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IMPLEMENTATION OF COMPUTER PHYSICIAN ORDER ENTRY

IN THE EMERGENCY DEPARTMENT

by

Frederick D. Watters

B.A. University of Colorado

B.S.N. University of Pennsylvania

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Advisory Committee:

Ann Sossong Ph.D., R.N., Associate Professor of Nursing

Patricia Poirier Ph.D., R.N., Associate Professor of Nursing

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Abstract

An analysis of the research literature on computer physician order entry (CPOE) produced over the past decade is useful in order to prepare for the launch of a fully integrated electronic medical record (EMR) in an Emergency Department. This review of the literature guides those making these institutional decisions about health information technology (HIT). Studies on rates of use, qualitative and quantitative effects, errors and safety concerns, and policy implications are used to address patient engagement, staff workflow, communication, and implications for future practice and research.

Implementation of Computer Physician Order Entry in the Emergency Department

Interactions between patients, their environment, and clinical systems have been recognized as the arena of the nurse since the writings of Florence Nightingale. The profession and science of nursing operates in this intricate realm of the patient experience and manifestations of their state of health from both historic and anthropologic perspectives. These observations and data points are then communicated to the rest of the healthcare team in the form both verbal and written records. This clinical record then serves as a repository of knowledge and a reference for setting a course of treatment.

To assess how fundamental changes in patterns of communication can affect the relationship between the healthcare team and the patient, it is illustrative to briefly examine the definition and etymology of the word ‘chart.’ According to the open-source online Wiktionary, chart comes to English from *charta* which was Middle French, Latin, and before that Greek; it’s roots are in the word for papyrus (Chart, 2012). This metaphorically as well as concretely shows that women and men, caregivers, doctors, nurses, and all members of the healthcare team have been charting for a very long time and it is no small shift to leave behind this written record and enter into ‘uncharted waters.’

A chart is a representation of a specific location or systemic representation of data (Wiktionary contributers, 2012). It can be a record of trajectory, a diagram, a graph, or a table. It is also a verb. The essential act of charting is a fundamental function of the patient-provider interaction. It has taken many different physical manifestations throughout history, but a written record has been a core tool of the present healthcare model. Computers changed everything in this model over the past few decades. All the data, projections, graphs, and communications have been slowly moving to the electronic realm. The chart in many clinical settings is now primarily in the form of bytes of data. The introduction of electronic medical records (EMR) or electronic health records (EHR) into healthcare is an evolution in the human act of charting both in the physical sense of the tool or technology in the hands of the clinician, but also in the metaphor of mapping out points, setting a course, and communicating to others an understanding of the past and possible future events.  It is a restructuring of the communication processes across every aspect of healthcare.

Emergency departments, perhaps more than any healthcare setting, have always been the ultimate meeting ground for policy, science, and reality with every possible dramatic human interaction.  Electronic charts must aid not hinder the gathering of relevant and accurate data in a timely fashion and allow relevant timely action.  This is essential to saving lives and delivering quality care in this, at times, chaotic arena.  The Institute of Medicine’s landmark study *To Err is Human: building a safer health system* suggested the electronic medical records were poised to reduce medical errors and improve safety and efficiency across healthcare (Kohn, Corrigan, & Donaldson, 1999).  Emergency medicine serves as a microcosm of the challenges facing the greater healthcare system and society. Geisler, Schuur, and Pallin suggest in their 2010 study of electronic medical records in emergency medicine,

We believe that the ED is a particularly important setting for analysis of EMR implementation, and not only because EDs may uniquely benefit from EMRs, due to the urgency of information needs and the lack of long-term relationships between patients and providers. It is also important because EDs may be uniquely vulnerable to the unintended consequences of EMRs. (p. 4)

One of the many aspects of this new form of charting is the key instance at which the ordering clinician conveys to the healthcare team the plan of care, whether it is a medication, a test, or an activity. Where the orders were once written with the doctors own hand, they are now typed directly into the record and carried out by the rest of the team. In emergency departments (EDs) that physical act is fundamental to the entire relationship of daily workflow, quality communication, and safety. The official term used in the healthcare for this process is Computer Physician Order Entry (CPOE). A concise definition of CPOE offered by the Oregon Health Science University Physician Order Entry Team (2011) is “a computer system that allows direct entry of medical orders by the person with the licensure and privileges to do so” (para. 3).

