View metadata, citation and similar papers at core.ac.uk

brought to you by CORE

provided by CSUSB ScholarWorks

Communications of the IIMA

Volume 13 | Issue 3 Article 5

2013

A Clinician's Report of the Unintended Consequences of Electronic Health Records

Trevor Rohm

Medical Director, Foard County Rural Health Clinic

Follow this and additional works at: http://scholarworks.lib.csusb.edu/ciima

Recommended Citation

Rohm, Trevor (2013) "A Clinician's Report of the Unintended Consequences of Electronic Health Records," *Communications of the IIMA*: Vol. 13: Iss. 3, Article 5.

Available at: http://scholarworks.lib.csusb.edu/ciima/vol13/iss3/5

This Article is brought to you for free and open access by CSUSB ScholarWorks. It has been accepted for inclusion in Communications of the IIMA by an authorized administrator of CSUSB ScholarWorks. For more information, please contact scholarworks@csusb.edu.

A Clinician's Report of the Unintended Consequences of Electronic Health Records

Trevor Rohm, MD, MS
Medical Director, Foard County Rural Health Clinic
Medical Director Emergency Department, Hardeman County Memorial Hospital Chief Information Officer, Hardeman County Medical Group
trevorrohm@yahoo.com

ABSTRACT

Electronic health records (EHRs) are complex. Clinicians must interact with patient data, order entry, decision support, reporting services, messaging programs, administrative data, and many other services. These services require user input and decision making, known as user interactions, between clinician and the EHR. EHRs have features designed to facilitate users' interactions, such as alerts, reminders, keyboard shortcuts, and mouse click menus. These features can lead to unintended consequences, which combine with user interactions, thus making the EHR complicated and difficult to use. Awareness of user interactions and the unintended consequences will improve EHR design and lead to greater clinician acceptance of EHRs.

INTRODUCTION

The future of patient charts and information is in the electronic health record (EHR). The world of EHRs is upon us all. Just because we switch from paper to electronic records does not mean it is without its' mishaps. There are a number of things that have changed with electronic implementation of paper charts. Paper charts are a repository of patient information. Clerical, administrative, scheduling, billing, and messaging are not found in paper charts. The advent of the electronic chart frees data from isolated sections, allowing them to be combined into one single chart, the EHR, which not only encompasses patient data, but a myriad of other services that are not always familiar to the clinician.

The EHR enables patient data to be combined with other services, thus making it a complete record of the patient. The EHR can contain clerical, administrative, billing and ancillary service information. Labs, x-ray, and diagnostic services can all be included. One of the main benefits of the EHR is a messaging system, where clinicians involved with the patient can be contacted simply by using the integrated messaging system. Clinical decision support (CDS) allows best practice recommendations to be fully integrated with the individual patient, with alerts, reminders and individually tailored recommendations made to clinicians These new services make the transition from a single patient chart to electronic records conceptually difficult for clinicians. Shifting from isolated patient data to a fully-integrated, complex, electronic records system can be difficult to comprehend for technology un-savvy clinicians. Not only

does the basic model of a patient chart become fully integrated into other services, but the move from paper to electronic is—in and of itself—difficult as well.

A basic understanding of the conceptual (chart) changes is necessary to understand why there are so many unintended consequences when an EHR is designed and implemented. I want to offer a view of the most common unintended consequences found in EHR design. They are divided into two categories, those that are directly related to the EHR and those that are indirectly related to the EHR. These consequences are events that occur as a direct result of EHR features that were originally designed to augment and supplement the EHR, but instead have led to events, such as:

- Alert fatigue
- Click frustration
- Keyboard chaos
- Mouse madness
- Guessing game (aka Synonyms)
- Connect-the-dots

There are also a number of system issues that are indirectly related to the EHR; nonetheless, they also lead to unintended consequences, for example:

- Security time-outs
- Password nonsense
- Clerking
- Information overload
- Visual cues

While there are many types of unintended consequences, the focus of this article will be on the direct and indirect items mentioned. Knowing why these events occur can lead to a better understanding as to why clinicians do not always readily embrace the EHR. Unintended consequences can be found in every facet of the EHR, from administrative and billing, to patient care and ancillary services, this article is written from the clinician's perspective. The main point is that the basic underlying conceptual model of a patient chart has changed to fit into the EHR, thus changing how medicine is practiced by clinicians. A change to how medicine is practiced is/was never the intention of the EHR, but it is nonetheless an unintended consequence of the change.

