available at http://www.mathematica-mpr.com/~media/publications/pdfs/health/rpt_chievaluation.pdf.

56. See CHIPRA Mandated Evaluation of the Children's Health Insurance Program: Final Findings, available at http://www.mathematica-mpr.com/~media/publications/pdfs/health/rpt_chipevaluation.pdf.
57. Children's Health Coverage: Medicaid, CHIP and the ACA-<http://kff.org/health-reform/issue-brief/childrens-health-coverage-medicaid-chip-and-the-aca/>.
58. Agency for Healthcare Research and Quality. Health care coverage analyses of the National Healthcare Quality and Disparities Reports: 2000–2008 trends. Baltimore, MD: U.S. Department of Health and Human Services, Centers for Medicare & Medicaid Services; March 2014. Available at <http://www.medicaid.gov/medicaid-chipprogram-information/by-topics/quality-of-care/downloads/health-coverage-analyses-of-nhqr-2000-2008-trends.pdf>.
59. The Impact of the Children's Health Insurance Program (CHIP): What Does the Research Tell Us? <https://kff.org/medicaid/issue-brief/the-impact-of-the-childrens-health-insurance-program-chip-what-does-the-research-tell-us/>.
60. Bloom, B., R.A. Cohen, G Freeman. 2012. "Summary health statistics for U.S. children: National Health Interview Survey, 2011." National Center for Health Statistics. Vital Health Statistics 10(254). http://www.cdc.gov/nchs/data/series/sr_10/sr10_254.pdf
61. America's Health Rankings analysis of American Medical Association, United Health Foundation, AmericasHealthRankings.org, Accessed 2020.
62. Starfield B. Contribution of primary care to health systems and health. *Milbank Q.* 2005;83(3):457.
63. Petterson SM, Liaw WR, Phillips RL, Rabin DL, Meyers DS, Bazemore AW. Projecting US primary care physician workforce needs: 2010-2025. *Ann Fam Med.* 2012;10(6):503-509.
64. Committee on Adolescence. Achieving quality health services for adolescents. *Pediatrics.* 2016;138(2): e20161347.
65. Valderas, J.M., Starfield, B., Forrest, C.B. et al. Routine care provided by specialists to children and adolescents in the United States (2002-2006). *BMC Health Serv Res* 9, 221 (2009). <https://doi.org/10.1186/1472-6963-9-221>
66. Irwin CE Jr, Adams SH, Park MJ, Newacheck PW. Preventive care for adolescents: few get visits and fewer get services. *Pediatrics.* 2009;123(4). Available

at:www.pediatrics.org/cgi/content/full/123/4/e565pmid:19336348Abstract/FREE Full TextGoogle Scholar

67. Klein JD, Wilson KM, McNulty M, Kapphahn C, Collins KS. Access to medical care for adolescents: results from the 1997 Commonwealth Fund Survey of the Health of Adolescent Girls. *J Adolesc Health*. 1999;25(2):120-130pmid:10447039 CrossRefPubMedGoogle Scholar
68. Cheng TL, Savageau JA, Sattler AL, DeWitt TG. Confidentiality in health care: a survey of knowledge, perceptions and attitudes among high school students. *JAMA*. 1993;269(11):1404-1407.
69. Ginsberg KR, Slap GB, Cnaan A, Forke CM, Balsley CM, Rouselle DM. Adolescents' perceptions of factors affecting their decisions to seek health care. *JAMA*. 1995;273(24):1913-1918.
70. Ford CA, Millstein SG, Halpern-Feisher B, Irwin CE Jr. Influence of physician confidentiality assurances on adolescents' willingness to disclose information and seek future health care. A randomized controlled trial. *JAMA*. 1997;278(12):1029-1034.
71. Thrall JS, McCloskey L, Ettner SL, Rothman E, Tighe JE, Emans SJ. Confidentiality and adolescents' use of providers for health information and for pelvic examinations. *Arch Pediatr Adolesc Med*. 2000;154(9):885-892.
72. Grilo SA, Catallozzi M, Santelli JS, et al. Confidentiality discussions and private time with a health-care provider for youth, United States, 2016. *J Adolesc Health*. 2019;64(3):311-318.
73. Lewin ME, Altman S, eds. *America's health care safety net: intact but endangered*. Washington, DC: National Academy Press; 2000. Available at: <http://books.nap.edu/catalog/9612.html>
74. Karen Davis and Cathy Schoen, *Health and War in Poverty* (Brookings Press, 1977).
75. Human Resources and Services Administration—Health Center Programs [Internet]<http://bphc.hrsa.gov/about/what-is-a-health-center/index.html>.
76. Bureau of Primary Health Care. (2017). 2016 National Health Center Data: Health Center Program Look-Alike Data. <http://bphc.hrsa.gov/uds/lookalikes.aspx?state=national>
77. Nguyen, O. K., Makam, A. N., & Halm, E. A. (2016). National Use of Safety-Net Clinics for Primary Care among Adults with Non-Medicaid Insurance in the

