# Chapter 2
# Conceptual Modeling in Health Information Technology

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## ABSTRACT

*Electronic health record (EHR) systems are the cornerstone of any modern health service. Studies have consistently shown, however, that introducing EHR systems is a complex task, with difficulties stemming from technical designs that fit poorly with the details of clinical work practices. Given the evolving role of EHRs, a unified framework for a holistic modeling approach is needed in health IT. Current conceptual modeling techniques use object-oriented diagrams as their main tools; the nature of this methodology requires breaking the system's behavior into several pieces and then further decomposing those pieces into other diagrams. This chapter introduces a conceptual-modeling methodology that is based on flows; it also presents different conceptualizations of such notions as processes, things (objects), and events. Without a loss of generality, this chapter focuses on documenting patterns of clinician-information use cases and tools for evaluating EHR implementation.*

## INTRODUCTION

An electronic health record (EHR) system involves the methodological collection and organization of health information in an electronic format that is theoretically capable of being shared across health care settings (Gunter, 2005). EHRs embrace several types of health information, including medical history, medications and allergies, laboratory test results, radiology images, age and weight, and billing data; they are generated and maintained within a health care institution and are meant to give patients, physicians, and care providers access to medical records.

EHRs are the cornerstone of any modern health service (Greenhalgh, Potts, Wong, Bark, & Swinglehurst, 2009). They improve health care, allow for integrated information, and help prevent administrative errors such as lost or duplicated records (Department of Health, 2008; Institute of Medicine, 2009). An EHR system can improve workflow efficiency, the effectiveness of health care services, and the synthesis of patient data with medical evidence to support the decision-making process (Kupersmith et al., 2007; Stead & Lin, 2009).

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In such systems, "the key challenge was seen as getting the design right, implementing the technology, and ensuring that clinicians used it" (Greenhalgh et al., 2009, p. XX). Some researchers have reservations about using such a holistic approach to organizing electronic health information (Avison & Young, 2007; Kreps & Richardson, 2007) because failures in this context have been reported recently (Røed, 2011). Despite such apparently negative conclusions, research in this area is still quite extensive for several reasons, including the fact that

*There is considerable scope for more flexible and technologically sophisticated forms … (e.g., mobile devices) to overcome current limitations. But for this to happen, technology [re]design must occur in intimate proximity to the work process and actively involve users and potential users… (Greenhalgh et al., 2009, see also Hartswood, Procter, Rouncefield, & Slack, 2003; Oudshoorn & Pinch, 2005).*

Armijo, McDonnell, and Werner (2009a) stated,

*Given the evolving role of EHRs in clinical practice and the importance of information design and display to meaningful use, further exploration of EHR usability . . . [is] an opportunity for innovation in health IT with the potential for significant impact on clinical practice.*

## PROBLEM AND SOLUTION

Studies have consistently shown that the introduction of EHR systems is a complex task in which difficulties arise because "technical designers typically [miss] subtleties and [produce] artefacts that [fit] poorly with the situated nature of knowledge and the micro-detail of clinical work practices" (Greenhalgh et al., 2009). Currently, efforts to evaluate EHR systems in terms of identifying the best practices in information design have been insufficient. Recognition of usability as a critical issue is inconsistent, and objective evidence is insufficient for design considerations. Hence, standards for the design of user interfaces are needed to guarantee efficiency and quality (Armijo et al., 2009a). Greenhalgh et al. (2009) identified several tensions in relation to the users, organizational context, clinical work, change process, implementation success, complexity, and scale.

Many approaches have been used, and many solutions have been proposed related to the establishment and development of EHR systems. An extensive (600-page) review in this area can be found in Car et al. (2008). This chapter focuses on a narrow subfield of EHR systems that is concerned with establishing a foundation for the application of information design principles to the use of health information technology in primary care settings. Without reducing the methodology's generality, this chapter examines a specific attempt that Armijo et al. (2009a) made to build a framework for "the usability of these systems and their ability to effectively integrate with clinical decision making and workflow." These aspects of EHR systems have "not been adequately explored to date" (Gans, Kralewski, Hammons, & Dowd, 2005) even though financial and technical issues have received much attention.

*Information design, the art and science of preparing information so that it can be used by human beings efficiently and effectively, is central to system usability and implementation success. As such, the further exploration of EHR information design . . . [is]. . . an opportunity for innovation in health IT that will improve the safe, efficient, effective, patient-centered, equitable, and timely delivery of care. . .*

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