CONCEPTUAL MODEL

A conceptual model is a mapping of an idea or concept, which is used to understand a complete project prior to development. Software engineers use conceptual models to build and design programs and to understand what problems may arise during project development and implementation. Without a conceptual understanding, the software engineers cannot design the project to meet the specified requirements. A conceptual model is a well-defined map of the system requirements, in a graphical form, which allows project developers to determine all possible combinations of input and output. In the EHR, a conceptual model defines the scope and abilities; for example, an EHR that allows prescription writing would need to define types

of medications, such as oral, intravenous, and/or intramuscular. If the system does not allow for intranasal medication administration, then the EHR would not allow clinicians to prescribe a medication intra-nasally, even if they wanted to. A conceptual mapping and defining what the system capabilities are - is the conceptual model.

There are fundamental conceptual differences between paper patient charts and EHRs. These differences occur because EHRs are not an electronic version of paper charts. EHRs are more complex. While paper charts serve as a repository for patient data, such as clinician notes, EHRs bring together a variety of services into one location, making it more conceptually complex.

Paper Charts

Paper charts are a surrogate representation for the patient. These charts have historically been used to capture patient data and are found in every medical setting: clinics, hospitals and emergency departments. There are two main sections in every paper chart: an administrative section and a patient information section. The administrative section contains copies of referrals, lab and x-ray reports, and any other paper item that relates to the patient. The patient information section contains a problem list, medication list, allergy list, and clinician notes. Paper charts do not contain information related to patient demographics, insurance, or scheduling, nor do they provide for ordering labs or x-rays, writing prescriptions, or making referrals. These services are available through other means, such as a nurse.

Paper charts are conceptually very simple. Clinicians have a sheet of paper and can make a note in whatever form they deem necessary; for example, sketching a simple drawing of the location of pain can be more informative than a lengthy, wordy description. A clinician is not limited by, nor constrained to, a particular conceptual model. A note can be made in a list format, in a simple standard history and physical format, or in a standard clinic note format, known as SOAP notes. SOAP is an acronym for the four parts of a clinic note: the subjective, objective, assessment and plan. This standard format is universally taught and is culturally the format of all clinic notes. Within these sections, clinicians can freely document and manipulate information in any order or at any time. There are no constraints as to the order or processing of patient data.

Electronic Medical Records

EHRs are not just an electronic format of the paper chart but rather a suite of tools that combine with patient data. A single electronic chart (theoretically) spans multiple clinics, hospitals and emergency departments. There are not multiple copies of the same information stored at various locations. The EHR offers administrative services, demographic information, scheduling, messaging systems, reporting, image viewing, prescription writing, and clinician notes. By ordering labs and x-rays, the clinician now has total control of the patient, care of the patient, results, billing and data. The fundamental concept of a chart has now changed, from patient data to patient management - all combined in a single system/user interface/EHR. The electronic version of the paper chart has now become a single entity within the EHR.

Conceptual Differences

The EHR is much more that patient data. It is more than a surrogate representation of the patient. It has become a multi-purpose tool for managing patients and managing patient data (Shortliffe & Cimino, 2006). There is a fundamental paradigm shift in how the patient is managed. With paper charts, administrative services were managed by support staff, such as nurses, medical assistants and clerical staff. They would fill out paperwork, communicate with patients and other clinics, and schedule appointments. While these services are still available in the EHR, they are now combined with the patient data into one location, known as the EHR.