United States. PloS one, 11(3),
e0151610. <https://doi.org/10.1371/journal.pone.0151610>

78. ACP Hospitalist—PCPs in the Hospitals;
<https://acphospitalists.org/archives/2018/03/pcps-in-the-hospital.htm>
79. Stevens JP, Nyweide DJ, Maresh S, Hatfield LA, Howell MD, Landon BE. Comparison of Hospital Resource Use and Outcomes Among Hospitalists, Primary Care Physicians, and Other Generalists. *JAMA Intern Med.* 2017;177(12):1781-1787. doi:10.1001/jamainternmed.2017.5824
80. Community Health Centers: Growing Importance in a Changing Health Care System; <http://files.kff.org/attachment/Issue-Brief-Community-Health-Centers-Growing-Importance-in-a-Changing-Health-Care-System>
81. Gustafson EM. History and overview of school-based health centers in the US. *Nurs Clin North Am.* 2005; 40:595–606.
82. Impact of School-Based Health Center Use on Academic Outcomes. Walker, Sarah Cusworth et al. *Journal of Adolescent Health*, Volume 46, Issue 3, 251 – 257. [http://www.jahonline.org/article/S1054-139X\(09\)00264-X/fulltext](http://www.jahonline.org/article/S1054-139X(09)00264-X/fulltext)
83. Keeton, V., Soleimanpour, S., & Brindis, C. D. (2012). School-based health centers in an era of health care reform: building on history. *Current problems in pediatric and adolescent health care*, 42(6), 132–158. <https://doi.org/10.1016/j.cppeds.2012.03.002>
84. Mental health characteristics and health-seeking behaviors of adolescent school-based health center users and nonusers. Amaral G, Geierstanger S, Soleimanpour S, Brindis CJ *Sch Health.* 2011 Mar; 81(3):138-45.
85. Soleimanpour S, Geierstanger SP, Kaller S, McCarter V, Brindis CD. The role of school health centers in health care access and client outcomes. *Am J Public Health.* 2010; 100:1597–603.
86. The role of school health centers in health care access and client outcomes. Soleimanpour S, Geierstanger SP, Kaller S, McCarter V, Brindis CD *Am J Public Health.* 2010 Sep; 100(9):1597-603.
87. Nawar, E. W., Niska, R. W., and Xu, J. (2007). National Hospital Ambulatory Medical Care Survey: 2005 emergency department summary. *Advance Data from Vital and Health Statistics*, 386(June 29).
88. Nordin JD, Solberg LI, Parker ED. Adolescent primary care visit patterns. *Ann Fam Med.* 2010;8(6):511-516. doi:10.1370/afm.1188