An analysis of the research literature and professional doctrines produced over the past decade is useful in order to look at a larger map of the course ahead as an Emergency Department launches into this phase of completing a fully implemented electronic medical record. The purpose of this paper is to analyze the experiences and recommendations of research in order to guide those making these institutional decisions about health information technology (HIT), a fundamental component to the future of medicine. Issues surrounding patient engagement, staff workflow, communication, and safety will each briefly be addressed, as they are reflected in the published research on CPOE implementation in emergency medicine.

**Research Methods**

In an effort to reflect on expert knowledge in the arena of health information technology, a unique research design was required to address a field that crosses boundaries between many disciplines. Nursing research in its infancy looked to other social sciences such as anthropology and psychology for legitimacy and interdisciplinary discovery. Research in the nursing literature such as Osborne (1969) as well as the anthropology literature such as Doughtery and Tripp-Reimer (1985) suggest a unique connection between anthropology and nursing and even reflect that nursing itself is a unique body of knowledge, tools, and approach to research of the human species.

As a nurse researcher and anthropologically trained participant observer, reflections on past experiences with electronic medical systems were recognized even as they inextricably drove initial expectations and hypotheses about this research topic. Although an expectation of a paucity of quality literature on the subject drove a bias against traditional literature searches early in the process, this bias then drove investigations into several new frontiers of electronic research that later informed the use of traditional database sources in a more focused manner.

As a first step, to gather the latest research and industrial changes, the Boolean phrase, “cpoe implementation emergency technology hardware” was used to create a search alert for any published work or patent application on Google Scholar (Google, 2012). Over the course of a year, email alerts were sorted into a cloud-based data file and organized with keyword tags such as “CPOE, HIT, ED, Telemedicine, EHR, HIE, mHealth (mobile health), Primary Care, Policy, and Staffing.” Additionally, in order to assess up to date conversations concerning this topic, a twitter account was used to make connections with researchers, doctors, nurses, pre-hospital staff, administrators, information technology (IT) engineers, entrepreneurs, and policy makers. Additional media presentations on national and state public radio as well as live video streams from technology conferences further emphasized the importance and timeliness of the topic. By partaking in this ongoing social media conversation, by reflecting with co-workers about their experiences with technology in healthcare, and by using experiences as an anthropologist and nurse, after a search of CINAHL and PUBMED using key authors, keywords, and concepts led to the selection of a sample of relevant research articles with which to reflect on the available research on CPOE implementation in EDs and to address successes and pitfalls of the past in order to create better solutions for healthcare’s future.

**Results**

**Adoption Rates and Implications**

There have been a myriad of shifts in policy and medicine affecting the implementation of CPOE in the U.S. healthcare system (Rothenhaus, et al., 2009). A collection of studies have looked at adoption rates and to illustrate these in brief it is interesting to look at data from before and after implementation of the HITECH Act and American Recovery and Reinvestment Act (ARRA) of 2009 (The Office of the National Coordinator for Health Information Technology, 2012).

Prior to these changes, Cutler, Feldman, and Horwitz (2005) sought to highlight the need for greater incentives to push use of electronic medical records. In the early part of the last decade, they found that fewer than 5% of U.S. hospitals had fully implemented CPOE. Though not focusing on emergency medicine, this study used a previous survey from 2002-2003 of hospital progress on CPOE implementation and analyzed the variables between sites on barriers to successful change. They found large healthcare systems were more likely to have fully integrated EMRs and that government-funded health centers were more invested in HIT than smaller rural centers. At the time of the survey there was no financial incentive for infrastructure investments necessary to make such a major change to delivery and payment structures. Ohsfeldt et al. (2005) found rural and critical-access hospitals in particular could not handle the monetary burden. The 2009 ARRA has changed this with meaningful use and policy incentives that are still being implemented with the release of phase two of the meaningful use policies in fall of 2012 (The Office of the National Coordinator for Health Information Technology, 2012).

