

Applying an Institutional Perspective to the Adoption of Health Information Technology in
Dental Clinics in Tennessee

By

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CHAPTER 1

INTRODUCTION

Oral health is an integral component to the overall health of an individual. However, for the greater part of the past two centuries, the dental and medical fields have operated in separate domains —divided by policy, insurance, education, and professionalization (McCluggage, 1959). Oral health care, focusing on structures that occupy the oral cavity, has been solidified in the United States healthcare system as a distinct entity from medical care, which focuses on more systemic bodily systems. Recently, there has been a movement (mostly academic) that has challenged the division between the “dental” and the “medical.” Those who have challenged this division believe that dentistry's organizational, educational and intellectual isolation from the rest of the medical field is detrimental to both professions and society as a whole (V. Powell, 2012). For example, insurance policy, health insurance coverage, and access to care are not the same for the medical and dental fields due to differential treatment. The percentage of individuals without health insurance has always been lower in comparison to those without dental insurance: In 2013, 20 percent of nonelderly adults did not have health insurance compared to 33 percent of nonelderly adults who did not have dental insurance (Vujicic, Buchmueller, & Klein, 2016; Vujicic, Yarbrough, & Nasseh, 2014). Since health insurance has been shown to correlate with health care access and income levels, the prevalence of dental diseases tends to be higher among immigrant and low income populations (Kominski, Nonzee, & Sorensen, 2017; Wilper et al., 2008). The disproportionately high prevalence of dental diseases among racial minorities, the poor, and rural areas amplifies stigmatization of these groups (Horton & Barker, 2009).

As knowledge increases about oral diseases and their relationship to the rest of the body, “oral disease prevention and the promotion of oral health needs to be integrated with chronic disease prevention and general health promotion as the risks to health are linked” (“Oral health in America: a report of the Surgeon General,” 2000; Petersen, 2009, p. 1). One

cited mechanism for bridging the medical-dental divide, is improving collaboration between medical and dental care at the level of patient data (V. Powell, 2012; V. J. H. Powell & Din, 2012). A study by A. Acharya, Shimpi, Mahnke, Mathias, and Ye (2017) found that medical care providers reported “substantial value” in having access to a patient’s oral health data (p. 336). The appropriate exchange of patient data, such as medical history, dental history, lab reports, and prescribed medications, between dental and medical clinics has the potential to breakdown structural barriers that obstruct medical and dental communication, allow for better cooperation between medical and dental clinics, and provide more reliable data on a patient’s overall health (Dimitropoulos & Rizk, 2009; V. Powell, 2012; Thyvalikakath, Monaco, Thambuganipalle, & Schleyer, 2008).

One of the essential first steps to an integrated medical-dental patient data environment is the development, implementation and widespread use of interoperable electronic health record (EHR) systems in both the dental and medical fields. Most health information technology (IT) record keeping systems fall into the categories of electronic health records (EHRs), electronic medical records (EMRs), or, in the case of dentistry, electronic dental records (EDRs). All these terms broadly describe a computer system used for tracking a patient’s clinical data electronically (Ford, 2015). The term electronic health record (EHR), however, is mainly reserved for software systems that are “designed to reach out beyond the health organization that originally collects and compiles the information” (Garrett, 2011, p. 6). In other words, EHRs can share patient data electronically with other health care providers and laboratories. Electronic health records that are interoperable can “communicate, exchange data, and use the information that has been exchanged” with different EHR systems (Healthcare Information and Management Systems Society., 2017, p. 190). Electronic medical records (EMRs) and EDRs, on the other hand, are simply digital

versions of a paper chart. These software systems do not have the embedded capabilities of transferring data electronically between providers.

To eventually have a truly integrated health IT ecosystem that includes dentistry as a critical component of one's overall health, there needs to be the development and use of interoperable medical-dental "integrated" electronic health record systems (iEHRs). An iEHR software system is capable of sharing data between medical and dental EHR components so that communication flows in both directions, or, on the other hand, it may be a single system that includes oral health as a specialty (V. J. H. Powell & Din, 2012). However, there have been very few iEHR systems developed and implemented (Amit Acharya, Yoder, & Nycz, 2012). For dental IT vendors, researchers, and policy makers to gauge the feasibility of designing, implementing, and legislating the use of medical-dental iEHRs, there should be an initial assessment on the current state of adoption of EDR and EHR systems in both the medical and dental fields and an analysis of the factors that contribute to adoption. The following sections will detail the (1) broader contextual background for this study and the central research problem, as well as (2) the purpose of the study and its significance, including a brief description of the theoretical approach used, a list of the specific aims, and lastly, an outline for the rest of the work.

Contextual Background and Research Problem

Increasing the adoption of interoperable EHRs has been one of central goals of the U.S. healthcare system. Healthcare in the U.S. has gone through some radical changes over the past few years with the advent of the Affordable Care Act (ACA). However, a less politicized piece of legislation has arguably made just as much of an impact on a doctor's day-to-day tasks. The Health Information Technology for Economic and Clinical Health (HITECH) Act, which provided approximately 27 billion dollars of federal stimulus funds to

speed up the adoption of EHRs, was enacted in 2009 as part of the American Recovery and Reinvestment Act (Gold & Mc, 2016). The HITECH Act contained two primary programs: First, the “Meaningful Use” program stipulated that qualified providers who adopted a certified EHR received an incentive package to alleviate the high cost of purchasing an EHR system. Furthermore, those providers that did not adopt were to be penalized with a 1% reduction in Medicare/Medicaid reimbursements for five years (Department, 2010). The second component of the HITECH Act, the EHR certification program, set down parameters for what capabilities a software system should contain in order to qualify as an EHR and meet meaningful-use requirements (*A Shared Nationwide Interoperability Roadmap*, 2015). One of the required capabilities of a software system to be certified was that it needed to meet specifications for health information exchange (HIE) (Adler-Milstein, 2017). The standards for HIE overlap with definitions of interoperability mentioned earlier. In fact, these terms are often used interchangeably. The major difference between the two is that HIE standards do not specify “use” requirements.

Many studies have analysed the adoption and factors that contribute to adoption of EHRs in medicine (Brunt & Bowblis, 2014; DesRoches et al., 2008; Dranove, Garthwaite, Li, & Ody, 2015; Hsiao et al., 2013; Schleyer et al., 2013; Singh, Lichter, Danzo, Taylor, & Rosenthal, 2012; Xierali, Phillips, Green, Bazemore, & Puffer, 2013). Furthermore, the Office of the National Coordinator for Health Information Technology (ONC), an agency of the U.S. Department of Health and Human Services, releases yearly, publicly available survey data detailing national and state-level estimates of the adoption of EHRs in non-federal acute care hospitals and office-base practices (*Office-based Physician Health IT Adoption and Use*, 2015). Data indicate that adoption rates in the medical field increased substantially after the implementation of the HITECH act. From 2008 to 2015 office-based physician adoption of EHRs rose from 42 percent to 87 percent with an overall use of certified EHRs at 77.9

percent as of 2015 ("Office-based Physician Electronic Health Record Adoption," Health IT Quick-Stat #50," 2016).

In dentistry, on the other hand, there have been few studies analysing the adoption of EDRs and EHRs (Abramovicz-Finkelsztain, Barsottini, & Marin, 2015; Schleyer et al., 2013). The consensus from researchers and practitioners is that the adoption of IT software in dentistry has been slower than the medical field. A study by Ford (2015) detailed a few of the possible reasons for the slow transition in dentistry: Firstly, most dentists do not qualify for the federal incentive program under the HITECH act because Medicare does not typically cover dental services (Jaffe, 2016). Furthermore, dentists must have a 30 percent Medicaid patient volume to qualify for Medicaid reimbursements. Secondly, there is a prevalence of small, private, and solo practices in dentistry (Wendling, 2009). This puts the high cost of purchasing an EHR largely on one individual. With the high cost of purchasing an EHR system, a lack of financial incentives to offset the upfront costs, and the potential for lower productivity at the initial stages of adoption, it is predicted that dentistry lags behind medicine in adoption. However, a literature review was unable to find solid numbers of adoption rates of certified EHRs or EDRs in dentistry for all types of practitioners. The overarching research problem that is examined in this study is centrally a question that attempts to fill this void: What are the rates and factors that are associated with the adoption of EDRs and EHRs in dentistry in Tennessee?

Purpose and Significance

Why has the U.S. government invested so much in the goal of increasing EHR adoption rates in healthcare? One reason is the potential improvement in health outcomes: A study conducted in 2016 found that an integration of electronic health records between ambulatory and hospital practices was responsible for a 37 percent reduction in severity of

adverse birth outcomes (Meyerhoefer et al., 2016). Another reason is the interoperable capabilities of electronic health record systems, which allow for increased interoffice communication. Increased interoperability has been shown to better inform a clinician about the overall health of his or her patient, thereby leading to more appropriate decisions on patient care (Meyerhoefer et al., 2016). Furthermore, the economics of EHR adoption indicate a positive return on investments in the long run through practice efficiencies, suggesting the potential of financial savings for providers, payers, and the government (Ford, 2015; Langabeer, Walji, Taylor, & Valenza, 2008).

At face value, it would seem there is very little holding providers back from adopting EHRs, because when an innovation is both effective and financially rewarding, adoption rates of that innovation are high (Coleman, Katz, & Menzel, 1957). However, since EHR-related advancements are primarily remunerative through lowering healthcare costs, the benefits accrued from health IT adoption are mainly imparted to the payers of healthcare services (S. A. Sherer, Meyerhoefer, & Peng, 2016). Providers do not usually see direct benefits in the short run. In fact, providers have the added burden of high upfront costs when purchasing an EHR system. In addition, providers must deal with induced costs, which include the added burden of coping with drastic changes in clinic workflow post-EHR adoption that have been shown to lower productivity in the short run (Novak, Johnson, & Lorenzi, 2010).

It has been suggested then that adoption of innovations in the healthcare context are guided not only by financial reward, but also by the perceived benefits and the organizational structure (Baicker & Chandra, 2010). Organizational economists have long acknowledged that the healthcare system is a unique, complex industry that does not function like a conventional market. Demand-side and supply-side factors differ in many respects from the competitive markets that guide behavior in other organizations (Aday, 1998). Thus,

traditional methods of inquiry, such as cost-benefit analysis, are difficult to quantify:

“Benefits associated with the adoption of a new technology or medical intervention are often in terms of intangible long- term benefits such as the dollar value of prolonging life or an enhancement in the quality of life” (Santerre & Neun, 2007, p. 61).

Theoretical Approach

Since the benefits of EHR adoption are not likely conferred directly to providers in the short run, this begs the question: What are the primary drivers for EHR adoption at the provider level? One notable theoretical framework for understanding adoption of information technology in multiple industries is the technology acceptance model (TAM), which was developed by Fred Davis (Davis, 1985). TAM reasons that IT acceptance and eventual use are predicated upon two primary variables: “perceived ease of use” and “perceived usefulness” ([see Figure 1](#)) (Davis, Bagozzi, & Warshaw, 1989)

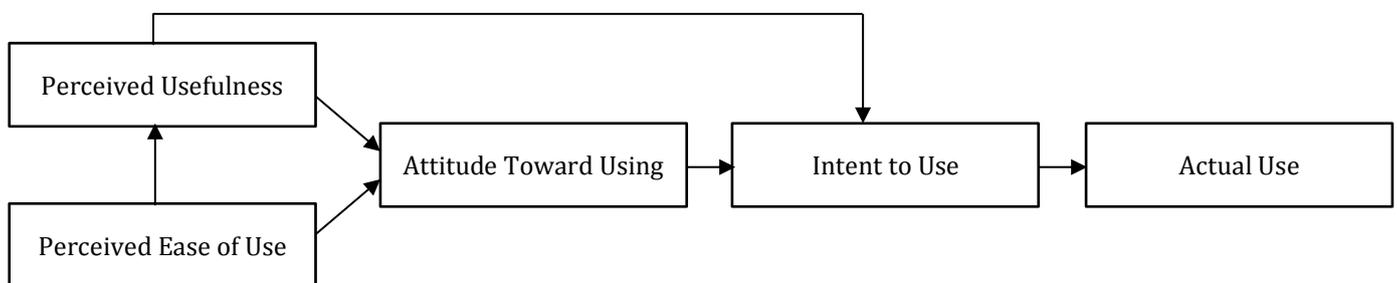


Figure 1. Technology Acceptance Model. Adapted from “The technology acceptance model: its past and its future in health care,” by R. Holden and T. Karsh, 2010, *J Biomed Inform*, 43(1), p. 161.