The basic conceptual model of the patient chart has changed. The EHR conceptual model is now a complete suite of tools for patient care, and not just a patient data repository.

DIRECT UNINTENDED CONSEQUENCES

By changing the underlying conceptual model of patient data, there arise some unintended consequences. Unintended consequences occur because complex interactions are difficult to predict when combining the EHR with clinical data (Ash, Sittig, Dykstrab, Guapponea, Carpenter, & Seshadri, 2007; Ko et al., 2007). These unintended consequences where not designed as part of the EHR, rather they are series of features that were not well planned or executed during the EHR development and implementation (Staren & Eckes, 2009).

Alert Fatigue

Alerts and reminders are beneficial for EHR use. One benefit of the EHR is the ability to offer clinical decision support (CDS). CDS reminds clinicians about recommendations and alerts them to possible medication reactions or allergy reaction (Varonen, Kortteisto, & Kaila, 2008). The EHR offers an automated alert/reminder system that constantly displays a prompt whenever a potential alert or reminder is needed (Vashitz et al., 2008). There are times when the automated reminder system can be overbearing causing the clinicians to become desensitized to the alerts and reminders. This renders them useless, as the alerts and reminders are ignored. This is known as alert fatigue (Overhage, Tierney, Zhou, & McDonald, 1997).

Alert fatigue has been well documented as an unintended consequence of EHR design and implementation (Steele et al., 2005; van der Sijs, Aarts, van Gelder, Berg, & Vulto, 2008; Weingart et al., 2003). While it is necessary to have alerts and reminders, burdening clinicians with unnecessary information leads to the opposite effect. Instead of alerts and reminders being used as tools to improve patient care, they are ignored and forgotten (van der Sijs, Aarts, Vulto, & Berg, 2006). There is a threshold and balance between too many alerts and reminders and not enough (Weingart et al., 2003). Where this threshold lies is still undetermined. There are many things that can be improved upon (Shah et al, 2006).

Click Frustration

Click frustration is an unintended consequence of complex EHR interaction. Click frustration has been previously defined as overuse of the mouse button click Rohm, (2009). When clinicians must constantly click, it can become cumbersome. When EHRs use point and click documentation, the mouse becomes the major input device. While mouse driven input is standard, the amount and number of clicks can be overwhelming and frustrate clinicians. The overuse of mouse input leads to click frustration. For example, in one EHR system, it takes 18 different mouse clicks to refill one medication. Instead of simplifying and improving the documentation process, the mouse click has become burdensome, thus leading to click frustration.

Keyboard Chaos

The keyboard is the major EHR input device. Speed is key to EHR input. Keyboard shortcuts improve input times for data. However, misuse of shortcuts can lead to opposite intentions and unintended consequences. Clinician interactions with the keyboard can be chaotic. Keyboard shortcuts such as Alt-tab, Windows key-E, F2, and F9, all have meaning for super-users of some programs, but for clinicians, such shortcuts are meaningless and confusing. Requiring a clinician to learn that F9 key will close a section and progress to the next is not helpful. When you combine multiple shortcuts, the keyboard no longer becomes an input device, rather a cluster of keys that produce chaotic results. This is known as keyboard chaos. Standard keyboard input should be just that—standard.

Mouse Madness

Standard point and click technology can cause mouse madness. Mouse madness results from changing standard mouse features by developing new features that are non-standard. Take, for example, right clicking the mouse button to get to a menu. This seems standard enough, if you have a right mouse button! Many EHR systems use the mouse clicks to enter input. Standard user interface design uses the left mouse click for input selection but the right mouse button is often used also. Some computers only have one mouse button, such as Apple computers. Many handheld devices do not have mouse buttons. When EHRs use the right mouse button for menu selection and input control, they have employed non-standard input features into a system that is already complex, leading to the unintended consequence of mouse madness.