89. HITECH Act Enforcement Interim Final Rule. [Http://www.hhs.gov/hipaa/for-professionals/special-topics/HITECH-act-enforcement-interim-final-rule/index.html](http://www.hhs.gov/hipaa/for-professionals/special-topics/HITECH-act-enforcement-interim-final-rule/index.html).
90. Lehoux, P. (2010). The problem of health technology: Policy implications for modern health care systems (2nd ed.). New York, NY: Routledge.
91. National Association of County & City Health Officials. (2010). Glossary of public health informatics organizations, activities and terms. Retrieved from <http://www.naccho.org/topics/infrastructure/informatics/glossary.cfm>
92. Children's Health Care Quality Measures: Initial Core Set of Children Health Quality Measures [internet]; <https://www.medicaid.gov/medicaid/quality-of-care/performance-measurement/adult-and-child-health-care-quality-measures/childrens-health-care-quality-measures/index.html>
93. Friedman, C. P., & Wyatt, J. C. (2006). Evaluation methods in biomedical informatics (2nd ed.). New York: Springer Science + Business Media, Inc.
94. Brink, H. 2006. Fundamentals of research methodology for health care professionals 2nd edition. Cape Town: Juta.
95. Pallant, J. (2010). SPSS survival manual (4th ed.). New York, NY: McGraw-Hill.
96. Office-based Physician Health IT Adoption and Use <https://catalog.data.gov/dataset/office-based-physician-health-it-adoption-and-use>
97. Burns, N & Grove, SK. SS. 2017. The practice of Nursing Research: Appraisal, Synthesis, and Generation of Evidence. 8th Edition. St. Louis: Elsevier.
98. About ONC-What we do-<https://www.healthit.gov/topic/about-onc>
99. Meaningful Use and the Shift to the Merit-based Incentive Payment System- <https://www.healthit.gov/topic/meaningful-use-and-macra/meaningful-use>
100. Quality of care performance--<https://www.medicaid.gov/medicaid/quality-of-care/performance-measurement/adult-and-child-health-care-quality-measures/childrens-health-care-quality-measures/index.html>
101. Adolescents: health risks and solutions. <https://www.who.int/news-room/fact-sheets/detail/adolescents-health-risks-and-solutions>.
102. Quality of Care for Children in Medicaid and CHIP: Findings from the 2017 Child Core Set
[http://public.qualityforum.org/MAP/Medicaid%20and%20CHIP%20\(MAC\)%20Scorecard/2018-child-chart-pack.pdf](http://public.qualityforum.org/MAP/Medicaid%20and%20CHIP%20(MAC)%20Scorecard/2018-child-chart-pack.pdf)

103. National Use of Safety-Net Clinics for Primary Care among Adults with Non-Medicaid Insurance in the United States--
<https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0151610>
104. Health Center Program-
https://cityofracine.org/uploadedFiles/MainSiteContent/Departments/Health/_Documents/FQHC%20Health%20Center%20Program%20Info.pdf
105. School-Based Health Center and Managed Care <https://oig.hhs.gov/oei/reports/oei-05-92-00681.pdf>
106. What is Meaningful Use-<https://www.quatrishealthco.com/understanding-meaningful-use/>
107. A Longitudinal Medical Record Is Key to Clinical Decision Support [Harris Stutman, MD](#) | November 05, 2010 | [EHR & EMR](#)
108. LI ZHOU, 2009. Journal of the American Medical Informatics Association Volume 16 Number 4 July / August 2009
109. Fenn J, Raskino M. Mastering the Hype Cycle: How to Choose the Right Innovation at the Right Time. Harvard Business Press, 2008
110. McManus, M. A., Shejavali, K. I., and Fox, H. B. (2003). Is the Health Care System Working for Adolescents? Perspectives from Providers in Boston, Denver, Houston, and San Francisco. Washington, DC: Maternal and Child Health Policy Research Center.
111. AdolescentHealth-GlobalSituation-https://www.who.int/health-topics/adolescent-health/#tab=tab_2
112. Quality of Care for Children in Medicaid and CHIP: Findings from the 2017 Child Core Set- <https://www.medicaid.gov/medicaid/quality-of-care/downloads/performance-measurement/2018-child-chart-pack.pdf>
113. Maternal and Child Health Bureau. (2005). The Oral Health of Children: A Portrait of States and the Nation, 2005. Rockville, MD: U.S. Department of Health and Human Services, Health Resources and Services Administration.
114. National Center for Injury Prevention and Control. (2007). Leading Causes of Death and Fatal Injury Reports (2004 data). Available: <http://www.cdc.gov/ncipc/wisqars/> [July 30, 2007].
115. Overview of the HIMSS Interoperability Showcase [Internet]—
<https://www.interoperabilityshowcase.org/overview>.

116. Health IT Standards—[Internet] <https://www.healthit.gov/topic/standards-technology/health-it-standards>
117. Electronic Health Reporter; How is Interoperability Critical to Healthcare Innovation? —[Internet] <https://electronichealthreporter.com/how-is-interoperability-critical-to-healthcare-innovation/>
118. National Health Service (NHS), England—Primary Care Service: [internet] <https://www.england.nhs.uk/participation/get-involved/how/primarycare/>

APPENDIX

- A. Medicaid and CHIP (Dependent Variable Dataset)
- B. Find Clinical Information (Independent Variables)
- C. Send Clinical Information (Independent Variable)
- D. Receive Clinical Information (Independent Variable)
- E. Integrate Clinical Information (Independent Variable)
- F. ANOVA Tables:

A). Medicaid and CHIP (Dependent Variable Dataset):

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	65.5	1	1.9	1.9	1.9
	67.3	1	1.9	1.9	3.7
	72.9	1	1.9	1.9	5.6
	74.9	1	1.9	1.9	7.4
	77.0	1	1.9	1.9	9.3
	78.7	1	1.9	1.9	11.1
	81.1	1	1.9	1.9	13.0
	83.7	1	1.9	1.9	14.8
	84.1	1	1.9	1.9	16.7
	85.0	1	1.9	1.9	18.5
	85.2	1	1.9	1.9	20.4
	85.7	1	1.9	1.9	22.2
	86.2	1	1.9	1.9	24.1
	86.6	1	1.9	1.9	25.9
	86.8	1	1.9	1.9	27.8
	88.0	1	1.9	1.9	29.6
	88.1	1	1.9	1.9	31.5
	88.2	2	3.7	3.7	35.2
	88.7	1	1.9	1.9	37.0
	89.1	1	1.9	1.9	38.9
	89.3	1	1.9	1.9	40.7
	89.4	2	3.7	3.7	44.4
	89.5	1	1.9	1.9	46.3
	89.6	1	1.9	1.9	48.1
	90.0	2	3.7	3.7	51.9
	90.2	1	1.9	1.9	53.7
	90.3	1	1.9	1.9	55.6
	90.9	1	1.9	1.9	57.4
	91.2	3	5.6	5.6	63.0
	91.4	3	5.6	5.6	68.5
	91.6	1	1.9	1.9	70.4
	91.7	1	1.9	1.9	72.2
	92.0	1	1.9	1.9	74.1
	92.1	1	1.9	1.9	75.9
	92.2	2	3.7	3.7	79.6
	92.4	1	1.9	1.9	81.5
	92.8	1	1.9	1.9	83.3
	92.9	1	1.9	1.9	85.2
	93.0	1	1.9	1.9	87.0
	93.3	1	1.9	1.9	88.9

	93.4	1	1.9	1.9	90.7
	93.5	1	1.9	1.9	92.6
	94.3	1	1.9	1.9	94.4
	94.8	1	1.9	1.9	96.3
	95.0	1	1.9	1.9	98.1
	96.7	1	1.9	1.9	100.0
	Total	54	100.0	100.0	

B). Find Clinical Information (Independent Variables Dataset):

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	19.8	1	1.9	1.9	1.9
	21.0	1	1.9	1.9	3.7
	22.6	1	1.9	1.9	5.6
	25.1	1	1.9	1.9	7.4
	28.0	1	1.9	1.9	9.3
	31.1	1	1.9	1.9	11.1
	32.8	1	1.9	1.9	13.0
	32.9	1	1.9	1.9	14.8
	33.1	1	1.9	1.9	16.7
	33.4	1	1.9	1.9	18.5
	34.2	1	1.9	1.9	20.4
	34.5	1	1.9	1.9	22.2
	34.7	1	1.9	1.9	24.1
	35.3	1	1.9	1.9	25.9
	35.7	1	1.9	1.9	27.8
	36.1	1	1.9	1.9	29.6
	36.2	1	1.9	1.9	31.5
	36.9	1	1.9	1.9	33.3
	37.6	1	1.9	1.9	35.2
	37.9	1	1.9	1.9	37.0
	38.6	1	1.9	1.9	38.9
	38.6	1	1.9	1.9	40.7
	38.7	1	1.9	1.9	42.6
	38.7	1	1.9	1.9	44.4
	39.1	1	1.9	1.9	46.3
	39.7	1	1.9	1.9	48.1
	41.0	1	1.9	1.9	50.0
	41.9	1	1.9	1.9	51.9
	43.1	1	1.9	1.9	53.7
	46.4	1	1.9	1.9	55.6
	46.4	1	1.9	1.9	57.4