When TAM has been applied to the healthcare setting, it has been shown that “perceived usefulness” is a consistent predictor in the health field; however, “perceived ease of use” has been shown to be much more inconsistent (Holden & Karsh, 2010). Furthermore, there has been some criticism leveled toward TAM and similar models due to their focus on

the level of the individual (Cao, Jones, & Sheng, 2014). In a large hospital, or even a small clinic, the decision to adopt is rarely the choice of one person. Instead, adoption decisions are largely organizational, with nurses, administrators, doctors, and managers all contributing. Lee, Kozar, and Larsen (2003) have suggested that more research should be focused on understanding the external factors that influence “perceived usefulness” and “perceived ease of use” in TAM, stating: “more efforts to examine the broader environmental factors including emotion, habit, personality difference, technology change, even going beyond individual acceptance to organizational and societal acceptance are necessary” (p. 767). As the healthcare field becomes more integrated, and healthcare IT becomes more interoperable, it has been predicted that the environment, taking into account the individual provider as well as the broader organizational structure of the profession, will play an ever-increasing role in influencing and modulating adoption decisions (see Figure 2) (S. A. Sherer et al., 2016).

To account for these external factors, institutional theory has been one framework proposed to describe the exogenous tensions that play a role in influencing EHR adoption (S. Sherer, 2010). Currently, there are no published studies that have applied an institutional framework to the adoption of health IT in dentistry. The purpose of this study is to begin to understand the significance of an institutional perspective in explaining factors associated with the adoption of EHRs in dentistry.

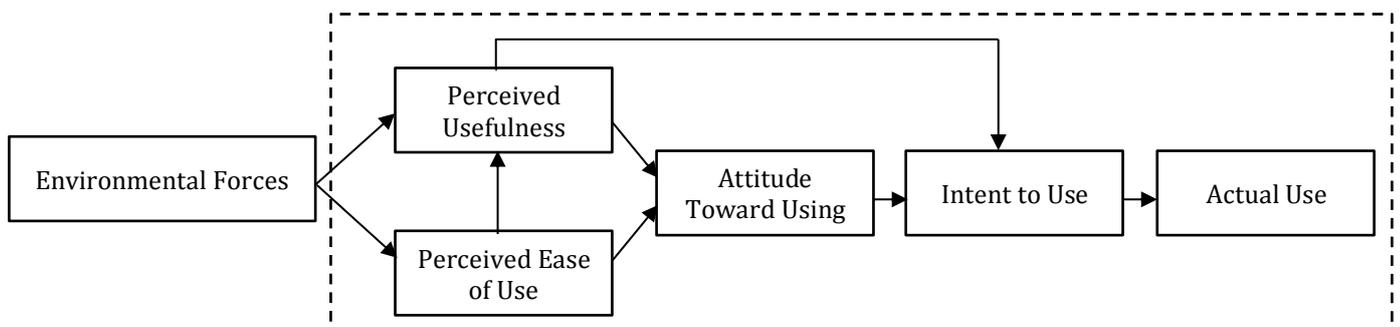


Figure 2. TAM constructs considering an external component.

Specific Aims

The central aim of this study is to assess the adoption of EDRs and EHRs in dental practices across Tennessee using survey methods. In order to apply an institutional perspective to the adoption of health IT in dentistry, a review of institutional theory and its application in the healthcare field is required. Furthermore, a historical examination of the dental institution provides useful a background, since few studies have examined the institutional components of the dental field. Therefore, a historical review of the dental organization and its separation from medicine is included in this work. The following is a list of specific aims:

1. To describe how institutional theory has been used in the medical field to explain EHR adoption.
2. To delineate the historical formation of a separate dental organization from medicine and identify potential factors associated with adoption of the dental health information technology.
3. To quantitatively estimate the adoption rates of EDRs and certified EHRs in dental clinics in Tennessee, while examining factors associated with adoption.

Thesis Organization

The remaining sections of the study are organized in the following manner: The design for this study, including the conceptual framework, is provided by a review of institutional theory and an historical analysis of the dental institution. Chapter 2, titled “Institutional Theory,” contains a review of the literature on institutional theory and its application in healthcare IT research. Chapter 3, titled “The History and Formation of the American Dental Institution,” provides a detailed review of the American dental institution from both an historical and a sociological perspective. This subsection will focus on the

factors that contributed to the medical-dental divide and subsequent formation of the organization and institutional forms of dentistry. Chapter 4, “Conceptual Framework and Hypothesis,” develops the hypotheses for the quantitative analysis portion of the study. Chapter 5, “Methods,” describes the methodological approach, data, and statistical tests used. Chapter 6, “Results,” includes the results from the quantitative analysis. Chapters 7 and 8 provide the “Discussion” and “Conclusion” for the work by reviewing the study findings, discussing limitations of the study, and considering areas of future research.

CHAPTER 2

INSTITUTIONAL THEORY

The review of academic literature on institutional theory was conducted through book chapters and electronic sources, including World Cat, PubMed, and Google Scholar. The sources include works on institutional theory, generally, and its application in the healthcare field, specifically. Also included are studies that have used institutional theory as a framework for explaining the adoption of EHRs in medicine.

Central Concepts

Institutional theory is a complex and diverse formulation whose roots originate in a variety of disciplines, such as economics, sociology, history, and political science (Currie & Shoib, 2009). This study primarily uses the sociological formulations of institutional theory, more specifically those originating in the field of organizational studies. It is important to note at the outset that there is no one, unified conceptual framework that encompasses institutional theory. Instead, institutional theory is composed of several variants due to the diversity in the ways that institutions and institutionalization have been defined (W Richard Scott, 1987). For example, W Richard Scott (1987) reviewed the four central sociological formulations of institutional theory and named the following: “Institutionalization as a process of instilling value,” “institutionalization as a process of creating reality,” “institutions as distinct social spheres,” and “institutional systems as a class of elements” (p. 493-501). The latter version resides most closely in the sociological sub-field of organizational behavior. In this formulation, it is argued that when belief systems become institutionalized they are composed of certain elements that influence organizational structure. This idea can be dated to Meyer and Rowan (1977) where they argued:

Institutional rules function as myths which organizations incorporate, gaining legitimacy, resources, stability, and enhanced survival prospects. Organizations whose structures become isomorphic with the myths of the institutional

environment, in contrast with those primarily structured by the demands of technical production and exchange, decrease internal coordination and control in order to maintain legitimacy. Structures are decoupled from each other and from and from ongoing activities (p. 340).

To decode what Meyer and Rowan (1977) are suggesting here, it is important to have an understanding of several terms. In organizational institutional theory, institutions have been defined by Greenwood (2008) as “more-or-less taken for granted repetitive social behavior that is underpinned by normative systems and cognitive understandings that give meaning to social exchange and thus enable self-reproducing social order” (p. 3). In other words, when ideas or shared beliefs become a social norm, they serve to create institutional rules that organizations conform to and, thereby, create a level of homogeneity in organizational structure. Meyer and Rowan (1977) use the term “myths” or “rationalized myths” to describe the shared beliefs that make-up the institutional environment. They suggest that when an organization conforms, or becomes “isomorphic,” with rationalized myths that have become institutionalized, it gains legitimacy and economic stability. These isomorphic tendencies of organizations create pressures that lead to a “decoupling” process. This decoupling refers to the separation of rules laid down by the institutional environment and those defined by the technical, or material-resource, environment (Boxenbaum & Jonsson, 2008).

The separation of the “institutional” and the “technical” environments is a central idea in institutional theory. Meyer and Scott (1983) defined the technical environments as “those within which a product or service is exchanged in a market such that organizations are rewarded for effective and efficient control of the work process” (p. 140). The institutional environments, on the other hand, “are characterized by the elaboration of rules and requirements to which individual organizations must conform if they are to receive support and legitimacy” (p. 149). However, it is important to note that rules laid down by these

environments interact and may overlap. For example, what constitutes a “product” or “service” in the technical environment is influenced in part by institutional beliefs and rule systems (W. Richard Scott, 2000).

DiMaggio and Powell (1983) argued that when organizations conform to rationalized myths, there is a similarity of organizational form that occurs, termed isomorphism. They argued that this conformational, or isomorphic, process is a result of pressures exerted by the institutional environment on the organization. These pressures stem from the diffusion of certain institutionalized ideas and practices. DiMaggio and Powell (1983) noted three pressures that drive organizations to conform to the institutional environment: Coercive isomorphism, normative isomorphism, and mimetic isomorphism. Coercive isomorphism stems from governmental influence and resource dominant groups, normative isomorphism from occupational constituencies and relational channels, and mimetic isomorphism from other, structurally equivalent organizations.

W. Richard Scott (1995) furthered this idea by linking each isomorphic pressure with an element of the institutional environment: coercive with the regulative elements, normative with normative systems, and mimetic with cultural-cognitive systems. Regulative structures are composed of rules and authority systems. Normative systems include “informal and diffuse rule systems that operate to structure expectations and establish and enforce a system of mutual obligation” (W. Richard Scott, 2000, p. 168). Cultural-cognitive systems include the shared beliefs and rationalized myths that were pointed out by Meyer and Rowan (1977). [Figure 3](#) details the various components of the institutional environment, including the various elements and their associated pressures. Note that these elements and pressures often coexist and interact with each other to guide organizational behavior.

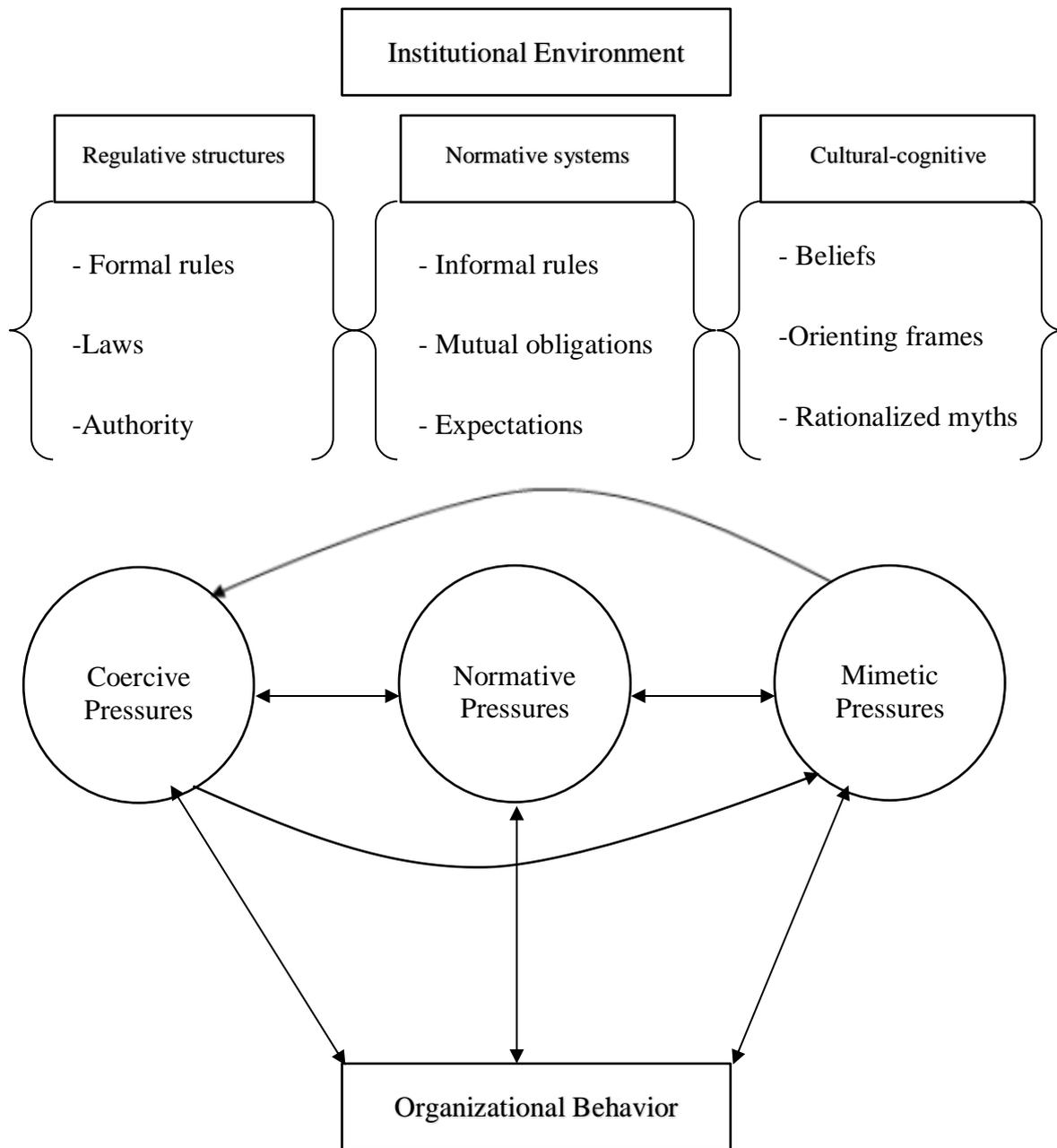


Figure 3. The institutional environment, including the elements from which it is composed and associated pressures.