Guessing Game (aka Synonyms)

Many EHRs included synonyms. The purpose of the synonym is to facilitate ordering of medications, labs and x-rays. Synonyms are supposed to make ordering a much easier task, but this is not always the case. A common order is the chest x-ray, completed every day in every EHR system. Instead of having to type "chest x ray," things are much more complicated. Some chest x-rays are taken from the patient's front to back, others from back to front, which defines the way the patient is positioned for the x-ray. Some chest x-rays are portable, which entails bringing the x-ray machine to the patient if the patient is too sick to transport.

Therefore, the phrase "chest x ray" can mean many things. It is important that the order be completed correctly, so synonyms can be helpful to facilitate that process.

The most common chest x-ray is the chest x-ray series, where one image of the patient is taken from the patient's back, known as PA (posterior to anterior). The series also includes a sideways (or lateral) view of the patient. Therefore, when a clinician orders "chest x-ray," what is meant is the standard chest x-ray series (PA and Lateral views). If a clinician wants an anterior to posterior (AP) view, or a portable view, those are not standard and must be explicitly ordered as such. So now the dilemma begins, how can synonyms help simplify the ordering process in the EHR.

The chest x-ray order, while a simple concept, can be very difficult to implement. A chest x-ray can have many synonyms: see Table 1.

chest x ray	chest x ray posterior-anterior and lateral	x-ray chest	cxr pa and lateral
chest x-ray	chest x-ray posterior-anterior and lateral	x ray chest	cxr lateral and pa
chest xr	chest x ray posterior-anterior and lateral	xr chest	cxr pa and lat
chest xray	chest x ray pa and lateral	xr chest posterior-anterior and lateral	cxr pa/lat
chest xray pa/lat	chest xr posterior-anterior and lateral	xr chest posterior-anterior and lat	cxr pa lat
chest x-ray pa/lat	chest xr pa/lat	xr chest pa and lateral	cxr pa & lat
chest x ray pa/lat	chest xr pa and lat	xr chest pa/lat	cxr

Table 1: Synonyms for Chest X-Ray.

There are a number of synonyms, but they all mean the same test, a standard chest x-ray series with PA and Lateral images. This is known to clinicians, as a "chest x-ray" or "CXR." Now the guessing game begins. Is there a hyphen? Abbreviations? Do you use the "/" or the "&" or write out the word "and"? Which of these synonyms will map to CXR? All of them should, they all mean the same thing. If a clinician were to order any of these in a paper chart or paper order, they would all be ordered as a standard chest x-ray series. However, the EHR is more complicated because a preconceived conceptual model is being forced on clinicians, who have to guess by trial and error. While a simple chest x-ray can be complicated to order, the complexity of the ordering process and implementation is exponential, especially when considering that clinicians agree that it means a chest x-ray series with a PA and Lateral view of the chest.

To expound the guessing game, let's consider lab orders. A simple blood count, known as a complete blood count or CBC, is a set of labs that includes white blood cell count, red blood cell count, hemoglobin and hematocrit. This test sometimes comes with additional labs, known as a "differential," which indicates which type of cells are present. The CBC can be with a differential or without. A clinician must specify when ordering which of the CBC test is needed. This can be complicated. First, the clinician must know which test is the default. Some facilities always order CBC tests with differentials—some facilities do not. So if a differential test is wanted, but not standard at the facility, the clinician must know before ordering the test what is the standard for that facility. While this seems simple enough, what happens when the clinician must know the standards for a chemistry panel, coagulation

panel, viral swabs, throat swabs, wound cultures, liver function tests, lipase, and even complicated rheumatologic panels?

Even more complicates is how is the clinician to know the synonym for each test, the correct blood tube, special instructions for drawing the blood (such as time constraints), and the standards for any given facility? Not possible. The problem now presents itself, for implementation of the order, the lab technician must correctly draw the patient's blood using the correct blood collection tube and special any instructions. Lab technicians receive special instructions and training, which is why they are lab technicians. They know the standard tests and are well versed in what the clinician orders.

