Chapter 23
Towards Semantic Interoperability in Health Data Management Facilitating Process Mining

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ABSTRACT

As an evidence-based business process analysis method, process mining can be used to investigate variations in delivery of care. Existing approaches are only based on one data source. A variety of data sources means different domain languages and understanding, special processes workflows in various organizations, varying documentation with different goals and different designations and varying use of coding systems. This article describes a modular, rule-based information extraction algorithm based on CDA and compares it to a proprietary healthcare reference model approach and a resource-based extraction of healthcare data using the new standard FHIR. All three approaches can be used to derive models to extract clinical and patient pathways. Similarities and differences according to interoperability and process mining tasks are described. It is concluded that standards-based approaches allow for more interoperability and can be used for a wide range of systems to provide process insight, thus facilitating better healthcare management across institutional boundaries.

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INTRODUCTION

Efficient and patient-centered delivery of care across different hospital settings and healthcare providers requires intensive coordination between concerned organizations. Clinical pathways are used as management tools to define the best process in a healthcare organization, using the best procedures and timing, to treat patients with specific diagnoses or conditions according to evidence-based medicine (Panella, Marchisio and Di Stanislao, 2003). (Partington et al., 2015) propose the application of process mining as an evidence-based business process analysis method to gain insight into and enable comparative analysis of clinical practice and delivery of care across different organizations.

The objective of this publication is to give an overview of available models that facilitate process mining in Healthcare. Since information on (proprietary) models is often lacking, or not publicly available, the scope of this research is limited to models based on international standards, which are free of charge.

Existing approaches which use process mining for healthcare management are only based on data sources within one organization. More precisely the formal representation and the semantics (including code systems and value sets) of the different data sources are basically the same (Partington et al., 2015; Mans et al., 2008). To investigate variations in clinical practice and delivery of care across different healthcare domains, various data sources have to be taken into account (as shown in Table 1): Integrating the Healthcare Enterprise (IHE) and Health Level Seven (HL7) Clinical Document Architecture (CDA) are used in wide parts of the US and Europe as a technically interoperable solution to exchange healthcare data between healthcare providers (Franz et al. 2011). The use of standardized mechanisms increase the interoperability of information systems and minimize integration efforts (Norgall, 2003, Sunyaev et al., 2008). Nevertheless, there is still a lot of healthcare data exchange done using proprietary systems. New standards like HL7 Fast Healthcare Interoperability Resources (FHIR) try to cover this gap and allow a resource efficient data transfer (publication). OpenEHR and the use of ontology-based archetypes is another approach to allow interoperable healthcare data management. Since it uses SNOMED-CT (IHTSDO) to support automated clinical processes, which is subject to a fee, it is not taken into account in this article. (Mans, van der Aalst and Vanwersch, 2015) describe a (proprietary) healthcare reference model (HRM) that aims to help locating the needed data in healthcare information systems and thus facilitate the data extraction for process mining.

A variety of data sources means different domain languages and understanding, special processes and workflows in various organizations, varying documentation with different goals, varying structures in documentation, different designations and varying use of standards and coding systems. Thus, to extract data out of the (distributed) data sources and to transform them into the structure needed for process mining algorithms, preprocessing steps are necessary. This work describes and evaluates different approaches as a preceding step to enable the development of clinical pathways and medical guidelines.

Preceding Steps for Process Mining

Process mining algorithms work on event logs with a certain structure. Event logs must contain only data related to a single process and it must be ensured that all events in the log can be related to this process. Moreover, each event in the log must represent an activity and refer to a single process instance (case). The Extract, Transform and Load (ETL) steps preceding the actual process mining tasks describe: (a) extraction data from outside sources, (b) transforming it to fit operational needs (dealing with syntactical