Institutional Theory Application in Health IT Research

Orlikowski and Barley (2001) have suggested that researchers utilizing institutional theory focus on the regulative, normative and cultural-cognitive elements that guide the use and design of information systems, stating: “An institutional perspective would offer IT researchers a vantage point for conceptualizing the digital economy as an emergent, evolving, embedded, fragmented, and provisional social production that is shaped as much by cultural and structural forces as by technical ones” (p. 154). One notable example of a study using institutional theory is a recent work by S. A. Sherer et al. (2016) who used the model to explain the adoption of EHRs in ambulatory medical practices in the United States. In their study, coercive, normative, and mimetic pressures were the primary forces used to explain EHR adoption. S. A. Sherer et al. (2016) operationalized these pressures in the healthcare IT environment in following ways:

Firstly, coercive forces were defined as a physician’s percent revenue from Medicare and Medicaid. It has been suggested that competition and regulation are two central sources of coercive pressures (DiMaggio & Powell, 1983). In the unique healthcare context, private insurance and governmental payment programs, such as Medicare and Medicaid, are powerful dominant forces that control resources. If a provider is partially financially dependent upon governmental reimbursements through Medicare and Medicaid, then it is argued that any position that the government takes on EHRs will have a coercive force on providers.

Secondly, normative forces were defined as the percentage of physicians in the same hospital referral region that adopted an EHR. Normative forces can express themselves in two ways: One, through regional networks based on environmental location; two, through relational channels between members of a particular network (S. Sherer, 2010). As more physicians within a given area adopt an EHR, it becomes a norm in that area. Through

expectations and informal rules, there is the potential for influence on organizational behavior (DiMaggio & Powell, 1983).

Lastly, mimetic forces were defined as the percentage of physicians in the same specialty that adopted an EHR. Mimetic pressures are a result of one organization modeling the behavior of another organization that is in a similar sociopolitical / sociocultural environment. This has been shown to be a result when “organizational technologies are poorly understood, goals are ambiguous, or the environment creates symbolic uncertainty” (Sherer, Meyerhoefer, & Peng, 2016, p. 132). Because the value of adopting an EHR is uncertain, it is predicted that as more physicians in a specialty adopt an EHR other physicians in the same specialty will be subject to higher mimetic forces and will, thereby, have an increased pressure to adopt.

Results from the work of S. A. Sherer et al. (2016) showed that institutional forces were a major influence in adoption decisions in the medical field (p. 578). This work suggests that exploring adoption of health IT from an environmental perspective is useful. However, applying the exact model used by S. A. Sherer et al. (2016) will not likely prove to be meaningful in the dental field. Firstly, the way coercive forces were defined in their study will not apply to dentistry because Medicare does not typically cover dental services and most dentists do not take Medicaid. Secondly, the use of hospital referral regions for normative forces is problematic. A hospital referral region, which is a geographic proxy for the potential to share data between medical care providers, has been defined by determining the large hospitals in a region where most patients go to for surgical procedures (Kilaru et al., 2015). In dentistry, however, there is a prevalence of small, private, and solo practices in (Wendling, 2009). Furthermore, there is no reason to believe that referral patterns for dental care in a region overlap with those observed in medical care.

Dentistry as an Institution

Operationalizing institutional forces for a study design requires an understanding of the institutional environment of a field. However, few studies that have examined the organizational field of dentistry, with only one study found that utilized institutional theory. In that study, Mertz (2010) examined the institution and organization of dental care delivery in the United States. She suggested that the dental field is highly institutionalized, stating:

The six-month checkup and the expectation of daily brushing and flossing are well established social patterns, with the solo private practice dentist's office as the normative system within which the social exchange of receiving dental care takes place. This ritual is widely understood and adhered to; hence, it remains relatively unchallenged by America's culture of individual responsibility. One's participation in this social exchange is intricately tied to one's social status; therefore, the exchange is tied to reproduction of social order. (p. 67).

However, despite finding that the institutional components in dentistry are strong, Mertz (2010) concluded that dental practice is highly "individualistic and disaggregated" (p. 77). In fact, she suggests that the institutional context of dentistry is permeated with notions independent business and autonomy. Since isomorphism is defined as similarity in organizational form, this finding proves problematic when attempting to operationalize isomorphic pressures to fit a particular study design. One way to address this issue is to observe the institutionalization process in dentistry. Observing the institutionalization process has been shown to provide insights into the ideas and practices that lead to isomorphism (DiMaggio & Powell, 1983). By doing so, the varying structures in the dental field that serve as sources for institutional forces may become more apparent. In order to examine the institutionalization process in dentistry, and thereby gain an understanding of the institutional elements in the field, an historical examination of the formation of the dental institution, separate from medicine, was conducted.

CHAPTER 3

HISTORY AND FORMATION OF THE AMERICAN DENTAL INSTITUTION

The medical and dental fields have operated in separate domains for a greater part of the past two centuries. However, the invented demarcation between the oral and the medical was not always so. Dentistry in America was widely considered to be one with medicine and general surgery up until the early 19th century (Guerini & National dental association. [from old catalog], 1909). It was not until between 1830-1860 that dentistry began to emerge as an autonomous profession (O'Shea, 1971). Surprisingly, this occurred before the rise of American medical specialization, which was non-existent prior to 1856 (Weisz, 2006). The emergence of a distinct dental field correlated with the development of the first dental college in 1840 (McCluggage, 1959). Furthermore, it occurred during the time of the establishment of the first dental journal, *The American Journal of Dental Science*, in 1839 (Koch & Thorpe, 1909).

Throughout these events, voices of disapproval were heard on both sides of the aisle. One prominent medical practitioner, Dr. Daniel Brainard —professor of surgery in Rush Medical College —based the blame for the beginnings of this demarcation on the medical field, citing “deep-seated prejudice” as the cause (Brainard, 1865, p. 49). However, when one compares the path of separation that dentistry took with the path of specialization followed by other surgical-based fields, like ophthalmology, “prejudice” was not likely the only factor at play. It was found through historical analysis that the rise of the dental institution, separate from medicine, was due, in part, to two interrelated factors. The first factor was the growth of cities in the 1820s and 1830s, which lead to an increase in the number of practicing dentists; notably, an increase in the number of unqualified dentists. The second was the creation of organizations, such as dental colleges and journals, separate from medicine. Each of these factors is examined in detail in the two following subsections: “The Rise of Urban Dentistry” and “The Formation of Organized Dentistry.”

To examine the formation of the dental institution in the United States, while avoiding a teleological, one-dimensional approach, this section focuses on the institutional, economic, and cultural-cognitive environments in which the dental organization resided in the late 19th and early 20th century. The institutional environment of the dental and medical field was analyzed through both primary and secondary sources consisting of academic journal publications at the time, books, internet sources, and written personal experiences of dentists and patients. The primary sources analyzing the institutional environment came from reports and proceedings from organizational bodies —such as state regulatory boards and the American Medical Association— and prominent journals, such as *JAMA*, *JADA*, *New England Journal of Dentistry*, and *the Journal of Practical Dentistry*. The economic factors that drove the split between the two fields mainly focused on secondary book sources due to the difficulty in accessing and analyzing primary quantitative data during this time. The cognitive understanding of dentists and medical doctors was delineated through the examination of primary sources of two types: Dental and medical magazines as well as written personal experiences of individual dentists. Both these types of work contain personal opinions of individual dentists and doctors, thus giving insight into the views and ideas of various players.

Rise of Urban Dentistry

The steady movement of the U.S. population from rural to more urban areas has occurred, to greater and lesser extents, since the founding of the United States. In the early- to mid-1800s, urbanization was attributed to both the location and the function of larger cities. These cities emerged as central locations for farmers to process and sell crops, which was primarily due to the geographic advantages of cities, such as the presence of waterways and nearness to productive farmland (Cronon, 1991). It was during the time period of 1830 to

1910 that urbanization accelerated substantially: the proportion of the population living in urban areas increased from 10 percent to over 60 percent (Boustan, Bunten, & Hearey, 2013). Dr. James Tylor, Professor of Mechanical Dentistry at the Ohio College of Dental Surgery, in his valedictory address to the graduating class in 1847 made an elegant observation of the demographic shifts at this time, “The wilderness has melted away and cities, towns, and villages have risen as if by enchantment” (Taylor, 1855, p. 200) For dentists practicing during this time, the “enchantment” of city life also likely included the doubling of wages that occurred in urban areas from 1820 to 1880 due to the expanding market (Boustan et al., 2013).

How did this market expansion occur? One possibility is that agglomeration in big cities lowered transportation costs and, thereby the price of medical and dental care. Much work has been written on the benefits of agglomeration economies on the development of industries. One of the major benefits is that firms located near suppliers and consumers have lower transportation costs (Ellison, Glaeser, & Kerr, 2010). Starr (1982) points out in his work, *The Social Transformation of American Medicine*, that the fundamental constraint on American medicine in the early- to mid- 19th century was the high cost of medical care, which was predominantly driven by the large distances between doctor and patient. This greatly limited the number of patients a doctor could see in one day and increased the indirect costs associated with treating patients. As a result, financial returns for physicians were small. Many doctors simply could not support themselves.

The difficulties of traveling long distances to visit patients was not limited to the practitioner of medicine. Dentists often had to search for patients by traveling city to city. One dentist, writing about his beginnings in the dental field in 1823, stated that, “I began dentistry with a horse and wagon and travelled from house to house, and from town to town” (Robinson, 18??). Such examples were the norm for most dentists and medical practitioners

outside of urban areas. Starr (1982) points out that these conditions lead to doctors in the early and mid-1800s having a cap on both the number of patients they could see, which was on average five to seven in one day. Those dentists who did not travel depended on patients traveling to see them. This put the cost-of-care burden on the patient.

As urban areas began to blossom during the 1830s, dentist and patient came in closer proximity and prices of care dropped. In cities, the growth of a medical and dental practice was no longer limited by the high indirect costs. With lower transportation costs, a closer proximity of patient and practitioner, and the rise of the urban population, there was a large expansion of the market for dentists. Starr (1982) points out that “the reduction of indirect prices from the local transportation revolution and the rise of cities put medical care within the income range of more people” (pg. 70). Starr suggests that there was no radical or sudden change in policy or technology that cut the cost of doctor services. He argues that lower prices were a direct cause of a more concerted urban life. The growth of the number of practicing dentists then was a natural reaction to the changes in economic environment at the time. One observer of the growth of dentistry in New York in the years after 1835 stated, “We have often been struck with admiration at the vast increase in the number of dentists practicing in this city within the last few years; we can remember, and that not very long ago, when there were but six or eight, and at present, we are informed that the list is swelled to eighty” (Brown, 1920, p. 936). Unfortunately, the increase in the number of dentists did not always translate into improvements in quality.

The 19th century economist Alfred Marshall noted another effect of agglomeration: The flow of ideas. Marshall believed that co-agglomeration patterns, such as one business relocating to an area near another business in the same industry, have positive benefits through the exchange of knowledge; he stated, “the mysteries of the trade become no mystery, but are, as it were, in the air” (Henderson, 2008). These benefits included dentists

being able to more readily exchange knowledge about more effective treatments and better practices. However, it was not always the case that better and more effective methods of practice were “in the air.” In such cases, the flow of ideas may be detrimental to practice, or, in the case of dentistry, the profession.