Synonyms can help to simplify the ordering process if implemented correctly. To implement a synonym function, all possible combinations of words and abbreviations need to be made available to clinicians. If we return to our chest x-ray example, a standard order would be "chest x-ray," but if the orders are all mapped as x-ray chest, or xr chest, or x ray chest, then the guessing game begins. The clinician must guess for every x-ray order the correct abbreviation and remember what the order maps to. The guessing game then spreads the entire ordering system: labs, x-rays, nurse orders, and medications. Once an order is guessed correctly, assume that the clinician learns it for the next time, and after time, the clinician will be trained in the constrained conceptual model provided by the EHR.

Connect-the-Dots

Program flow control is a conceptual necessity. The ability to follow clinician thought processes is important. If an EHR does not follow standard clinical documentation processes, then the documentation flow changes and becomes difficult to follow. Clinicians use a standard format for clinic notes, known as the SOAP format. EHRs are not designed in this format. They follow very rigid flow controls, whereas on paper, a clinician can manipulate any section at any time. However, in an EHR, flow control is locked into a single flow system, a synchronous input mechanism. Moving between sections can require extra work and time. On paper, the ability to manipulate data is simple, on one page, and moving between sections is quick.

Trying to follow the EHR flow control is a lot like "connecting the dots." You have to know where to go. If you go the wrong way, you will never make it to the correct end result, like a completed patient note. Take, for example, moving from the patient note to the order section. On paper, the orders are normally located at the bottom of the note. The nurse or medical assistant will complete the order. In the EHR, the clinician must move from the note section to the order section, play the synonym game, sign and complete the orders. The clinician has now has to know how to maneuver the EHR, complete the tasks that were previously assigned to the nurse or medical assistant, and then complete the EHR charting. Flow control should be simple and easily learned, not a puzzle to be solved by connecting the dots.

INDIRECT UNINTENDED CONSEQUENCES

Indirect unintended consequences are a result of poor system implementation and interactions. These events occur as a result of the EHR interaction with other services. When the patient's paper chart becomes electronic, some basic usability issues arise. These events are not from the EHR itself, rather usability issues with the interactions of the patient chart in an electronic format.

Security Time-outs

EHR security features can cause unintended consequences. Patient data privacy is extremely important and the ability to protect that data in a clinical setting can be difficult. There are multiple entry points into a patient chart: administrative, clerical, nursing, ancillary services, and physician. While every individual user must have a login account, the person's is not fixed to one terminal/workstation. For example, a clinician may use the computer in the office or the exam room to review patient information. Shared computers, such as in a hospital workroom allows multiple users access. Protecting patient data in a shared environment can be difficult. Most EHR systems have security time-out features, which automatically log out of the system when idle for a predetermined amount of time. This feature is useful in a shared environment, for example, in a hospital workroom where clinicians and nurses share a workstation. If someone forgets to logoff, the system automatically logs off the workstation to prevent unauthorized access to patient data. In a clinic setting, where there is one workstation to every clinician, then a time-out feature becomes burdensome, time consuming and an unintended consequence that should be rectified.

Password Nonsense

Patient data should always be provided over a secure network. The EHR is a program within the security of the network. Network security can have many aspects, such as physical security, usernames, passwords, encrypted data, firewalls, internet security, and anti-virus protection. All of these features function together to provide a secure network for patient data. While network security is necessary, the implementation can drastically change and alter user interactions. Take, for example, password implementation. A "strong" password is always desirable. Strong passwords are difficult to guess. They contain both upper and lowercase letters. They also contain characters, such as !,@,#,$,%, and/or they contain numbers. Strong passwords make it difficult for others to guess the password to gain access to the network.

