Tools and Considerations to Develop the Blueprint for the Next Generation of Clinical Care Technology

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ABSTRACT

This article provides a brief historical look at the genesis and evolution of clinical information systems. Based upon this historical background and the expertise of the authors, which encompasses, clinical, IT/cybersecurity, clinical engineering, as well as quality control expertise the article provides a roadmap for the next generation of clinical information systems. This next generation will not only provide consulting services to physicians via computer clinical decision support systems, but also the ability to perform autonomous and semi-autonomous care at the bedside via interfaces to medical devices (e.g. ventilators and infusion pumps), as well as auto ordering protocols.

KEYWORDS

Clinical Information Systems, Cybersecurity, Healthcare IT Cybersecurity, Next Generation EMR

BACKGROUND

The implementation of new information technologies in the healthcare sector is revolutionizing the delivery of healthcare, and has the potential to greatly improve efficiencies and outcomes by automating select processes. Assistance to physicians, nursing staff, and other caregivers at the bedside from clinical automation based on proven best practices has tremendous potential. However, this next generation needs to incorporate the three principle tenets of IT security which are Availability, Integrity, and Confidentiality due to the criticality of life safety systems that are supporting and controlling. This article will identify specific concerns, as well as provide insight into challenges with future implementations. For this article, we will define a clinical information system (CIS) as a ‘...a computer based system that is designed for

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collecting, storing, applying proven clinical algorithms, and making available clinical information important to the healthcare delivery process…’ This is a derivation of a definition from a definition provided by the Biohealthmatics with the additional of ‘applying proven clinical algorithms’ to their definition (Biohealthmatics, 2017). For this article we will also define the electronic medical record (EMR) as, ‘the electronic replacement of paper charts, is the record of patient health information generated by encounters at one particular provider’ (“Project Watch: High Blood Pressure,” 2012). Autonomous control will be defined as control without human intervention, while semi-autonomous control will be defined as machine control requiring a human interface to approve the recommended machine control settings.

The history of large-scale digitization of healthcare information began in the 1960’s with the implementation of hospital billing systems that evolved to meet the invoicing needs of the 3rd party payers. These early systems were focused on collecting information on procedural data which was then converted to invoices. With the evolution of PC’s as well as the increased requirements to capture diagnostic information to warrant the clinical procedures, these early billing systems gradually transitioned into early clinical repositories. The vast majority of the deployments were in the hospital setting, as these early systems were cost prohibitive for the private practitioners in the ambulatory environment. Clinical systems also began to digitize, first with laboratory information systems (LIS), then radiology information systems (RIS), which were initially staged to track orders and results, then grew into early electronic medical record (EMR) systems.

In the United States a major tipping point was the passage of American Reinvestment Recovery Act (ARRA) of 2009 which had the overall goal of providing government stimulus to improve a faltering U.S. economy during what was referred to as the ‘Great Recession’. One of the major initiatives of the ARRA was the Health Information Technology for Economic and Clinical Health act (HITECH) which provided financial incentive to health care providers to digitize their patient medical records in form that would be easily transportable with the philosophy that increased visibility and availability of clinical information would help to reduce overall health care expenses. The HITECH Act has continued to evolve in the US, which is arguably the major market for health care technology, and now requires health care providers to report on specific quality metrics. A more detailed history is provided in the work by Eta Berner (2013). Figure 1 provides an overall view of this evolution, with a preview of the next logical steps in this evolution.

**Current State**

Computer Decision Support Systems (CDSS) provide the technology to input in real time, or near real time, clinical data on a specific patient and provide clinical advice at the bedside based off current best practice algorithms. In order to further the acceptance and accuracy of this technology consideration needs to be given to insuring that the information provided is accurate, available and based upon clinically
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