R. W. McCluggage (1959) in his work *A History of the American Dental Association* accounts the dissemination of a radically different treatment for dental caries that grew out of one of the most prominent urban areas in the country, New York City. Two English individuals, named the Crawcours, proposed that they had developed a new method for treating dental caries that would avoid the discomfort associated with traditional treatments at the time. Their proposed treatment involved using an amalgam of silver and mercury, which did not require, in their opinion, cavity preparation. This ran in direct opposition to the ideas of the dental elite. In the very first publication of the first dental journal, L. Mackall (1839) did not mention the Crawcours by name when he critiqued the practice of the use of amalgam. Much of the evidence that Mackall provides against its use is through personal experience with patients. The first issue was that the filling material in amalgam used mercury. Many physicians at the time argued that mercury was a dangerous substance to use in the oral cavity due to the risk of mercury poisoning. The second issue was that if the cavity was not properly prepared, a filling only created the “illusion of treatment” (p. 86). In time, the tooth would eventually become unsalvageable.

However, the Crawcour method was attractive to many dental practices. The amalgam that they used was much easier to manipulate than more traditional methods. Furthermore, without having to laboriously remove the decay by hand, the Crawcour method saved the dentist time and the patient from pain. Eventually patients began to become more attracted to the new method, providing an economic incentive to use the technique. With its ease of use and new economic advantages, amalgam became a hit. One report in 1844 stated

that upwards of 50 percent of all fillings placed in upstate New York at the time consisted of amalgam (Westcott, 1844). This growth in the use of amalgam had a detrimental effect on the view the medical profession had toward dentistry. One medical professional in 1882 wrote in the Ohio State Journal, “The better class of dentists waged war against it (amalgam) on general principles, not alone on account of the deleterious effects of the mercury in its composition, but because of its unsightly appearance and demoralizing effects upon the dental profession” (Mayr, 1882, p. 64).

The eventual war that was waged against amalgam was not solely due to the “unscientific” nature of its use. The ease of use of the Crawcour method led to another major problem, the increase in the number of unqualified dentists. As dental practice was largely unregulated in the 1830s, this also meant that access to the pursuit of dentistry was not restricted. Anyone who wanted to practice dentistry in these larger cities simply had to spend a few weeks with any of the numerous dentists around the area. Furthermore, with the ease of use that amalgam fillings provided new dentists, there was a large increase in the number of so-called “quacks” in the field. Chapin Harris, M.D., protested in 1839 that “the calling of the dentists seems to be considered open ground into which any fellow who has impudence, some steadiness of hand, and a case of instruments, thinks himself free to take up a position” (Chapin, 1839, p. 49-56).

The use of amalgam and the eventual increase in the number of unqualified dentists in the 1830s had two severe consequences on the state of the dental field: Firstly, from the perspective of the patient, this made it harder to locate a capable dentist. One anonymous patient stated, “I note the contemptuous sneer of the victim of some quack, I hear the loud guffaw of a dozen urchins at the street corner, who have spelled out dentist signs upon half the doors in the neighbourhood, and I listen the indignant rustle of silks worn by fair demoiselles, who have been cheated into premature loss of cupids, when I say, ‘it is a difficult

thing to find a dentist” (Creighton, 1864, pp. 13-16). Secondly, from the view of the medical practitioner, dentistry was unscientific and the field began to lose its prestige in the eyes of the medical profession. One physician noted, “It is a remarkable and humiliating fact, that though dental surgery was never better understood, yet its principles were never more erroneously practiced and shamefully abused than at the present day” (Brown, 1839, p. 8-10). As the dental profession faced the twin problems of amalgam and quackery, it needed to respond.

The Formation of Organized Dentistry

By the 1840s, three responses emerged. The first response by the dental elite was the development of a body of literature, in the form of academic journals, to inform practising dentists about proper techniques and to expose errors. Not long after the publication of the first dental journal, dental colleges were established, with the first being in 1840 in Baltimore (M.E. Ring, 2005). Lastly, was the formation of professional guilds. In essence, dentistry's response was to organize; leading to the formation of a young dental institution separate from medicine. This young institution was vital in influencing the trajectory of the dental profession for years to come. To understand how this organizing led to the formation of a dental institution and how it was so influential, it is important to understand the institutionalization process.

Social scientists who have theorized about institutions have hypothesized that the process of institutionalization takes place when values and norms become manifest in organizational practice. In the healthcare environment, there have been three interdependent components that have been used to describe the institutionalization process (not to be confused with institutional elements discussed previously). These components include governance structures, institutional logics, and institutional actors (W. Richard Scott, 2000).

Governance structures are composed of regulative and normative elements that serve to enact rules and enforce adherence (DiMaggio, & Powell, 1983). Institutional logics, or belief systems and associated practices, are composed of normative and cultural-cognitive elements, and are associated with professionalization in an organizational field (W. W. Powell & DiMaggio, 1991). Institutional actors are the individuals and organizations that embody the institutional environment and are responsible for enacting logics (DiMaggio, & Powell, 1983). W. Richard Scott (2000) noted the complex interdependencies of these components, stating:

Institutional actors carry but also create logics, and actors are, variously, the subjects of power wielders within and claimants and petitioners attempting to benefit from and alter governance structures. Governance structures instantiate the dominant logics but may change more slowly than ideas and interests (p. 174).

What occurred in density in the generation following 1839 allowed for the formation of these three components and, through isomorphic pressures, led to the diffusion of the professions values and norms. However, prior to 1839 there was no real organization in dentistry and, therefore, no real way to shape behavior of dentists. Instead, dentistry was simply a component of medicine. Many M.D.'s practiced dentistry and medical colleges taught limited dental courses (McCluggage, 1959). However, as agglomeration allowed for the growth of both the number of dental and medical practitioners in urban cities, the unique problems that dentistry faced began to become evident (Parmele, 1882). It was dentistry's response to their unique problems that allowed for the field's values and norms to become apparent and eventually institutionalized.

The first response to dentistry's problem, the establishment of academic journals, was initially proposed by the dental practitioner, Shearjashub Spooner, M.D., in 1838 in his

book “An essay on the art of the manufacture of mineral, porcelain, or incorruptible teeth.”

He stated:

What has conduced to this state of dentistry in America? Our countrymen are a money making people. The accumulation of wealth as a means of obtaining worldly good, and as conducive to our happiness, possess a large share of our desires. Hence, our national enterprise; hence, too, we see that any kind of business which offers a prospect of rapid emolument (amalgam), is eagerly embraced by a great number of enterprising individuals. Dentistry has heretofore been considered a very lucrative business, and as it requires but little capital to enable a man to engage in it, a great number of poor, but perhaps well educate gentlemen, “have taken up the profession in their own head,” to use common parlance, and with little or no dental information, have assumed to discharge the duties of a dentist. Many mechanics have pursued the same course; and in the country, Tom, Dick and Harry, have “turned dentist.” The consequence of all this is, a distrust of any utility in dental operations by a large portion of community, especially in the country. What remedies do these facts suggest? First, that means be employed to inform community sufficiently on the subject of dental surgery, to convince people of its utility when judiciously practiced, and to enable them to discriminate between a scientific dentist and a charlatan; and second, that means be taken to improve the mass of dentist throughout the country—to purge the profession. To effect the latter object, the author knows of no plan more feasible than this; that the profession unite in establishing a semi-annual or quarterly annual periodical devoted to dental science and information, and the whole profession, throughout the country, be invited to contribute to its pages (p. 9).

Prior to Spooner’s recommendation, most dental related articles appeared in medical journals. But, as Spooner and many others believed, the problems that dentistry faced necessitated a focused journal. By 1839 there was enough support for the development of a journal and the *The American Journal of Dental Science* was born (Harris, 1839). In the eight years following 1839 multiple other dental journals were created, solidifying dental periodical literature. Four notable examples are *Stockton’s Dental Intelligencer* (1844), *New*

York Dental Recorder (1846), *Dental Register of the West*, and the *Dental News Letter*.

Through these journals, dentistry laid the grounds for the first organizational steps toward legitimizing their profession. One physician praised the newly created *American Journal of Dental Science* in an article in the *The Maryland Medical and Surgical Journal* where he stated, “It has reached its third number; one which has not in the least disappointed the high expectations created by its predecessors. We look upon this undertaking as fraught with interest, and pregnant with good to the community at large, and more particularly to the members of the profession” (“Bibliographic Notices,” 1840). However, the establishment of professional literature, in and of itself, was not enough to legitimize the authority of the dental profession.

Starr (1982) argues that legitimation of professional authority requires that three claims be met: First, that knowledge and competency of the professional have been validated by a community of peers; second, that this knowledge and competency be based on rational and scientific merits; lastly, that professional judgment be focused toward an acknowledged value (see p. 15). As mentioned previously, professionalism is associated with one of the primary components of institutions, namely, institutional logics. These logics are related to the belief systems that embody the institution. Professionalization is a means by which beliefs are able to diffuse (W Richard Scott, 1987). Despite providing a reliable source of scientific and rational thought for dentists and improving the image of dentistry among its medical peers, dental journals did not have a wide spread impact on dentistry on the ground. This was primarily due to the fact that dental journals are not capable of creating new, adequately trained dentists. Furthermore, most of these early journals subscribers were more educated dentists who agreed with the journal philosophy (“Our Next Volume,” 1841). Because of the lack of impact of journals, the diffusion of ideas from the dental elite was not widespread.

However, the formation of dental professional literature was integrally linked to the second element of organized dentistry: Dental Colleges. Prior to 1840, dental education was much like that of medicine in the previous decades. The primary method of training for dentists was apprenticeship (Zederbaum, 1908). A trained dentist would take a young aspirant into his practice and teach him for a fee. However, with the advent of a dental journal, the professional elite were able to more readily exchange ideas about the possibilities of developing a new dental college. In fact, the idea was first pitched by the founders of the American Journal of Dental Science (“On the Uniformity of Dental Fees,” 1865). One year after the journal’s first publication, the efforts of the dental elite were realized and the first dental college opened its door in 1840 in Baltimore. By the mid-1850s, dental colleges opened up in Ohio, Philadelphia, and Boston (McCluggage, 1959).

With the dental colleges and dental journals formed, dental professional organizations soon followed with the advent of the American Society of Dental Surgeons by the mid-1840s (Moorehead, 1913). It was with these three structures in place that dentists finally formed the primary components of an institution. Dental colleges and journals provided the development of institutional logic and actors, through both disseminating knowledge and producing new, trained dentists, while the formation of the American Society of Dental Surgeons provided a governance structure. By 1850 all of these structures were in place, the young dental institution was in nascent form, and professional values and norms were disseminated.

What were those values and norms? Here is where things become less linear. From 1860 until the turn of the twentieth century, there were varying opinions from the professional elite on what direction dentistry should head. On one hand, some professionals glorified this new separation from medicine. They believed that the advancement of dentistry to a science relied on the field’s refinement of dental procedures, both mechanical and

operative (Allport, 1864). One dentist made a stark warning to the profession, “there is danger that in the laudable ambition to justify the doctorate by medical culture the necessity of handicraft may be to a great extent neglected” (“American Dental Association,” 1864, p. 68). On the other hand, some believed that the sciences of dentistry depended upon its focus in the traditional medical sciences:

“I have always believed that dentistry ought never to have been established as a separate profession; but that every person desiring to practice in any department of medicine should be required to follow a regular course of medical education, and, having graduated as a doctor in medicine, to then perfect himself in the desired department. Thus it is that those who practice ophthalmology, otology, gynecology, etc., are educated, and why should not those desiring to be dental and oral surgeons be required to educate themselves in the same way? Dentists are not, and never can be, specialists of medicine and recognized by the medical profession as such until they are educated in the same manner as other specialists” (Parmele, 1882, p. 65).

By the end of the 19th century there was no real fixed and recognized standard to the dental curriculum (Zederbaum, 1908). Some schools focused on teaching the mechanical aspects of dentistry in priority to medical-based training, while others required two years of medical training in order to receive a degree. As a result, there was stark political division among dental organizations (McCluggage, 1959). Therefore, despite dentistry having formed into a nascent institution, the profession’s values and norms that were disseminated at this time were contradictory. Meanwhile, the field of medicine, which had become increasingly scientifically oriented, began to view dentistry as a mechanical trade and a business rather than a profession (Rosebury, 1957). The next twenty years up until 1926 solidified this separation, leading to Gies’s conclusion in his famous report on the state of dental education in the United States and Canada: “Dentistry cannot now be made a specialty of medicine” (Gies, 1926).