Despite the unknown effects of continued policy changes, Geisler, Schuur, and Pallin (2010) have shown that EMR use has increased regardless of and at the same time as government incentives. They found 46% of U.S. Emergency Departments had implemented at least a basic EMR by 2005. More than half of ED visits took place in a department with an electronic chart, by 2005-2006. At the same time, only 21% of EDs with EMRs used CPOE. Regional differences in adoption continued to exist with rural areas less likely than urban to use EMRs or CPOE. This larger study of hundreds of hospitals used retrospective data from the National Center for Health Statistics for their analysis. Geisler et al. concluded that variation in the definition of “meaningful use” affected their results and further studies and policies could affect financial incentives for implementation.

Landman, Bernstein, Hsiao, and Desai (2010) used the same 2006 National Hospital Ambulatory Medical Care Survey to retrospectively analyze EHR adoption with similar findings. It is still not known how any of these systems have actually affected patients. Future auditing and policy definitions will only be beneficial with careful research into intended and unintended consequences, cost-effectiveness, and actual rates of acquisition and adoption (Geisler, Schuur, & Pallin, 2010; Landman, Bernstein, Hsaio, & Desai, 2010).

Pallin, Sullivan, Espinola, Landman, and Camargo, Jr. (2011) also report increased adoption over the past decade with great variance noted state by state. There continues to be a major split between urban and rural but also generalized regional differences with the U.S. northeast seeing high levels of EMR and CPOE usage compared to the rural south. As one example, Massachusetts tripled its EMR use prior to any federal monetary incentives. Despite these incentives, less than 2% of U.S. hospital systems now have fully functional CPOE systems. Pallin et al.(2011)concluded that providers must be part of policy discussions moving forward for quality policy to be created and health implications to be studied. Given the low rates of adoption shown in these studies, any clinician or hospital system in the process of implementing a fully electronic medical record with CPOE should realize they are leading the way and carefully look at research on similar efforts in the past.

**Qualitative Research on Psychosocial Effects**

While both information technology and medicine are largely dependent on sound quantitative data for changes in practice, the human behavior and real-time aspects of these systemic changes must be addressed by looking at qualitative effects. Designing and implementing such major changes in clinical medicine delivery has the potential to illicit a wide range of emotions in the clinical staff itself. Nursing research on efficient care, improved care coordination, and patient safety can be used to increase acceptance, guide management, and aid in clinical information systems design and implementation. As far back as 1997, emergency nurses were both heralding the future of information technology in emergency medicine and recognizing the essential place nurses have in this change (Zimmerman, 1997). Kutney-Lee and Kelly (2011) found nurses who work in hospitals with even basic EMRs consistently report better patient safety and improved quality outcomes.

Several studies have looked at qualitative aspects of CPOE implementation (Ash, Sittig, Seshadri, Dykstra, Carpenter, & Stavri, 2005; Klauer, 2009). In their 2005 study of these emotional effects of CPOE implementation, Sittig, Krall, et al. documented the critical qualitative responses of clinicians as CPOE was implemented at their hospitals. Through individual interviews and focus groups, Sittig, Krall et al. (2005) found that negative responses and emotions were by far more prevalent than positive ones. Fear, anger, hostility, disgust, and even shame were used to describe physicians’ reactions to these software systems (Sittig, Krall, et al., 2005, p. 563). They found an intense need for positive feedback from system administrators and fellow clinicians, evidence that concerns were being heard and acted upon, and real-time positive feedback from the electronic record itself were essential for any successful implementation. They warn that implementation could utterly fail to be accepted by staff if system designers fail to recognize CPOE systems can cause these strong emotions.

Due to these findings, researchers went on in 2008 to conduct an open-ended survey of clinicians to address key successes and failures (Sittig, Ash, Guappone, Campbell, & Dykstra, 2008). Focusing on three separate hospital systems, the researchers created a tool for any clinician, chief information officer, or chief medical officer to “assess their organization's CPOE readiness, make the necessary mid-course corrections, and be prepared to deal with the currently identified unintended consequences of CPOE should they occur” (Sittig, Ash, et al., 2008, p. 8). They emphasize creating sound organizational change plans, preparing for unintended consequences, clinician involvement in choosing EMR systems, and hiring individuals able to traverse the knowledge and philosophical differences between information technology and clinical medicine. Sittig, Ash, et al. (2008) note that without intensive training and walkthrough sessions for all staff to both prepare for this major change and react to real-time challenges of patient care, the needs of both patients and clinicians will not be met. The authors also point out that at the time they published their findings at the three hospital systems, one had successfully implemented CPOE, one had made major changes and delays due to medication-related errors and general unhappiness with their new system, and one and delayed implementation indefinitely due to financial difficulties (Sittig, Ash, et al., 2008).