	47.0	1	1.9	1.9	59.3
	48.5	1	1.9	1.9	61.1
	48.9	1	1.9	1.9	63.0
	49.3	1	1.9	1.9	64.8
	50.6	1	1.9	1.9	66.7
	55.0	1	1.9	1.9	68.5
	55.0	1	1.9	1.9	70.4
	56.1	1	1.9	1.9	72.2
	56.9	1	1.9	1.9	74.1
	57.2	1	1.9	1.9	75.9
	57.4	1	1.9	1.9	77.8
	57.6	1	1.9	1.9	79.6
	57.6	1	1.9	1.9	81.5
	59.6	1	1.9	1.9	83.3
	60.7	1	1.9	1.9	85.2
	61.3	1	1.9	1.9	87.0
	61.8	1	1.9	1.9	88.9
	62.9	1	1.9	1.9	90.7
	67.1	1	1.9	1.9	92.6
	68.2	1	1.9	1.9	94.4
	68.8	1	1.9	1.9	96.3
	72.2	1	1.9	1.9	98.1
	80.3	1	1.9	1.9	100.0
	Total	54	100.0	100.0	

C). Send Clinical Information (Independent Variable Dataset):

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	20.5	1	1.9	1.9	1.9
	22.7	1	1.9	1.9	3.7
	24.3	1	1.9	1.9	5.6
	25.5	1	1.9	1.9	7.4
	27.4	1	1.9	1.9	9.3
	28.5	1	1.9	1.9	11.1
	28.5	1	1.9	1.9	13.0
	29.9	1	1.9	1.9	14.8
	30.0	1	1.9	1.9	16.7
	31.2	1	1.9	1.9	18.5
	31.3	1	1.9	1.9	20.4
	32.3	1	1.9	1.9	22.2
	32.6	1	1.9	1.9	24.1
	32.6	1	1.9	1.9	25.9

33.5	1	1.9	1.9	27.8
34.3	1	1.9	1.9	29.6
34.5	1	1.9	1.9	31.5
34.9	1	1.9	1.9	33.3
35.8	1	1.9	1.9	35.2
36.3	1	1.9	1.9	37.0
36.4	1	1.9	1.9	38.9
36.9	1	1.9	1.9	40.7
37.4	1	1.9	1.9	42.6
37.4	1	1.9	1.9	44.4
37.7	1	1.9	1.9	46.3
38.0	1	1.9	1.9	48.1
38.1	1	1.9	1.9	50.0
38.2	1	1.9	1.9	51.9
39.0	1	1.9	1.9	53.7
39.2	1	1.9	1.9	55.6
39.3	1	1.9	1.9	57.4
39.8	1	1.9	1.9	59.3
40.1	1	1.9	1.9	61.1
40.5	1	1.9	1.9	63.0
40.5	1	1.9	1.9	64.8
40.6	1	1.9	1.9	66.7
41.0	1	1.9	1.9	68.5
41.1	1	1.9	1.9	70.4
41.8	1	1.9	1.9	72.2
43.6	1	1.9	1.9	74.1
44.0	1	1.9	1.9	75.9
44.8	1	1.9	1.9	77.8
44.9	1	1.9	1.9	79.6
45.8	1	1.9	1.9	81.5
47.8	1	1.9	1.9	83.3
47.9	1	1.9	1.9	85.2
48.6	1	1.9	1.9	87.0
49.4	1	1.9	1.9	88.9
49.7	1	1.9	1.9	90.7
49.9	1	1.9	1.9	92.6
50.2	1	1.9	1.9	94.4
50.5	1	1.9	1.9	96.3
56.0	1	1.9	1.9	98.1
56.3	1	1.9	1.9	100.0
Total	54	100.0	100.0	

D). Receive Clinical Information (Independent Variable):

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	23.7	1	1.9	1.9	1.9
	25.0	1	1.9	1.9	3.7
	25.1	1	1.9	1.9	5.6
	26.1	1	1.9	1.9	7.4
	26.8	1	1.9	1.9	9.3
	27.1	1	1.9	1.9	11.1
	28.0	1	1.9	1.9	13.0
	29.3	1	1.9	1.9	14.8
	29.6	1	1.9	1.9	16.7
	29.8	1	1.9	1.9	18.5
	30.6	1	1.9	1.9	20.4
	30.8	1	1.9	1.9	22.2
	30.8	1	1.9	1.9	24.1
	30.8	1	1.9	1.9	25.9
	30.9	1	1.9	1.9	27.8
	31.2	1	1.9	1.9	29.6
	32.0	1	1.9	1.9	31.5
	32.8	1	1.9	1.9	33.3
	34.4	1	1.9	1.9	35.2
	34.9	1	1.9	1.9	37.0
	35.1	1	1.9	1.9	38.9
	35.5	1	1.9	1.9	40.7
	37.1	1	1.9	1.9	42.6
	37.2	1	1.9	1.9	44.4
	37.6	1	1.9	1.9	46.3
	37.8	1	1.9	1.9	48.1
	38.4	1	1.9	1.9	50.0
	38.9	1	1.9	1.9	51.9
	38.9	1	1.9	1.9	53.7
	39.4	1	1.9	1.9	55.6
	39.5	1	1.9	1.9	57.4
	39.5	1	1.9	1.9	59.3
	39.9	1	1.9	1.9	61.1
	40.2	1	1.9	1.9	63.0
	40.5	1	1.9	1.9	64.8
	40.6	1	1.9	1.9	66.7
	41.0	1	1.9	1.9	68.5
	41.4	1	1.9	1.9	70.4
	42.3	1	1.9	1.9	72.2
	42.8	1	1.9	1.9	74.1

