Chapter 22
Healthcare Information System Modelling

Jean-Luc Hainaut
University of Namur, Belgium

Anne-France Brogneaux
University of Namur, Belgium

Anthony Cleve
University of Namur, Belgium

ABSTRACT

This chapter studies the requirements for a wide range of healthcare information systems, including, but not limited to, clinical pathways management, patient record management, home care management, and medical personnel and resource management. The analysis concentrates on the description and management of medical activities, leaving aside the standard management processes common to all enterprises. It develops a generic architecture for these information systems comprising four central submodels devoted to the description, respectively, of organizational structures, care processes, information, and resources. Each submodel is analysed independently of the others then integrated into a consistent global model. Extensions of this model to other facets of the healthcare information system are discussed and some practical applications are suggested.

INTRODUCTION

Grossly speaking, healthcares are structured human, possibly machine-assisted, activities that could be described as standard processes specialized to the health application domain. They follow more or less precise care paths, they require medical resources of various kinds, they are carried out by health professionals and are applied to patients. Healthcare activities are supported by a large offering of software systems devoted to home care clinical pathway management, patient record management, home care management and medical personnel and resource management, for instance. Though they address similar and complementary issues, most of these systems are incompatible despite efforts to standardize, at least, data communications between them.

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The objective of this chapter is to identify the common concepts underlying a wide variety of models, notations and tools from the e-health domain. These concepts will be translated into an integrated Entity-relationship conceptual schema covering four coordinated core sub-systems, namely Organization, Care processes, Resources and Information. This chapter being conceptual by nature, no practical application will be described. However, several potential usages will be suggested and discussed in section *Future Research Directions*.

BACKGROUND

Many models and standards do exist in the broad domain of healthcare information systems (HIS). Each of these models focuses on one or several particular aspect(s) of the system including the modelling of care guidelines and processes, clinical information, clinical resources and organization, and information/process security. In this section we briefly summarize the major HIS models and standards by identifying their main underlying concepts.

Care Guidelines

EON (Tu & Musen, 2001) is a guideline modelling and execution system that includes an extensible, component-based suite of models to represent parts of a clinical guideline, domain ontologies, a view of patient data, and other entities (e.g., those defining roles in an organization). The guideline model defines guideline knowledge structures such as *eligibility criteria*, abstraction definitions, guideline *algorithm*, decision *models*, and recommended *actions*. A guideline algorithm consists of a set of *scenarios*, *action steps*, *decisions*, *branches*, and *synchronization* nodes that are connected through *followed-by* relationships.

GLIF (Boxwala et. al., 2004) is a language for modeling and executing clinical guidelines. In addition to defining an ontology for representing guidelines, it also defines a medical ontology for representing medical data and concepts. The guideline ontology covers several kinds of guideline steps such as *Action*, *Decision*, *Patient_state*, *Branch* and *Synchronization*.

PRODIGY (Johnson et. al., 2000) is a guideline model that was initially designed to support the management of chronic diseases such as asthma, angina or hypertension. According to this model, a guideline is organised as a network of *patient scenarios*, *management decisions* and *action steps* which, in turn, may produce further scenarios. The sequencing of action steps is achieved by *followed-by* relations.

PRO*forma* (Sutton & Fox, 2003) is a guideline representation language supporting the management of medical procedures and decision systems. According to this language, a guideline application is modelled as a set of *tasks* and *data items*. The notion of a task is central - the PRO*forma* task model divides generic tasks in four subcategories: *plans*, *decisions*, *actions* and *enquiries*.

GUIDE (Ciccarese, 2004) is a multi-level architecture that integrates:

1. A formalized model of the medical knowledge contained in *clinical guidelines*,
2. A workflow/*care process* management system, and
3. An *electronic patient record* system.

The message-based interaction between the GUIDE subsystems is defined through specific *contracts*, and relies on common *ontologies*, *terminologies* and *datatypes*. The care process model of GUIDE is based on Petri nets.

SAGE (Tu et. al., 2007) is a guideline model that integrates *guideline-based* decision support with care *processes*. The model includes *organizational knowledge* to capture *workflow information* and *resources*. The guideline-driven *processes* are modelled by means of *Activity Graphs*, while *Decision Maps* are used to represent recommen-