CHAPTER 4

CONCEPTUAL FRAMEWORK AND HYPOTHESES

From the review of literature on institutional theory and the historical analysis of the dental institution several factors emerge as environmental forces that may serve to influence dental practice. Firstly, in the 1800s urbanization was central in developing the economic environment that allowed for the widespread adoption and use of the Crawcour method in dentistry. It is evident that the location of a clinic could be an important factor that influences decision making. Furthermore, currently in the medical field, there has been concern that technology adoption is lower in rural areas. In fact, in order to combat potential disparities in the adoption of EHRs, the Office of the National Coordinator for Health Information Technology (ONC) funded 62 Regional Extension Centers (RECs) in 2010 in rural, small practices and underserved areas (Ford, 2015). By 2013 these extension centers had provided technical assistance to more than half of all rural health providers (Heisey-Grove, 2016; Singh et al., 2012). However, it is not known whether RECs have impacted the dental field in a substantial way or not. Due to the institutional and organizational separation of the medical and dental fields, RECs may not have had a significant influence. Therefore, it is predicted that there is an association between adoption of dental IT and rurality. More specifically, it is predicted that more urban areas will tend to have higher levels of EDR and certified EHR adoption than more rural areas. This leads to the study's first hypothesis:

Hypothesis 1: *There is an association between adoption of an EDR or EHR and rurality, with more urban areas having higher levels of adoption than more rural areas.*

Secondly, mimetic forces, which have been operationalized in previous studies as the percentage of physicians in the same specialty that adopted an EHR, have been shown to be a useful predictor of health IT adoption (S. A. Sherer et al., 2016). In the early formation of organized dentistry, academic journals were central in developing institutional logic through disseminating ideas. Today, there are specialized academic journals for nearly all

dental specialties. Furthermore, there are numerous dental societies and annual conferences for varying dental specialists and generalists. If each branch of dentistry takes a position on EDR or EHR adoption, whether by vocally supporting its use or by general adoption trends within the field, this will serve as a mimetic force for other practices in the same branch. Previous studies on EHR adoption in the medical field have indicated that specialists were significantly less likely to adopt EHRs than their general practice counterparts (Grinspan, Banerjee, Kaushal, and Kern, 2013). Therefore, it is predicted that, due to the varying sociocultural environments that specialists operate in compared to generalists and, due to previous studies showing lower EHR adoption within specialties among physicians, there will be higher rates of EDR and EHR adoption in general dental clinics compared to specialty clinics. This leads to the study's second hypothesis:

Hypothesis 2: *There is a difference between the adoption of an EDR or EHR between general dental clinics and specialty clinics, with general dentists having higher levels of adoption than specialists.*

Thirdly, normative forces, which have been operationalized as the percentage of physicians in the same hospital referral region that adopted an EHR, have been shown to be a useful predictor of health IT adoption (S. A. Sherer et al., 2016). However, as previously mentioned, the use of hospital referral region will not be useful due to the prevalence of small, private, and solo practices in dentistry (Wendling, 2009). Furthermore, since hospital referral region is a geographic proxy developed for the medical field, it does not apply to dentistry. One potential substitute for the hospital referral region that may serve as a proxy that can be used to examine normative forces in dentistry in Tennessee is the Tennessee Department of Health (TDH) Oral Health Regions (*Oral Health Regions*, 2017). There are seven TDH oral health regions (see the [Appendix](#) for a table of counties in each TDH region). Each of these regions has a central office and a public health dental clinic. Because work by

Mertz (2010) concluded that dental practice is highly “individualistic and disaggregated,” it is predicted that normative forces, stemming specifically from mutual obligations and expectations, will be less pronounced in dentistry. Therefore, it is predicted there will not be an association between adoption and the TDH region the clinic is located within. This leads to the study’s third hypothesis:

Hypothesis 3: *There is no association between adoption of an EDR or EHR and TDH region.*

Lastly, competition and regulation have been cited as two sources of coercive pressures in the medical field (DiMaggio & Powell, 1983). Both private insurance and governmental payment programs, such as Medicare and Medicaid, are powerful dominant forces that control resources. A physician’s percent revenue from Medicare and Medicaid has been used as an indicator of coercive forces in medicine (S. A. Sherer et al., 2016). However, Medicare does not typically cover dental services and most dentist do not take Medicaid. Therefore, percent revenue from Medicare and Medicaid will not likely serve as a useful indicator of coercion. One potential source of coercion in dentistry is private insurance. Because benefits accrued from health IT adoption are mainly imparted to the payers of healthcare services, private insurance companies have a vested interest in having clinics adopt a health IT product. Any position that private insurance companies have toward EDRs or EHRs serves as a source of coercion for clinics. As a clinic becomes more financially dependent upon private insurance resources, there is likely a greater level of coercion. Furthermore, larger practices, as estimated by the number of dentists working in the clinic, may have a greater dependency upon insurance due to higher operating costs. Numerous studies have also found that organization size is an important explanatory factor for adoption of health IT in medicine (Singh et al., 2012). Therefore, it is predicted that larger dental

practices will have higher levels of EDR and EHR adoption. This leads to the study's fourth hypothesis:

Hypothesis 4: *There is an association between adoption of an EDR or EHR and practice size, with larger practices having higher levels of adoption.*

CHAPTER 5

DATA & METHODS OF INVESTIGATION

This study utilizes survey methodology to assess the impact of external, institutional forces on the adoption of EDRs and certified EHRs in dental clinics in Tennessee. The following sections detail the methods and data used for the quantitative analysis portion of the study.

Survey Data and Methods

State-wide representative dental clinic telephone survey data were collected in 2017 in Tennessee. The target population was all dental clinic offices, which included general dental offices and specialty practices. Specialty offices included practices where oral maxillofacial surgeons, endodontists, periodontists, prosthodontists, orthodontists and pediatric dentists worked. Interviews were administered by the author with data collection and analysis procedures approved by the Vanderbilt University Institutional Review Boards for the protection of human subjects.

Survey Design

The dental office was selected as the primary unit of analysis for several reasons. Prior to designing the survey, a direct observation study was conducted by the author to assess clinic workflow in rural and urban dental clinics. One of the findings showed that dental staff, as opposed to the dentist, were the primary users of dental IT, from booking to inputting treatment and medication data. Interviews from several members of the dental staff team indicated that staff were well-versed in the type of EDR used in the clinic. Furthermore, in both clinics observed, staff were integral in the decision-making process of what type of EDR the dentist purchased. This finding falls in line with several studies that have indicated that health IT adoption is an office-level decision instead of an individual decision (Singh et al., 2012; Ward, Jaana, Bahensky, Vartak, & Wakefield, 2006). Therefore, it was concluded

that the dental staff would be able to answer questions regarding EDR adoption and the name of the IT product used.

The sampling frame was obtained from the Tennessee Department of Health (TDH). The TDH releases publicly available licensure reports of all dentists who are licensed to practice in Tennessee (*Health Professional Licensing Reports, 2017*). This report includes information such as race, gender, date of graduation, specialization, clinic location, and clinic contact information. Because the unit of analysis in this study is the dental clinic (and not the individual dentist), this data set needed to be cleaned to uniquely represent each office. The data set was cleaned as best as possible in the following manner: First, all licensed dentists practicing outside the state were removed. Furthermore, dentists who were represented in the dataset more than once were removed by deleting duplicate licensing numbers. Second, since many clinics have more than one practicing dentist, duplicate values for practice address were removed. Third, to increase precision, duplicate values for practice phone number were removed. It was noticed that there were still several issues with the data set, including phone numbers with incorrect lengths and practice addresses that were very similar. These phone numbers were retained because “not reported” or incorrect phone numbers could be located by practice address from Delta Dental (*Find a Dentist in Your Area, 2017*). Delta Dental is a dental insurance company that releases publicly available data containing contact information for dental clinics and other clinic information. Furthermore, practice addresses that were very similar were often found to be public health dental offices or a dental college that contained multiple clinics with varying specialties. To provide the best possible representative sample for the number of varying dental clinics in Tennessee, these addresses and corresponding phone numbers were retained. This cleaning process led to the size of the data set dropping by 3,704 observations, from 5,770 dental licensing numbers in the original data set to 2,066 dental clinics in the cleaned data set.

Each of the counties represented was then given a numerical value using the Index of Relative Rurality (IRR). The IRR, which was introduced by Dr. Brigitte Waldorf (2006) at Purdue University, provides a continuous measure of the relative rurality of a county based on four dimensions: population size, density, percentage of urban residents, and distance to the closest metropolitan area. The rurality measure varies from 0-1, with 0 being the most urban and 1 being the most rural. The exact value for the rurality of each of Tennessee's 95 counties using the IRR has been previously calculated by the Tennessee Advisory Commission on Intergovernmental Relations and published in a report in 2016 (Roehrich-Patrick, Moreo, & Gibson, 2016).

For sampling and analytic purposes, the IRR for each county was then stratified into 4 groups: Urban, Low Rurality, Medium Rurality, and High Rurality. To do this while avoiding arbitrarily categorizing the IRR, the K-means clustering method was used. K-means is a technique that is designed to group similar observations in a dataset, such that observations in the same group are as similar to each other as possible and observations in different groups are as different from each other as possible (Wilkin & Huang, 2008). The final clustering is dependent upon both the initial centroid position and the initial K-value that is picked. The initial centroid position was determined by randomly assigning a value and then, through a dispersed method, selecting the farthest available point for the next centroid. Picking the initial K-value of how many categories used is primarily up to the researcher. To avoid bias in selecting a K-value, a scree plot and a search for a kink in the curve generated from the within sum of squares (WSS) for numerous cluster solutions was used. After twenty cluster solutions (K-values of 1-20) were tested with random starting points, a kink was found in the WSS curve at a K-value of four. The final categorization generated from the K-means cluster and descriptive statistics for the intervals are detailed in Table 1.

Table 1

Descriptive Statistics for Intervals in Rurality Categories for 2,066 Dental Offices in Cleaned Data Set.

Rurality Category	Centroid*	Lower bound†	Upper bound	Frequency (# offices)	Relative Frequency	Frequency (# Counties)
Urban	0.152	0.133	0.236	950	0.460	4
Low	0.270	0.237	0.344	619	0.300	12
Medium	0.392	0.345	0.446	272	0.132	21
High	0.491	0.447	0.611	225	0.109	53

* Data point at the center of the cluster.

† Lower value indicates more urban on the IRR scale.

In order to adequately compare differences in adoption of an EDR or a certified EHR in dental clinics between rural and urban areas a disproportionate stratified sampling procedure was used. In this method, the population of size “N= 2,066,” which represent dental offices, was divided into “K=4” homogenous strata and simple random sampling was then conducted within each stratum (Fowler, 2009). The strata used was rurality category. Initially, simple random sampling was conducted in each rurality category until a total of 25 survey responses in each category were recorded with a total of 100 completed surveys. A review of the data showed an insufficient number of specialty clinics were sampled. Simple random sampling was conducted on the population until a total of 50 additional survey responses were recorded. Of the 50 survey responses, 1 was determined to be ineligible as the clinic was composed of multiple practices, some using a health IT system and others not.

Survey Instrument and Measures

The survey included an opening script, a consent script, and a 10-item questionnaire (see [Appendix](#)). The survey was pretested on several clinics and was determined to take around 3 minutes to complete. The adoption of EDR was measured based on the item, “Does your practice currently use an electronic dental record keeping system of some kind?” The reason that this language was used, specifically “electronic dental record” and “of some

kind,” was an attempt to encompass the wide range of IT systems used in dentistry that fall in the category of an EDR or practice management system (Thyvalikakath et al., 2008). The specific type of health IT system used was then determined by the question, “What is the name of the electronic dental record system you are using?” Having the name of the product used in the clinic allows for determining if the system is certified by the CMS and ONC. If the system is certified, then it qualifies as an EHR. This is because an EHR is necessary to meet the established standards for certification. Each product used was looked up at the Certified Health IT Product List generated by the ONC (*Certified Health IT Product List*, 2017). If the participant said they do not use an EDR of some kind, the interviewer clarified the response by asking if the clinic is predominantly paper-based. Additional questions determined practice characteristics, such as practice type (private, group, or corporate), specialty type, number of dentists working in practice, insurance type accepted, and number of patients seen each month.