**Quantitative Research on Time and Workflow**

Effects of EMR and CPOE implementation at the point of care has yet to be studied in terms of long-term implications for patient health; however the real-time effects on clinical workflow have been studied for some time as electronic systems have entered regular use. Poissant, Pereira, Tamblyn and Kawasumi (2005) conducted a systematic review of literature on the impacts of electronic health records, focusing on time efficiency of both physicians and nurses. Using statistical analysis of 23 papers including randomized controlled trials, retrospective, and prospective studies, Poissant et al.(2005) analyzed how the software and hardware involved in implementation can change clinical workflow. Time and motion-capture technologies were used as well as observational research to gather data. They found that EMR implementation can actually increase the amount of time spent documenting, but that using bedside versus centrally located hardware can strongly influence this effect positively and negatively and in different ways for nurses versus physicians. Specifically they found bedside computers decrease documentation time for nurses but increased documentation time for physicians. They also found CPOE increased the amount of time physicians spent on the computer as much as 98.1% to even 328.6% in one study. It is not known how these time-efficiency findings affect patient care, but they certainly have an impact on nurse and physician satisfaction. Poissant et al. (2005) conclude that assessing the impacts of EMR and CPOE on all work processes such as communication effectiveness as measured by patient outcomes could more effectively work as an incentive for clinicians to accept CPOE and become directly involved in its successful implementation and use.

Turning from system-wide analyses to ED specific research, CPOE and its related clinical decision-support software (CDSS) was also heralded by Handler et al. (2004) as a potential for improved care in emergency medicine; but they also cautioned the ED clinicians must be involved in critical systems decisions and designs. Handler et al. (2004) heralded EMRs and CPOE introduction as a “watershed moment” in emergency medicine but urged further study of clinical outcomes and implementation efforts to guide the use of HIT in the future (p. 1139).

Asaro and Boxerman (2008) conducted a workflow and time-motion study of nurses and physicians before and after CPOE implementation at Barnes-Jewish Hospital in St. Louis, MO. Previously the hospital had an integrated emergency department information system (EDIS) with functionality including electronic tracking board, triage documentation, physician discharge documentation, laboratory, radiology, and registration integration, and full nursing documentation. Physician documentation remained on paper. The study looked at the changes as CPOE was implemented on physician and nursing tasks and communication. Specifically Asaro and Boxerman (2008) tracked changes in the amount of time spent working with paper versus computer, time interacting between staff, and time interacting with patients before and after CPOE. They found nurses increased their time on computers from 9.5% to 25.7% but offset this with less time spent working with paper from 16.5% to 1.8%. This had a net result of a minimal decrease in time nurses spent with patients from 56.9% to 55.3%. For physicans it was a much different situation. Doctors increased their time on the computer from 30.0% to 38.9% and had a shift in time spent with patients that approached statistical significance from 36.8% to 29.1%. Asaro and Boxerman (2008) found that physicians spent more time retrieving and entering information to and from the EMR and less time communicating directly with nurses and patients; a clinican would monitor patient progress via their computer rather than by physical assessment or verbal interaction. This differed somewhat from results found by Yen et al.(2009) in their study of workflow in a pediatric emergency department, finding that physician and nurse time with patients did not change, but verbal communication between staff decreased. Some of this effect can certainly be due to communications being conducted electronically through standard order sets and careplans rather than in verbal or written format. However, any implementation of CPOE must recognize that strong communication between staff members in whatever format is essential to safe and accountable care.

**CPOE Effects on Clinical Outcomes**

Although there are many research presentations and consensus statements on CPOE implementation (The Menucha Conference Center, 2001; Ash, Fournier, Stavri, & Dykstra, 2003; Ash, Stavri, & Kuperman, 2003; Rothenhaus T. C., 2009) and there have been systemic reviews of the effects of CPOE and CDSS on practitioner performance and patient outcomes across healthcare systems (Garg et al., 2005), the real test for ED nurses and clinicians is when the patient comes through the front door of the department in distress.