While security features are necessary, the nonsense that accompanies password selection is not helpful for usability. Examine any basic EHR network system. There is usually a username for the computer, a username for email, a username for the EHR, a username for the lab program, a username for the radiology system, and usernames for any other online tools. While the same restrictions that apply to passwords are not the same as usernames, each username has a different password. Standard network systems require a new password every 3 months. Therefore, while I can have the same username for the computer login, EHR, radiology and labs, the passwords are rotating to change every 3 months, which is password nonsense. For example, if there are four different passwords that need to be changed four times a year,

that is 16 different passwords every year for each clinician. While this is true nonsense, there is a simple solution. The single sign-on feature that is available is an attempt to eliminate the password nonsense. However, it is not universally implemented since many networks, EHRs, and radiology systems are not yet communicating with each other and separate passwords are necessary.

Clerking

Patient data needs to be input into the EHR. There are only a few ways to input data, by either keyboard, mouse, transcription or scanning. Each method has its appropriate use. Transcription and scanning of data require additional resources that are not included in most EHRs. Mouse and keyboard input functions could be complex when dealing with any system. The problem with mouse and keyboard input is that it is user dependent. If a clinician cannot type, then a keyboard is not a great input device. If a clinician is not computer savvy, then the mouse is not a great input device. Clinicians become data entry clerks when using the keyboard and mouse for any significant amount of time. A data entry clerk is a person who has no other function than to enter data. "Clerking" is the term used to describe what clinicians do when entering data into the EHR. When an EHR becomes the center of the patient visit and more time is spent with the program than the patient, data entry becomes the most important aspect of the EHR. To get patient data, clinicians act as data entry clerks, clicking, typing and entering data, not caring for patients. Clerking can also be a financial disaster. Typically, clinicians are higher wage earners than are data entry clerks; but with the unintended consequence of clerking, the highest wage earners are now doing the work of lower wage earners. An ideal EHR would be to eliminate clerking.

Information Overload

A glance at any EHR can be overwhelming. Wrapped into the system are patient data, administrative, clerical, nursing, billing, medications, and ancillary services. Imagine all of these services in a paper chart - the chart would be unmanageable. The ability to organize and manipulate large volumes of data is beneficial for the EHR. The organization and visual display of these services prevents information overload. Information overload occurs when large quantities of information are poorly displayed on the same screenshot. There is always a standard file menu at the top of the EHR. There is usually a menu bar on the left hand side of the screen. The menu bar is usually complete with patient data. The center workspace can have any number of patient data, input variables, or other readily available information. When combined, the menus and workspace can become overbearing.

The ability to display all menus and information does not make it necessary to do so. Not all information is created equal. Some pieces of information are more important than are others. For example, a patient allergy is extremely important because there is a potential to kill a patient with the wrong medication. However, a list of 25 medications, 35 problems and 75 labs and x-ray reports do not all need to be in the same screen shot as the allergy medication. Information can be displayed in a visual manner that is meaningful and helpful for clinicians. Otherwise, it leads to the unintended consequence of information overload, where important

information is lost. The EHR has unlimited design potential and important information can remain important when presented in a visually useful manner.

Visual Cues

It can be difficult to distinguish information in an EHR if the visual display is always the same. Similar to how red or blue ink is used to highlight important information in paper charts, colors and visual cues can help to distinguish important information in the EHR. Visual cues can include color schemes, size and shape of fonts, highlights, location of information placement, and hints for user inputs. Simplicity makes the best EHR. Standard formatting techniques are required for good usability, such as a red star or red color for mandatory or required information. Maintaining the location of menus and workspace keeps things in a familiar format. Visual cues are an unintended consequence that can be eliminated with good planning.

CONCLUSIONS

Unintended consequences are a result of EHR features, which are conceptually different from paper charts. The EHR contains an assortment of services that centralize the management of the patient. A centralized patient management system allows for patient data, administrative services, clerical services, nursing, billing, messaging services, medications, and orders to be combined for improved patient quality of care in an electronic format.