Analysis

The central questions examined in the analysis seek to determine if there are associations and/or differences between adoption of an EDR or EHR and several external factors, including rurality, specialty, TDH region and practice size, determined by the number of dentists working in the clinic. The literature review details the justifications for examining these associations and the *a priori* hypotheses. The process of initially sampling equal number of dental clinics in each rurality category lead to 4.74 percent of urban offices, 8.4 percent of low rurality offices, 9.19 percent of medium rurality offices, and 12 percent of high rurality offices getting selected. To increase precision, poststratification weight adjustments were made based on sampling frame characteristics in the cleaned data set for analysis of rural-urban differences. Furthermore, since TDH regional information was available for all observations in the sampling frame, it was selected as another characteristic to postratify.

In order to test the hypothesis that there is an association between rurality and adoption of an EDR or an EHR, Chi-square and Fischer's exact tests were run. The chi-square test of independence was employed to determine if there was an association between adoption of an EDR or EHR and the rurality categories developed through the K-means clustering method. All assumptions, including an adequate sample size, independence of observations, and cross-sectional sampling, were met for the chi-square test examining the association between adoption of certified EHR and rurality categories. A Fisher's exact test was conducted due to an inadequate sample size, as established according to Cochran (1954), for the chi-square test between an EDR and rurality categories. Expected frequencies lower than 5 were detected in the medium rurality category.

To test the hypothesis that there is a difference between the adoption of an EDR or a certified EHR between general dentists and specialists, a two-proportions z-test was run. A two-proportions z-test determines if a difference exists between the binomial proportions of two groups on a dichotomous dependent variable. Specialty clinics were defined based on approved definitions by the Council on Dental Education and Licensure. Each clinic surveyed was asked if the clinic was a general or specialty practice. A follow-up question determined what type of specialty or specialties were practised. Of the 149 clinics surveyed, 66 were specialty clinics making up six of the nine recognized specialties approved by the Council on Dental Education and Licensure. Seven of the specialty clinics had two different specialties being practiced. These seven observations were treated as specialty clinics.

With respect to examining associations between TDH region and EDR or certified EHR adoption, a Fischer's exact test was used. The TDH region of each practice was determined by the county in which the clinic was located. All the 7 TDH regions were represented in the sample. To test the hypothesis that an association between practice size and adoption of EDR or certified EHR exists, a chi-square test was used. The practice size was

estimated by the number of dentists practising in the clinic, and was categorized into 1, 2, or 3 or more. The number of dentists working in a clinic is often used as a proxy for practice size (S. A. Sherer et al., 2016; Singh et al., 2012). All dentists surveyed accepted insurance of some kind, with a clear majority accepting only private insurance. Only 8 percent of surveyed clinics accepted Medicare or Medicaid.

CHAPTER 6

RESULTS

Descriptive statistics for the study, reported in Table 2, show that the sample consisted of 45 urban clinics, 52 low rurality clinics, 25 medium rurality clinics, and 27 high rurality clinics. Most of the clinics surveyed (56%) identified as being general practice. All of the 7 TDH regions were represented in the sample, with the Mid-Cumberland region (21%) being the largest surveyed and Upper-Cumberland (8%) being the lowest. A majority of the clinics consisted of only 1 practicing dentist (67%), with clinics consisting of 2 dentists (16%) and 3 or more dentists (17%) nearly evenly distributed. Overall, 149 successful surveys were recorded. This was a response rate of 36.3% (149 surveys/ 410 telephone calls).

Table 2

Descriptive Statistics of Study Sample and Sampling Frame

Variable	Number of Cases	Percentage of Sample	Number of Cases in Sampling Frame	Percentage of Sampling Frame
<i>Rurality</i>				
Urban	45	30	950	46
Low	52	35	619	30
Medium	25	17	272	13
High	27	18	225	11
<i>Clinic Type</i>				
General	83	56		
Specialty	66	44		
<i>Region</i>				
East	22	15	361	18
Mid-Cumberland	31	21	670	32
Northeast	20	13	144	7
South Central	13	9	92	4
Southeast	22	15	223	11
Upper Cumberland	12	8	72	4
West	29	19	504	24
<i>Size</i>				
1 Dentist	100	67		
2 Dentists	24	16		
≥ 3 Dentists	25	17		
Overall Sample	149	100	2,066	100

Note. “Number of Cases” values represent the frequency of dental offices per category.

All clinics successfully surveyed had either adopted a health IT product (EDR or certified EHR) or had not (predominantly paper-based). Seventy-seven percent of clinics (115/149) had adopted some kind of EDR product, while only 59 percent (88/149) had adopted a certified EHR. These percentages are lower than the adoption rates observed in the medical field. In 2015, 80.2 percent of office-based physicians had adopted a certified EHR product (*Office-based Physician Health IT Adoption and Use, 2015*). Seventy-eight percent of the urban dental clinics surveyed had adopted an EDR of some kind compared to 63 percent in the high rurality category. There was no association found between adoption of an EDR and rurality as assessed by a Fischer’s exact test, $p = .380$ (Table 3). After it was determined whether the EDR used by clinics qualified as being a certified EHR, the adoption rate in the urban category dropped to approximately 50 percent, with adoption of a certified EHR in high rurality areas at 52 percent. There was no association found between adoption of an EHR and rurality, $\chi^2(3) = 3.368, p = .338$. Furthermore, the strength of association was small (Cohen, 1988), Cramer’s $V = .156$.

Table 3

EDR and Certified EHR Adoption Rate by Rurality Categories.

Variable	Adoption Rate (%) by Rurality Category					P-Value*
	All Clinics	Urban	Low Rurality	Medium Rurality	High Rurality	
<i>EDR</i>						
Yes	77	78	85	76	63	.380
No	23	22	15	24	37	
<i>Cert. EHR[†]</i>						
Yes	59	51	68	63	52	.338
No	41	49	32	37	48	

Note. Numbers represent the percent in each rurality category.

* P-Values for design-adjusted chi-square and exact test.

[†] Certified EHRs were determined through ONC certification report.

Of the 149 clinics surveyed, 83 (56%) of the clinics were general practice and 66 (44%) were specialty (e.g., oral surgery, orthodontist, periodontist, etc.). In the general practice clinics, 65 (78%) had adopted an EDR of some kind compared 50 (76%) in the specialty category, an insignificant difference in proportions of .03, 95% CI [-.11, .16], $p = .7119$ (see Table 4). However, the difference between general practice clinics' and specialists' adoption of a certified EHR was significant. In the general practice clinics, 55 (69 percent) had adopted an EHR of some kind compared to 29 (47 percent) in the specialty category, a significant difference in proportions of .219, 95% CI [.06, .38], $p = .0082$.

Table 4

Difference in Adoption of EDR and Certified EHR Between Clinic Type.

Variable	Adoption in Clinic Type		Prop. Difference	95% CI	P-Value
	General (N = 83)	Specialist (N = 66)			
<i>EDR</i>					
Yes	78	76	.03	-0.11-0.16	.7119
No	22	24			
<i>Cert. EHR[†]</i>					
Yes	69	47	.219	0.06 - 0.38	.0082*
No	31	53			

Note. Numbers in "Clinic Type" represent percent in category.

* P-Values indicates a significant result.

† Certified EHRs were determined through ONC certification report.

The regions with the highest adoption of an EDR were the neighbouring regions of East Tennessee and Southeast Tennessee, both with an overall adoption of 86 percent (see Table 5). The region with the lowest overall adoption was West Tennessee. Despite there being a cluster of high adoption in East, Southeast, Upper Cumberland, and Mid-Cumberland regions, there was no overall evidence of a relationship between region and EDR ($p = .118$) or certified EHR adoption ($p = .897$). There was no statistically significant association

between practice size and EDR adoption, $\chi^2(2) = 3.454$ $p = .178$, or size and certified EHR adoption $\chi^2(2) = 3.563$ $p = .168$. The strength of associations were small (Cohen, 1988), with a Cramer's V of 0.152 and 0.158 respectively.

Table 5

EDR and Certified HER Adoption by TDH Region and Practice Size.

Variable	EDR Adoption (%)			Cert. EHR Adoption (%)		
	Yes	No	P-Value*	Yes	No	P-Value*
<i>Region</i>						
East	86	14	.118	67	33	.897
Mid-Cumberland	84	16				
Northeast	70	30				
South Central	69	31				
Southeast	86	14				
Upper Cumberland	83	17				
West	62	38				
<i>Size</i>						
1 Dentist	74	26	.178	54	46	.168
2 Dentists	92	8				
≥ 3 Dentists	76	24				

Note. Numbers represent percentage adoption in each category.

* P-Values for design-adjusted chi-square and exact test for regional analysis.

† Certified EHRs were determined through ONC certification report.

CHAPTER 7

DISCUSSION

Findings from this study, which is the first known state-wide assessment of the adoption of EDRs and EHRs in Tennessee dental clinics, indicate moderate to high levels of information technology adoption. The percent adoption of some type of EDR or practice management system among dental clinics in Tennessee in 2017 is comparable to 2014-level estimates of percent adoption of basic and certified EHRs in office-based physician practices in the same state, 77 percent and 76 percent respectively (*Office-based Physician Health IT Adoption and Use*, 2015). However, the adoption of a certified EHR product among Tennessee dental clinics remains relatively lower at 59 percent.

Clinics in varying rurality categories had comparable rates of adoption. This finding is similar to several national level studies that have examined adoption of EMRs in the medical field (Heisey-Grove, 2016; Singh et al., 2012). Comparability with these studies is limited due to methodological differences. For example, other studies examining rural-urban differences did not use the IRR to define rural and urban areas. The way rural and urban areas are defined and categorized could influence outcomes. It was expected that rurality may overlap with the other variables examined in this study, namely practice size and practice region. Despite there being a relationship between region and rurality, there was no association between practice size and rurality. Large offices were present in both urban and high rurality areas in near equal proportions. There was also no relationship found between clinic type and rurality. These findings provide evidence to reject the first hypothesis that, *“there is an association between adoption of an EDR or EHR and rurality, with more urban areas having higher levels of adoption than more rural areas.”*

Adoption of an EDR and clinic type was also not shown to be significant. However, there was an association between adoption of a certified EHR and clinic type: General practice clinics were found to be more likely to adopt a certified EHR than speciality clinics.

This provides some evidence for a mimetic influence in dental IT adoption. The significant association between EHR and clinic type may be explained by an increase in uncertainty about the benefits from EHR systems in specialty practices. S. A. Sherer et al. (2016) found that uncertain environments drive varying specialties to mimic and benchmark themselves against others. Furthermore, mimicry allows for organizations to hedge risks. In further examining this finding, there was no relationship found between clinic type and rurality, region, or practice size. The results from this analysis provides partial support for the second hypothesis that, *“there is a difference between the adoption of an EDR or EHR between general dentists and specialists, with general dentists having higher levels of adoption than specialists.”*

There were no discovered associations between dental IT adoption and TDH region or dental IT adoption and practice size. These findings are counter to studies in the medical field that have found associations between IT adoption and region and IT adoption and practice size, as measured by the number of practitioners. It should be noted that the proxy used for region was not the same as other studies (S. A. Sherer et al., 2016). Furthermore, the manner in which office size was categorized was different (Singh et al., 2012). However, the finding that there is no association between region and dental IT adoption does provide some evidence that dental practice is highly “individualistic and disaggregated” as concluded by Mertz (2010). While results from this analysis provide support for the third hypothesis that, *“there is no association between adoption of an EDR or EHR and TDH region,”* there is evidence to reject the fourth hypothesis that, *“there is an association between adoption of an EDR or EHR and practice size.”*

Overall, the results from this study suggest that external, institutional factors, in the manner that they were operationalized in this study, do not have a major impact on the adoption of information technology in dentistry. The only institutional factor found to be

associated with adoption was mimetic forces, as assessed by EHR adoption and clinic type. Normative forces, defined as TDH region, and coercive forces, defined as practice size, were not found to be associated with dental IT adoption. It should not be concluded, however, that these lack of associations disqualify an institutional approach in understanding IT adoption in dentistry. Further research should examine other institutional structures in dentistry that may serve as sources of coercive, normative, and mimetic forces. Furthermore, the statistical analyses conducted on the data in this study was primarily descriptive. Future research should bring in modelling techniques to predict the likelihood of dental IT adoption based on external, environmental factors.