Studies on CPOE implementation on care of chest pain patients offer an exemplar of these effects as well as implications for future practice (Asaro, Sheldahl, & Char, 2006; Adam, Waitman, Jones, & Aronsky, 2011). CPOE has been found to provide better documentation of orders and timely care for these patients as well as reduced ED length of stay (Adam, Waitman, Jones, & Aronsky, 2011). Laboratory and diagnostic study turn-around times have not been significantly affected. Moreover, adherence to clinical guidelines for acute coronary syndrome did not improve with CPOE implementation (Asaro, Sheldahl, & Char, 2006). Researchers suggest that although CDSS may aid in critical timing, patient-specific needs may not be addressed with rigid computer-generated order sets (Asaro, Sheldahl, & Char, 2006). Although CPOE offers the potential for new levels of safety to patient care, the fine-tuning of software design as well as clinician use will actually decide the cost and benefits for patient health outcomes.

**To Err with a Computer**

Although the famous IOM report in 1999 called for electronic medical records to reduce the burden of medical errors in the healthcare system, the introduction of computers in the daily care of patients has introduced new challenges as it solved others. A disquieting example from Han et al*.* in *Pediatrics* (2005) showed an increase in pediatric mortality after the implementation of CPOE in an emergency department at Children’s Hospital in Pittsburgh. Over 18 months, almost 2000 patients were tracked through the department with mortality increasing from 2.80% to 6.57% after CPOE implementation. Despite increased monitoring of medication calculations with electronic records, children requiring time-sensitive care had statistically poorer outcomes due to a slowing of workflow related to the new charting system. Koppel et al. (2005) echoes this finding in a study by in which a retrospective analysis at a major urban tertiary-care teaching hospital found that CPOE implementation had facilitated medication error risks.

Sittig and Singh (2011) elucidate nine types of clinical errors that can result from EMR and CPOE usage. From hardware and software malfunctions and human-computer interface errors to problems with clinical content and effects on workflow, there are profound effects from the rapid introduction of HIT. Erroneous or missing data can lead to adverse effects and unnecessary costs. Sittig and Singh (2011) suggest that the research literature is only beginning to define these new types of errors, track them, and offer solutions.

Van Scoter’s (2011) dissertation on the successful implementation of electronic systems in large organizations uses an industrial engineering approach to understanding the critical success factors in undertaking these types of major changes to complex systems. Van Scoter illustrates that identifying key people, training all staff, leadership from high in the organizational structure, IT software with strong interoperability as well as modularity, and open-communications are key to staff acceptance of change and successful software implementation. This research differed from much of the clinical outcome and workflow research already mentioned by specifically interviewing the project managers involved in past EHR software launches. Much like the CPOE implementation studies from more than a decade ago, Van Scoter’s (2011) research emphasizes that super-users and key individuals can make or break a project on launch.

**Discussion**

**Implications for Policy**

So where does this body of research level nursing, physician, and administrative leaders as they plan for CPOE implementation in their ED? In their paper on strategic considerations for implementation, Stone and Yoder (2012) offer critical information for clinicians as they interact with EMR vendors and support staff. Clinicians must address interoperability with other clinical information systems, training of staff, data storage, reporting tools, effects on workflow, and methods for addressing roadblocks and unforeseen events both during the acquisition of a EMR and CPOE systems and over the course of the months and years following implementation (Stone & Yoder, 2012). Meaningful use may be defined by government regulation, some yet to be written, but in order to result in meaningful outcomes, clinicians at the point of care must be continuously involved in the assessment and alterations of the electronic record.

One of the key pieces of an electronic medical record under these new meaningful use criteria, according to the Department of Health and Homeland Security’s latest policy statements, is the creation and use of continuity of care documents (CCD) (The Office of the National Coordinator for Health Information Technology, 2012). These electronic data files are essential lists of patient demographics, problem lists, allergies, current medications, and diagnostic test results. A healthcare system must be able to both receive and transmit this basic information electronically in order to fulfill meaningful use requirements. The infrastructure to maintain this information has already led to the formation of health information exchanges (HIE) in various regions of the country that will allow providers in various practice settings to quickly and accurately obtain and share patient information (The Office of the National Coordinator for Health Information Technology, 2012). Both the access and use, as well as the maintenance of this information, will in the future be a major task of clinicians, nurses, case managers and other allied health personnel in all settings. The ability to quickly access this information on patients both arriving and leaving the emergency room has the potential to drastically change the provision of care.

