Towards Process Mining in Radiology: Utilization of IHE SOLE

Emmanuel HELM[a,1]
[a] *University of Applied Sciences Upper Austria, Research Department for Advanced Information Systems and Technology, 4232 Hagenberg, Austria*

Abstract. Background: Audit trails of health information systems are not useful for business analytics. Objectives: To show how recent developments can be utilized to enable process mining in radiology. Methods: The SWIM lexicon is used to code the workflow steps. Results: Seven activities with their corresponding RadLex codes. Conclusion: The semantic enrichment of audit trails is an important step in operationalizing and improving the workflows in radiology.

Keywords. process assessment, health care; biomedical ontologies

1. Introduction

Interoperability in health IT is the precondition for a seamless flow of information between the multiple actors, medical personnel and information systems. One way to ensure a certain level of interoperability is the implementation of *integration profiles*, as defined by the international organization *Integrating the Healthcare Enterprise* (IHE).

Process Mining is an emerging discipline aiming on analyzing business processes based on observed IT systems behavior (event logs), also in healthcare. Some approaches utilize the event logs generated by actors of the IHE integration profile *Audit Trail and Node Authentication* (ATNA) to analyze processes in hospitals or practices.

However, ATNA was not designed with business analytics in mind, but for privacy and security surveillance. Therefore, applications utilizing ATNA typically do not record operational (workflow) events, so every process mining approach has to map the recorded events to their corresponding real-world events in a first step. This mapping brings ambiguity. E.g. in [1] the authors tried to map the events on activities based on semantic matching of the terms in the meta-model of the audit trail (RFC-3881).

In 2012, the Society for Imaging Informatics in Medicine (SIIM) formed an initiative to improve operational processes in healthcare, the SIIM's Workflow Initiative for Medicine (SWIM). This initiative aimed to create a lexicon that consistently names, codes and describes the workflow steps (activities) in radiology practices and departments [2]. The SWIM lexicon is now part of the RadLex ontology.

Standardized Operational Log of Events (SOLE) is a recently developed IHE integration profile supplement, describing capture and retrieval of operational events in the radiology domain utilizing transactions from the ATNA profile. The incentive for writing SOLE was the strong desire of healthcare providers to *increase throughput and*

[1] Corresponding Author: Emmanuel Helm, FH OÖ F&E GmbH, Softwarepark 11, 4232 Hagenberg, Austria, E-Mail: emmanuel.helm@fh-hagenberg.at

efficiency, both to improve the quality and timeliness of care and to control costs. SOLE defines the recorded events' semantics using the aforementioned SWIM lexicon.

2. Methods

This short paper aims to show how the SWIM Lexicon, and thus the SOLE integration profile, provides the means to record the events of the radiological workflow, enabling subsequent in-depth analytics like process mining. The simplified workflow identified in [1] names seven consecutive activities that should be recorded in order to measure the performance of a radiological practice or department: (1) Schedule Appointment > (2) Patient Admission > (3) Radiological Examination > (4) Diagnosis > (5) Report Writing > (6) Report Attestation > (7) Report Transmission.

3. Results

Table 1 shows how the identified activities can be recorded using SWIM codes (RadLex ID). This means that relevant activities in the workflow won't be derived by mapping events to the best semantic match, but having the information directly in the audit trail.

Table 1. Activities and their corresponding RadLex IDs

Activity	RadLex ID	RadLex Definition
Schedule Appointment	RID45821	Patient accepts appointment, or may modify scheduling
Patient Admission	RID45825	Patient check-in at the imaging facility
Radiological Examination	RID45897	(Time when) the patient enters the procedure room
Diagnosis	RID45859	Physician reviews image and renders a report in electronic audio format
Report Writing	RID45832	Audio transmitted to 'speech-to-text' system (human transcriber or speech recognition)
Report Attestation	RID45924	Final electronic text report is approved(signed) by the interpreting physician
Report Transmission	RID45865	Final report is sent to ordering physician (EMR confirmation of receipt)

4. Discussion and Future Work

The semantic enrichment of audit trails is an important step in operationalizing and improving the workflows in radiology practices and departments. Further research on how to exploit the recorded information is needed, including examples on process mining.

References

[1] Helm, E., and Paster, F. (2015). *First steps towards process mining in distributed health information systems.* In: International Journal of Electronics and Telecommunications, 61(2), 137-142.

[2] Wang, K. C. (2018). *Standard lexicons, coding systems and ontologies for interoperability and semantic computation in imaging.* Journal of digital imaging, 31(3), 353-360.