Limitations

There are several limitations to this study. In terms of survey error, the response rate was relatively low at 36 percent, indicating a 64 percent nonresponse bias. Furthermore, clustering techniques have the chance of increasing sampling error. The continuous measure for rurality used in the study (IRR) was categorized through a k-means clustering technique. Categorizing this variable reduced the natural variation of rurality in the population sample and, thereby, reduced the number of “true” observations that could be made (Fowler, 2009, p. 160). To partly address these problems, poststratification weights were made for the analysis using population characteristics, as estimated by the sample frame. However, despite poststratification having the potential to correct for some kinds of bias, it may worsen others (Fowler, 2009). Therefore, it should be noted that nonresponse and sampling error may have impacted the study results.

Another limitation to the study is that the exact mechanism through which the varying institutional elements work in dentistry is not examined. Therefore, it cannot be concluded that the difference in adoption of a certified EHR product between general practices and specialists is caused directly by the institutional environment. Only correlations

and associations could be made. Furthermore, because this is a cross-sectional sample study, patterns in changes of adoption over time could not be examined. This possess a limitation to the design since institutional elements have both spatial and temporal qualities.

CHAPTER 8

CONCLUSION

Increasing the adoption of interoperable EHRs has been one of central goals of the US healthcare system. There have been many studies that have analysed the adoption and factors that contribute to adoption of EHRs in medicine. However, less focus has been paid to adoption in the dental field. This work attempted to fill this void by assessing adoption rates of dental IT and exploring factors associated with adoption. Furthermore, this work utilized institutional theory as framework from which to examine the dental field and isolate several factors that could influence adoption.

A literature review and an historical analysis of the dental institution provided insight into several factors that may serve to influence dental practice. It was predicted that there would be relationships between adoption of dental IT and rurality, clinic type, region, and practice size. To test these hypotheses a survey was designed, implemented, and analysed. Findings from survey analysis show that adoption rates of health IT in dental clinics in Tennessee in 2017 are comparable to 2014 level estimates of office-based physician adoption in the same state. In analysing the factors associated with adoption, it is shown that institutional factors, in the manner that they were operationalized, do not have a major impact on the adoption of information technology in dentistry. The single significant result found an association between adoption of a certified EHR and clinic type (between general and specialists). However, it should not be concluded that a lack of associations between the other factors examined disqualifies an institutional approach to understanding IT adoption in dentistry. Further research should examine the other institutional structures in dentistry that may serve as sources of coercive, normative, and mimetic forces.

Since one of the essential first steps to an integrated medical-dental patient data environment is the adoption of interoperable electronic health record (EHR) systems in both the dental and medical fields, data from this study indicate that dentistry is in a good position

for integration. Policies to increase EHR adoption that are mindful of potential disparities in IT use between dental specialties and general practices may have special promise for success.

APPENDIX

Telephone Survey and Script



Clinic #: _____

Date: _____

TELEPHONE SCRIPT FORM
(Interview-Administered)

Opening:

"Hello, my name is Zain Chauhan. I am a graduate at Vanderbilt University at the Center for Medicine, Health, and Society. I am conducting a short telephone survey analyzing the use of electronic dental record systems in Tennessee. I am hoping to learn about the factors that influence adoption of health IT systems in the dental industry. Your clinic was randomly selected from a list of around 2000 clinics. Would you be willing to participate in a short six question survey that lasts around three minutes?"

(If later, when?)

Assurance/Consent: (If yes)

"Before we begin this survey, I am going to read this short consent form. At the end you will be need to verbally consent."

"Your participation in this survey is voluntary and you may skip any question that you do not want to answer. Nothing that could potentially identify you or the clinic will be reported. The confidentiality of your response is assured by Vanderbilt's Human Research Protection Program. The data obtained in this survey will be blended with all other data from other dental clinics across Tennessee for analysis. The only reported data will be from the combined results of statistical research. Do you consent to participate in this survey?"

IF YES:

"Thank you very much. Let's begin with the questions! "

Survey:

1. Does your practice currently use an electronic dental record keeping system of some kind?

- Yes
- No

a.) (If yes) What is the name of the electronic dental record system you are using?

2.) What type of practice is this?

- Private
- Group
- Corporate

3.) Is this a specialty practice or a general practice clinic?

- General
- Both
- Specialty

a.) (If a specialty or both) What type of specialty is practiced?

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4.) How many dentists work at this practice?

- One
- Two
- Three or more

5.) Do you take insurance of any kind? (if yes, move on to 'a')

- Yes
- No

a.) Do you take Medicare patients?

- Yes
- No

b.) Do you take Medicaid patients?

- Yes
- No

6.) Approximately how many patients do you see per month?

END:

"That is all the questions that we have. Thank you for taking the time to participate in this brief survey."

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Table of Counties in Each TDH Oral Health Region in Sampling Frame

TDH Region	County		
<i>East Tennessee</i>	Anderson Blount Campbell Claiborne Cocke Grainger	Hamblen Jefferson Knox Loudon Monroe	Roane Scott Sevier Union Morgan
<i>Mid-Cumberland</i>	Cheatham Davidson Dickson Houston Humphreys Montgomery	Robertson Rutherford Stewart Sumner Trousdale Williamson	Wilson
<i>Northeast Tennessee</i>	Carter Greene Hawkins Sullivan Unicoi Washington		
<i>South Central Tennessee</i>	Bedford Coffee Giles Hickman Lawrence Lewis	Lincoln Marshall Maury Moore Perry Wayne	
<i>Southeast Tennessee</i>	Bledsoe Bradley Franklin Hamilton Marion McMinn	Meigs Polk Rhea Sequatchie	
<i>Upper Cumberland</i>	Cannon Clay Cumberland DeKalb Fentress Jackson	Macon Overton Putnam Smith Warren White	
<i>West Tennessee</i>	Benton Carroll Chester Crockett Decatur Dyer Fayette	Madison McNairy Tipton Weakly Gibson Hardeman Hardin	Haywood Henderson Henry Lake Lauderdale Obion Shelby

REFERENCES

- Abramovicz-Finkelsztain, R., Barsottini, C. G., & Marin, H. F. (2015). Electronic Dental Records System Adoption. *Stud Health Technol Inform*, 216, 17-20.
- Acharya, A., Shimpi, N., Mahnke, A., Mathias, R., & Ye, Z. (2017). Medical care providers' perspectives on dental information needs in electronic health records. *J Am Dent Assoc*, 148(5), 328-337. doi:10.1016/j.adaj.2017.01.026
- Acharya, A., Yoder, N., & Nycz, G. (2012). An Integrated Medical-Dental Electronic Health Record Environment: A Marshfield Experience. In V. Powell, F. M. Din, A. Acharya, & M. H. Torres-Urquidy (Eds.), *Integration of Medical and Dental Care and Patient Data* (pp. 331-351). London: Springer London.
- Aday, L. A. (1998). *Evaluating the healthcare system : effectiveness, efficiency, and equity* (2nd ed.). Chicago: Health Administration Press.
- Adler-Milstein, J. (2017). Moving Past the EHR Interoperability Blame Game - NEJM Catalyst. *New England Journal of Medicine: Catalyst*. Retrieved from <http://catalyst.nejm.org/ehr-interoperability-blame-game/>
- Baicker, K., & Chandra, A. (2010). Understanding Agglomerations in Health Care. In E. L. Glaeser (Ed.), *Agglomeration Economics* (pp. 211-236): University of Chicago Press.
- "Bibliographic Notices." *The Maryland Medical and Surgical Journal*, vol. 1, no. 1, Jan. 1840, p. 110.
- Boustan, L. P., Bunten, D., & Hearey, O. (2013). Urbanization in the United States, 1800-2000. *NBER Working Papers*(19041).
- Boxenbaum, E., & Jonsson, S. (2008). Isomorphism, diffusion and decoupling. *The Sage handbook of organizational institutionalism*, 78-98.
- Brainard, D. (1865) "Specialties and Specialists in Medicine." *The Dental Times*, vol. 3, no. 2, 49-58.
- Brown, Lawrence P. (1920) "New Light on Dental History." *Dental Cosmos*, vol. LXVI, no. 8, 936-58.
- Brown, Solyman A. "Dental Science: Review." *American Journal of Dental Science*, vol. I, no. 11, Oct. 1839, pp. 8-10.
- Brunt, C. S., & Bowblis, J. R. (2014). Health IT adoption, productivity and quality in primary care. *Applied Economics*, 46(15), 1716-1727. doi:10.1080/00036846.2014.884705
- Cao, Q., Jones, D. R., & Sheng, H. (2014). Contained nomadic information environments: Technology, organization, and environment influences on adoption of hospital RFID patient tracking. *Inf. Manage.*, 51(2), 225-239. doi:10.1016/j.im.2013.11.007
- Certified Health IT Product List*. (2017). Retrieved from: <https://chpl.healthit.gov/-/search>
- Cochran, W. G. (1954). Some Methods for Strengthening the Common X² Tests. *Biometrics*, 10(4), 417-451. doi:10.2307/3001616
- Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Hillsdale, N.J.: L. Erlbaum Associates.
- Coleman, J., Katz, E., & Menzel, H. (1957). The Diffusion of an Innovation Among Physicians. *Sociometry*, 20(4), 253-270. doi:10.2307/2785979

- Creighton, S.T. (1864). "My Search for a Dentist." *The People's Dental Journal*, vol. 1, no. 2, 13-16
- Cronon, W. (1991). *Nature's metropolis : Chicago and the Great West* (1st ed.). New York: W. W. Norton.
- Currie, W., & Shoib, G. (2009). Contextualising the IT artefact: towards a wider research agenda for IS using institutional theory. *Information Technology & People*, 22(1), 63-77. doi:10.1108/09593840910937508
- Davis, F. D. (1985). *A technology acceptance model for empirically testing new end-user information systems : theory and results*. Available from <http://worldcat.org/z-wcorg/> database.
- Davis, F. D., Bagozzi, R. P., & Warshaw, P. R. (1989). User acceptance of computer technology: a comparison of two theoretical models. *Manage. Sci.*, 35(8), 982-1003. doi:10.1287/mnsc.35.8.982
- Department, M. G. A. (2010). *CMS defines 'meaningful use'. Proposed rule outlines requirements for EHR incentive payments* (1537-0240 (Print) 1537-0240 (Linking)). Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/20358745>
- DesRoches, C. M., Campbell, E. G., Rao, S. R., Donelan, K., Ferris, T. G., Jha, A., . . . Blumenthal, D. (2008). Electronic health records in ambulatory care--a national survey of physicians. *N Engl J Med*, 359(1), 50-60. doi:10.1056/NEJMsa0802005
- DiMaggio, P. J., & Powell, W. W. (1983). The Iron Cage Revisited: Institutional Isomorphism and Collective Rationality in Organizational Fields. *American Sociological Review*, 48(2), 147-160. doi:10.2307/2095101
- Dimitropoulos, L., & Rizk, S. (2009). A state-based approach to privacy and security for interoperable health information exchange. *Health Aff (Millwood)*, 28(2), 428-434. doi:10.1377/hlthaff.28.2.428
- Dranove, D., Garthwaite, C., Li, B., & Ody, C. (2015). Investment subsidies and the adoption of electronic medical records in hospitals. *J Health Econ*, 44, 309-319. doi:10.1016/j.jhealeco.2015.10.001
- Ellison, G., Glaeser, E. L., & Kerr, W. R. (2010). What Causes Industry Agglomeration? Evidence from Coagglomeration Patterns. *American Economic Review*, 100(3), 1195-1213. doi:doi: 10.1257/aer.100.3.1195
- Find a Dentist in Your Area*. (2017). Retrieved from: <https://www.deltadental.com/DentistSearch/DentistSearchController.ccl>
- Ford, D. T. (2015). Are Electronic Health Records the Future of Dental Practice? *J Calif Dent Assoc*, 43(5), 238-243.
- Fowler, F. J. (2009). *Survey research methods* (4th ed.). Thousand Oaks: Sage Publications.
- Garrett, P. (2011). EMR vs EHR-What is the Difference? Retrieved from <https://www.healthit.gov/buzz-blog/electronic-health-and-medical-records/emr-vs-ehr-difference/>
- Gold, M., & Mc, L. C. (2016). Assessing HITECH Implementation and Lessons: 5 Years Later. *Milbank Q*, 94(3), 654-687. doi:10.1111/1468-0009.12214
- Greenwood, R. (2008). *The SAGE handbook of organizational institutionalism*. Los Angeles ; London: SAGE.