**Implication for Nursing Practice**

In the IOM report *The Future of Nursing: Leading Change, Advancing Health* (2011) it is recognized that every aspect of nursing practice will be influenced by HIT to such a level that “all facets of care will be mediated increasingly by digital workflow, computerized knowledge management, and decision support” (p. 140). Specifically, the report calls for nurses to be integrally involved in the design, planning, and implementation of technologies used at the bedside. The report suggests that although nurses represent the largest segment of the healthcare workforce and often spend the greatest percentage of time with both patients and technologies, they are rarely asked for their input on the these major systemic changes. In their 2005 editorial in *JAMA*, Wears and Berg suggest the challenges to EMR and CPOE implementation are caused by a failure of organizations to recognize that technical solutions to systemic healthcare problems overlook social aspects of the provision of care. Wears and Berg (2005) point out “social and technical elements are deeply interdependent and interrelated—hence, the term *sociotechnical systems*” (p. 1262). Lack of recognition of this dual aspect of CPOE implementation is at the heart of organizations failing to listen to front-line staff as organizational changes are made. When sociotechnical systems are not tailored to the patients, workers, and their environments, these systems will not be productive, will create real frustrations for staff, and pose potential dangers for patients.

Amazing advances in HIT over the past decade and into the next will fundamentally change the workflow of both nurses and physicians. These new technologies will cause some previous clinician tasks to be completed by computer systems, some tasks to be delegated to assistive personnel, and new tasks to be created in the realms of clinical decision-making and case management. These changes in workflow will be informed by telepresence, biometrics, psychometrics, and other data captured and reported by the HIT infrastructure itself. This shift will continue the transition and growth of the role of advanced practice nurses (APRNs) throughout the US healthcare system (IOM, 2011). Working both in primary and acute care, APRNs will use their expert knowledge in the sociotechnical aspects of healthcare provision to chart the future course of medicine.

**Conclusion**

Study after study has emphasized clinicians must expect the unexpected when implementing CPOE, something that emergency medical staff are quite adept at doing in their everyday lives already. The rapid pace of new technologies including handheld computers, tablets, smartphones, electronic activity monitors, bedside lab testing, computer-aided decision-support software, genetic testing, and telemedicine, just to name a few, will profoundly effect the future of emergency medicine. Regardless of these advances, electronic health records will not necessarily improve patient care unless the paper and verbal based communications systems they seek to replace are sound to begin with. CPOE and EMR have the potential to make the same errors that presently confound the U.S. healthcare system simply happen with greater speed and efficiency.

Hospital administrators, Chief Nursing Officers, Chief Information Officers, Emergency Department Chiefs, Nurse Managers, Charge Nurses as well as software and hardware vendors must create sound yet flexible strategic plans for successful implementation of CPOE in the ED. A concerted effort must be made to identify key players in the process as well as hire individuals with the ability to bridge the gap between the multitudes of disciplines that will be involved in this major systemic change. These key players must work together to create a common language and definitions of terms in order to, not only ensure they are literally speaking the same language, but to clarify future communications with the rest of the ED staff as CPOE roll-out occurs. Present systems must be carefully evaluated and workflows of nurses and physicians literally mapped in order to accurately evaluate the effects of implementation. EMR and CPOE systems, both software and hardware, must be chosen based on interoperability with outside systems as well as modularity to address the introduction of unforeseen new technologies in the coming years. Meaningful clinical decision support software and care plans must be formed, but in a way that allows for individual clinician and patient needs to be met at the same time that safe and timely care is delivered. It must be recognized that CPOE implementation will slow workflow at least temporarily and will change workflow permanently. An emergency medicine CPOE system must be designed and implemented with the ability to return to paper charts and verbal communication at a moments notice due to technological system downtimes or mass-casualty incidents. Most importantly, healthcare leaders must work to create sound communication structures to address patient, nurse, and clinician concerns in a timely fashion.

Since ancient time, caregivers have sought to create historical records of a patient’s life and the care provided to them over a course of an illness, a clinical map or chart. But as digital systems enter every aspect of healthcare, nurses, doctors, researchers, HIT engineers, and administrators would be wise to heed the dictum of scientist and philosopher Alfred Korzybski at the 1931 meeting of the American Association for the Advancement of Science, “the map is not the territory” (2012, para. 2).

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