There are a number of conceptual differences between paper and electronic medical records. Those differences are often lost in EHR design and implementation, making it difficult to link preconceived knowledge from paper charts to the new EHR charts. Paper charts were limited to information related to health matters only, not administrative data. The advent of the EHR made changes to the conceptual model of medical chart. These changes lead to the direct and indirect unintended consequences of the EHR, which can impede clinician use and acceptance of the EHR. Understanding the unintended consequences is important to improve EHR design, and eliminate the barriers to clinician acceptance.

REFERENCES

Ash, J. S., Sittig, D. F., Dykstra, R. H., Guappone, K., Carpenter, J. D., & Seshadri, V. (2007). Categorizing the unintended sociotechnical consequences of computerized provider order entry. *International Journal of Medical Informatics*, 76, S21-S27.

Ko, Y., Abarca, J., Malone, D. C., Dare, D. C., Geraets, D., Houranieh, A., . . . Wilhardt. M. (2007). Practitioners' views on computerized drug-drug interaction alerts in the VA system. *Journal of the American Medical Informatics Association, 14*(1), 56-64.

Overhage, J. M., Tierney, W. M., Zhou, X. H., & McDonald, C. J. (1997). A randomized trial of "corollary orders" to prevent errors of omission. *Journal of the American Medical Informatics Association, 4*(5), 364-375.

Rohm, T. (2009, February 19). *Click frustration*. Retrieved October 12, 2010, from http://www.clinfowiki.org/wiki/index.php/Click_frustration.

Shah, N. R., Seger, A. C., Seger, D. L., Fiskio, J. M., Kuperman, G. J, Blumenfeld, B., . . . Gandhi, T. K. (2006). Improving acceptance of computerized prescribing alerts in ambulatory care. *Journal of the American Medical Informatics Association, 13*(1), 5-11.

Shortliffe, E. H., & Cimino, J. J. (Eds.). (2006). Biomedical informatics: Computer applications in health care and biomedicine (3rd ed.). New York, NY: Springer Science + Business Media.

Staren, E. D., & Eckes, C. A. (2009, October 1). Continuous quality improvement: The 'unintended' consequence of EHR implementation. *Healthcare IT News.* Retrieved October 2, 2010, from http://healthcareitnews.com/blog/continuous-quality-improvement-unintended- consequence-ehr-implementation

Steele, A. W., Eisert, S., Witter, J., Lyons, P., Jones, M. A., Gabow, P., & Ortiz, E. (2005). The effect of automated alerts on provider ordering behavior in an outpatient setting. *PLoS Medicine,* 2(9), e255.

van der Sijs, H., Aarts, J., van Gelder, T., Berg, M., & Vulto, A. (2008). Turning off frequently overridden drug alerts: Limited opportunities for doing it safely. *Journal of the American Medical Informatics Association, 15*(4), 439-48.

van der Sijs, H., Aarts, J., Vulto, A., & Berg, M. (2006). Overriding of drug safety alerts in computerized physician order entry. *Journal of the American Medical Informatics Association,* 13, 138-147.

Varonen, H., Kortteisto, T., & Kaila, M. (2008). What may help or hinder the implementation of computerized decision support systems (CDSSs): A focus group study with physicians. *Family Practice, 25*(3), 162-7.

Vashitz, G., Meyer, J., Parmet, Y., Peleg, R., Goldfarb, D., Porath, A, & Gilutz, H. (2008). Defining and measuring physicians' responses to clinical reminders. *Journal of Biomedical Informatics, 42*(2), 317-326.

Weingart, S. N, Toth, M., Sands, D. Z., Aronson, M. D., Davis, R. B., & Phillips, R. S. (2003). Physicians' decisions to override computerized drug alerts in primary care. *Archives of Internal Medicine, 1*63, 2625-2631.

This Page Was Left Blank Intentionally.