	42.8	1	1.9	1.9	75.9
	42.9	1	1.9	1.9	77.8
	42.9	1	1.9	1.9	79.6
	44.8	1	1.9	1.9	81.5
	45.4	1	1.9	1.9	83.3
	45.5	1	1.9	1.9	85.2
	45.8	1	1.9	1.9	87.0
	46.3	1	1.9	1.9	88.9
	46.8	1	1.9	1.9	90.7
	54.8	1	1.9	1.9	92.6
	55.0	1	1.9	1.9	94.4
	60.0	1	1.9	1.9	96.3
	60.6	1	1.9	1.9	98.1
	62.4	1	1.9	1.9	100.0
	Total	54	100.0	100.0	

E). Integrate Clinical Information (Independent Variable):

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	18.0	1	1.9	1.9	1.9
	18.3	1	1.9	1.9	3.7
	19.6	1	1.9	1.9	5.6
	21.1	1	1.9	1.9	7.4
	21.7	1	1.9	1.9	9.3
	21.9	1	1.9	1.9	11.1
	22.2	1	1.9	1.9	13.0
	22.7	1	1.9	1.9	14.8
	22.8	1	1.9	1.9	16.7
	23.1	1	1.9	1.9	18.5
	23.3	1	1.9	1.9	20.4
	23.4	1	1.9	1.9	22.2
	23.4	1	1.9	1.9	24.1
	23.7	1	1.9	1.9	25.9
	24.1	1	1.9	1.9	27.8
	24.6	1	1.9	1.9	29.6
	24.7	1	1.9	1.9	31.5
	24.8	1	1.9	1.9	33.3
	25.3	1	1.9	1.9	35.2
	25.9	1	1.9	1.9	37.0
	26.4	1	1.9	1.9	38.9
	27.0	1	1.9	1.9	40.7
	28.0	1	1.9	1.9	42.6

28.1	1	1.9	1.9	44.4
28.2	1	1.9	1.9	46.3
28.4	1	1.9	1.9	48.1
28.4	1	1.9	1.9	50.0
28.5	1	1.9	1.9	51.9
28.6	1	1.9	1.9	53.7
28.7	1	1.9	1.9	55.6
28.7	1	1.9	1.9	57.4
29.0	1	1.9	1.9	59.3
29.7	1	1.9	1.9	61.1
30.4	1	1.9	1.9	63.0
30.9	1	1.9	1.9	64.8
31.3	1	1.9	1.9	66.7
31.5	1	1.9	1.9	68.5
31.7	1	1.9	1.9	70.4
32.6	1	1.9	1.9	72.2
35.3	1	1.9	1.9	74.1
36.9	1	1.9	1.9	75.9
37.0	1	1.9	1.9	77.8
37.1	1	1.9	1.9	79.6
37.1	1	1.9	1.9	81.5
37.5	1	1.9	1.9	83.3
38.0	1	1.9	1.9	85.2
39.6	1	1.9	1.9	87.0
40.0	1	1.9	1.9	88.9
43.8	1	1.9	1.9	90.7
44.1	1	1.9	1.9	92.6
44.2	1	1.9	1.9	94.4
45.7	1	1.9	1.9	96.3
48.3	1	1.9	1.9	98.1
49.3	1	1.9	1.9	100.0
Total	54	100.0	100.0	

F). ANOVAa

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	29.997	4	7.499	.166	.954b
	Residual	2208.751	49	45.077		
	Total	2238.748	53			

a. Dependent Variable: Medicaid and CHIP

b. Predictors: (Constant), Integrate Clinical Information, Find Clinical Information, Send Clinical Information, Receive Clinical Information