- Grinspan, Z. M., Banerjee, S., Kaushal, R., & Kern, L. M. (2013). Physician specialty and variations in adoption of electronic health records. *Appl Clin Inform*, 4(2), 225-240. doi:10.4338/ACI-2013-02-RA-0015
- Guerini, V., & National dental association. [from old catalog]. (1909). *A history of dentistry from the most ancient times until the end of the eighteenth century*. Philadelphia and New York,: Lea & Febiger.
- Harris, Chapin A. (1839) "Observations on the Qualifications Necessary to a Practitioner of Dental Surgery-- and on the manner in which they should be obtained." *American Journal of Dental Science*, vol. I, no. III, 49-56
- Health Professional Licensing Reports. (2017). Retrieved from: <https://apps.health.tn.gov/licensurereports/default.aspx>
- Healthcare Information and Management Systems Society. (2017). *HIMSS dictionary of healthcare information technology terms, acronyms, and organizations* (Fourth edition. ed.). Boca Raton: CRC Press, Taylor & Francis Group.
- Heisey-Grove, D. M. (2016). Variation In Rural Health Information Technology Adoption And Use. *Health Aff (Millwood)*, 35(2), 365-370. doi:10.1377/hlthaff.2015.0861
- Henderson, D. R. (2008). *The concise encyclopedia of economics*. Indianapolis, Ind.: Liberty Fund.
- Holden, R. J., & Karsh, B. T. (2010). The technology acceptance model: its past and its future in health care. *J Biomed Inform*, 43(1), 159-172. doi:10.1016/j.jbi.2009.07.002
- Horton, S., & Barker, J. C. (2009). "Stains" on their self-discipline: Public health, hygiene, and the disciplining of undocumented immigrant parents in the nation's internal borderlands. *Am Ethnol*, 36(4), 784-798. doi:10.1111/j.1548-1425.2009.01210.x
- Hsiao, C. J., Jha, A. K., King, J., Patel, V., Furukawa, M. F., & Mostashari, F. (2013). Office-based physicians are responding to incentives and assistance by adopting and using electronic health records. *Health Aff (Millwood)*, 32(8), 1470-1477. doi:10.1377/hlthaff.2013.0323
- Jaffe, S. (2016). Seeking Dental Care For Older Americans. *Health Aff (Millwood)*, 35(12), 2164-2167. doi:10.1377/hlthaff.2016.1393
- Kilaru, A. S., Wiebe, D. J., Karp, D. N., Love, J., Kallan, M. J., & Carr, B. G. (2015). Do hospital service areas and hospital referral regions define discrete health care populations? *Med Care*, 53(6), 510-516. doi:10.1097/MLR.0000000000000356
- Koch, C. R. E., & Thorpe, B. L. (1909). *History of dental surgery*. Chicago, Ill.: The National art publishing company.
- Kominski, G. F., Nonzee, N. J., & Sorensen, A. (2017). The Affordable Care Act's Impacts on Access to Insurance and Health Care for Low-Income Populations. *Annu Rev Public Health*, 38, 489-505. doi:10.1146/annurev-publhealth-031816-044555
- Langabeer, J. R., Walji, M. F., Taylor, D., & Valenza, J. A. (2008). Economic outcomes of a dental electronic patient record. *Journal of dental education*, 72(10), 1189.
- Lee, Y., Kozar, K. A., & Larsen, K. R. T. (2003). The Technology Acceptance Model: Past, Present, and Future. *Communications of the Association for Information Systems*, 12(1), 50.

- Mackall, L. (1839). "On the impropriety of plugging teeth with two kinds of metals in the same mouth." *The American Journal of Dental Science*, vol. 1, no. 1, 1839, 86-87
- Mayr, Chas. (1882). "Dr. Talbot and His Experiments With Mercury, Amalgams, Roaches, Etc." *The New England Journal of Dentistry*, vol. I, p. 64.
- McCluggage, R. W. (1959). *A history of the American Dental Association; a century of health service*. Chicago,: American Dental Association.
- Mertz, E. (2010). *Reshaping professional boundaries and organizational forms in American dentistry: A case study of registered dental hygienists in alternative practice*. (Sociology Dissertation), University of California, San Francisco, California. (3398895)
- Meyer, J. W., & Rowan, B. (1977). Institutionalized Organizations: Formal Structure as Myth and Ceremony. *American Journal of Sociology*, 83(2), 340-363.
- Meyer, J. W., & Scott, W. R. (1983). *Organizational environments : ritual and rationality*. Beverly Hills: Sage.
- Meyerhoefer, C. D., Deily, M. E., Sherer, S. A., Chou, S. Y., Peng, L., Sheinberg, M., & Levick, D. (2016). The Consequences of Electronic Health Record Adoption for Physician Productivity and Birth Outcomes. *ILR Review*, 69(4), 860-889. doi:10.1177/0019793916642758
- Novak, L. L., Johnson, K. B., & Lorenzi, N. M. (2010). Traversing the many paths of workflow research: developing a conceptual framework of workflow terminology through a systematic literature review. *Journal of the American Medical Informatics Association*, 17(3), 265-273.
- O'Shea, R. M. (1971). Dentistry as an Organization and Institution. *The Milbank Memorial Fund Quarterly*, 49(3), 13-28. doi:10.2307/3349416
- "Office-based Physician Electronic Health Record Adoption," Health IT Quick-Stat #50. (2016). Office of the National Coordinator for Health Information Technology.
- Office-based Physician Health IT Adoption and Use*. (2015). [Survey]. Retrieved from: <https://dashboard.healthit.gov/datadashboard/documentation/physician-health-it-adoption-use-data-documentation.php>
- Oral health in America: a report of the Surgeon General. (2000). *J Calif Dent Assoc*, 28(9), 685-695.
- Oral Health Regions - TN.Gov. (2017). Retrieved from: <https://www.tn.gov/health/article/oralhealth-regions>
- Orlikowski, W. J., & Barley, S. R. (2001). Technology and Institutions: What Can Research on Information Technology and Research on Organizations Learn from Each Other? *MIS Quarterly*, 25(2), 145-165. doi:10.2307/3250927
- Parmele, Geo. L. "Dentists as Specialists." *The New England Journal of Dentistry and Allied Sciences*, vol. 1, no. 3, Mar. 1882, pp. 65-68
- Petersen, P. E. (2009). Global policy for improvement of oral health in the 21st century-- implications to oral health research of World Health Assembly 2007, World Health Organization. *Community Dent Oral Epidemiol*, 37(1), 1-8. doi:10.1111/j.1600-0528.2008.00448.x

- Powell, V. (2012). *Integration of medical and dental care and patient data*. London ; New York: Springer.
- Powell, V. J. H., & Din, F. M. (2012). Rationale and Need to Articulate Medical and Dental Data. In V. Powell, F. M. Din, A. Acharya, & M. H. Torres-Urquidy (Eds.), *Integration of Medical and Dental Care and Patient Data* (pp. 1-24). London: Springer London.
- Powell, W. W., & DiMaggio, P. (1991). *The New institutionalism in organizational analysis*. Chicago: University of Chicago Press.
- Ring M.E. (2005) "Founders of a profession: the original subscribers to the first dental journal in the world". *J Am Coll Dent*. vol 72, no. 2, 20–5.
- Robinson, J. A. (18??). *Evolution in Dentistry*. Cincinnati: Spencer and Craig Printing Works.
- Roehrich-Patrick, L., Moreo, B., & Gibson, T. (2016). *Just How Rural or Urban are Tennessee's 95 Counties?* : Tennessee Advisory Commission on Intergovernmental Relations Retrieved from <https://www.tn.gov/assets/entities/tacir/attachments/2016JustHowRuralOrUrban.pdf>.
- Rosebury, Theodor. (1957). "The Challenge to Dentistry." *Science News*, vol. 126, no. 3282, 1056-58.
- Santerre, R. E., & Neun, S. P. (2007). *Health economics : theories, insights, and industry studies* (4th ed.). Mason, Ohio: Thomson/South-Western.
- Schleyer, T., Song, M., Gilbert, G. H., Rindal, D. B., Fellows, J. L., Gordan, V. V., & Funkhouser, E. (2013). Electronic dental record use and clinical information management patterns among practitioner-investigators in The Dental Practice-Based Research Network. *The Journal of the American Dental Association*, 144(1), 49-58. doi:10.14219/jada.archive.2013.0013
- Scott, W. R. (1987). The adolescence of institutional theory. *Administrative science quarterly*, 493-511.
- Scott, W. R. (1995). *Institutions and organizations*. Thousand Oaks: SAGE.
- Scott, W. R. (2000). *Institutional change and healthcare organizations : from professional dominance to managed care*. Chicago: University of Chicago Press.
- A Shared Nationwide Interoperability Roadmap. (2015). Retrieved from <https://www.healthit.gov/sites/default/files/nationwide-interoperability-roadmap-draft-version-1.0.pdf>
- Sherer, S. (2010). Information Systems and Healthcare XXXIII: An Institutional Theory Perspective on Physician Adoption of Electronic Health Records. *Communications of the Association for Information Systems*, 26(1), 7.
- Sherer, S. A., Meyerhoefer, C. D., & Peng, L. (2016). Applying institutional theory to the adoption of electronic health records in the U.S. *Information & Management*, 53(5), 570-580. doi:10.1016/j.im.2016.01.002
- Singh, R., Lichter, M. I., Danzo, A., Taylor, J., & Rosenthal, T. (2012). The adoption and use of health information technology in rural areas: results of a national survey. *J Rural Health*, 28(1), 16-27. doi:10.1111/j.1748-0361.2011.00370.x
- Spooner, Shearjashub. (1838). *An essay on the art of the manufacture of mineral, porcelain, or incorruptible teeth*. New York, Collins, Kreese, pp. 7-54.

- Starr, P. (1982). *The social transformation of American medicine*. New York: Basic Books.
- Taylor, J. (1855). Valedictory Address. *TheDental Register*, VII, 200-203.
- Thyvalikakath, T. P., Monaco, V., Thambuganipalle, H. B., & Schleyer, T. (2008). A usability evaluation of four commercial dental computer-based patient record systems. *J Am Dent Assoc*, 139(12), 1632-1642.
- Vujcic, M., Buchmueller, T., & Klein, R. (2016). Dental Care Presents The Highest Level Of Financial Barriers, Compared To Other Types Of Health Care Services. *Health Aff (Millwood)*, 35(12), 2176-2182. doi:10.1377/hlthaff.2016.0800
- Vujcic, M., Yarbrough, C., & Nasseh, K. (2014). The effect of the Affordable Care Act's expanded coverage policy on access to dental care. *Med Care*, 52(8), 715-719. doi:10.1097/MLR.000000000000168
- Waldorf, B. (2006). *A continuous multi-dimensional measure of rurality: Moving beyond threshold measures*. Paper presented at the annual meeting of the American Agricultural Economics Association, Long Island, CA.
- Ward, M. M., Jaana, M., Bahensky, J. A., Vartak, S., & Wakefield, D. S. (2006). Clinical information system availability and use in urban and rural hospitals. *J Med Syst*, 30(6), 429-438.
- Wendling, W. (2009). "The private practice of dentistry." *The U.S. Oral Health Workforce in the Coming Decade: Workshop Summary*. Washington (DC).
- Westcott, A. (1844). "Report to the Onondonga Medical Society on metal paste (amalgam)". *American Journal of Dental Science*, vol. 1v, no 1, 175–201.
- Weisz, G. (2006). *Divide and conquer : a comparative history of medical specialization*. Oxford ; New York: Oxford University Press.
- Wilkin, G. A., & Huang, X. (2008). A practical comparison of two K-Means clustering algorithms. *BMC Bioinformatics*, 9 Suppl 6, S19. doi:10.1186/1471-2105-9-S6-S19
- Wilper, A. P., Woolhandler, S., Lasser, K. E., McCormick, D., Bor, D. H., & Himmelstein, D. U. (2008). A national study of chronic disease prevalence and access to care in uninsured U.S. adults. *Ann Intern Med*, 149(3), 170-176.
- Xierali, I. M., Phillips, R. L., Jr., Green, L. A., Bazemore, A. W., & Puffer, J. C. (2013). Factors influencing family physician adoption of electronic health records (EHRs). *J Am Board Fam Med*, 26(4), 388-393. doi:10.3122/jabfm.2013.04.120351