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Task Analysis and Interoperable Application Services for Service Event Management

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Abstract. In addition to the information specifications for electronic health records, functional and behavioral capabilities need to be agreed to achieve interoperability. In this paper, we present results from task analysis and specification of software services to support the management of service events. The work has been performed to support the management of the nationally shared EPR in Finland. The results support the specification of information sharing and composition in relation to healthcare workflows and activities. The specification of a functional reference model and software services for the management of service events and encounters promotes the integration of shared EHR and systems adaptability for migration towards interoperable electronic health records in healthcare networks.

Keywords. Health information systems, SOA, Interoperability, Activity analysis, Service events, Encounters, Electronic Health Record

1. Introduction

The requirement to collect and share service encounter data is the foundation of an electronic health record [1]. The challenge is to integrate these data from multiple source systems with different syntax and semantics. Encounters are used for organizing 1) healthcare acts which pertain to patient's health history [2] and 2) guidelines for multistep clinical processes [3]. EHR Systems should cover functionality for managing encounters and episodes of care [4]. If relationships between such functionality and documentation of care cannot be established, risks of disconnect between domain knowledge and databases as well as access control failures are increased [5,6].

Since 2006, the national health IT infrastructure projects in Finland have been producing support for information sharing and preservation for the entire health sector [7]. The main approach of the projects has been to provide national IT services for ePrescription and structured EPR. There services are used through the local health information systems of the service providers. The national ePrescription has been in rollout phase since 2010. All national EPR services and specifications for local systems will become mandatory for all public and private service providers in 2015.

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Numerous specifications have been produced to support the introduction of the national IT services. These specifications include the shared EPR content definitions and their refinements using HL7 CDA. In addition, architecture, requirements and use cases have been specified. In this paper, we focus on the functional capabilities of shared EHR which need to be agreed upon to achieve interoperability, focusing on the management of encounters using a service event concept.

One of the main challenges in the national EPR development efforts has been the difficulty of providing uniform and comprehensive composition rules. These rules are needed for integrating patient information from various systems and sources and from disparate local workflows in a consistent way. By 2009, some of these aspects had been specified as part of several different documents such as national use case specifications and interoperability standard implementation guides using the HL7 CDA R2 standard. The requirements and specifications stating the concepts and functionality related to the management of EPR information in clinical and administrative activities, however, were inconsistent and dispersed.

One of the central concepts to support interoperable EPR and the care continuum was *service event* which has been defined as "organizing or performing one healthcare service". Management and organization tasks in addition to clinical tasks are central in the management of service events. This concept is central in patient consent management, reporting and billing, as well as in achieving clarity and integrity of EPR use for professionals. Examples of service events include ambulatory visits and episodes of care, along with related examinations, procedures and encounters. These definitions, however, required clarification and harmonized interpretation. There was a need for shared specification of activities of care processes and their temporal constraints to achieve shared terminology for healthcare processes. Furthermore, support for uniform and interoperable implementation of these concepts was necessary for information systems which are used in the management of care processes and documentation.

2. Materials and Methods

The *SOLEA project* is a national R&D project focusing on the use of service-oriented enterprise architecture to support the management and interoperability of complex information systems in healthcare and other industries. The refinements required to support service events in relation to the national EPR specifications was selected as one of the main working items of the project in late 2009. The goals of this activity included the clarification of definitions of service events and coherent specification of their lifecycle. In addition, refinements to the interoperability specifications between various applications or services were pursued, supported by related rules and information and concept models. Furthermore, reusable application services were to be specified to support the management of care process documentation and consent management. These services could be combined depending on the local requirements, as long as they have open interfaces.

To support these goals, it was deemed necessary to analyze the activities related to the information management of the EPR. These activities are performed by the users of local or regional health information systems. An activity analysis approach was selected which has been previously used for analyzing tasks related to the national guidelines for citizen eBooking and electronic scheduling [8].

The goals, requirements and process descriptions related to service events were analyzed using a four-level process and activity modeling approach [9], based on various use case and requirements specifications of the national EPR project KanTA. Clinical document and concept specifications of national IT services and EPR were also reviewed. This document analysis produced the initial list of activities and tasks related to the management of service events. The requirements, tasks, activities and solutions were also discussed and refined in eight workshops. The results incorporate input from a group consisting of 29 experts in addition to authors.

The constructive results reported in this paper include the identification and analysis of tasks in service event management. These tasks and other requirements are mapped to functional application services following service-oriented architecture (SOA) specification and design techniques [10,11,12,2]. This paradigm promotes flexibility, modularity and reuse of the solutions. It also makes it possible to specify open interfaces to support gradual and incremental migration paths in different local settings. We focused on action and activity levels of process modeling [9] to identify tasks and services which should be implemented or automated in which national services, patient administration systems, local EHR systems or specialized departmental or clinical information systems in different settings.

3. Results

3.1. Task Analysis of Service Event Management Activities

Table 1. Information processing tasks in the management of service events (Pr = provider, Pa = patient, EHR = local EHR application, EAr = national EPR archive service, P = always participating, a = task could be partially automated or streamlined if the corresponding human or system actor participated in the task)

Task	Pr	Pa	EHR	Ear
1 Make a referral	P		P	P
2 Receive and process a referral	P		P	a
3 Insert a patient in the queue	P		P	a
4 Schedule an encounter based on a referral	P	a	P	a
5 Schedule an encounter without a referral	P	a	P	a
6 Cancel a scheduled encounter	P	a	P	a
7 Unanticipated registration and admission	P		P	a
8 Define information needs	P	a	a	a
9 Define justification of information transfer across organizations	P	a	P	a
10 Document query	P		P	P
11 Document retrieval	P		P	P
12 Assess and use information in care	P		a	
13 Make a new information entry	P		P	P
14 Make an information delivery consent or denial	a	P	a	P
15 Transfer patient to another ward / unit	P		P	a
16 Discharge patient / conclude a visit	P		P	P
17 Make a study or consultation request	P		P	a
18 Receive and fulfill a study or consultation request	P		P	a

The task analysis in Table 1 provides a generalized functional model for tasks which require the management of service events. The analysis provides a reference model to define actors, information and tools used, and constraints applied for each task.

The tasks in Table 1 are present in many healthcare workflows and high level processes. Tasks which could be streamlined or increasingly automated are also

identified. All tasks were further refined in 22 fine-grained information processing functions. These functions formed basis for specifying the operations of service event management in information systems and SOA services. All tasks were analyzed in detail to specify inputs, outputs, participants, exceptions, automation potential and interoperability needs. The lifecycle of service events was also refined using these tasks.

3.2. SOA Services for Service Event Management

One of the strengths of the SOA approach is flexibility in positioning tasks in legacy applications or new application services. The activities and tasks were specified in detail to support this and to identify interoperability needs. This supported the specification of the needed application services. Furthermore, the solutions were refined in terms of implementation scope: whether each function would be deployed on local (provider organization specific core or specialized application), regional (cross-organizational on regional level) or national (nationally centralized) level. These aspects which guide the implementations are summarized in table 2. The functionality of each service was further refined with service specification templates [12,11].

Table 2. Identified SOA services and application roles for service event management, in relation to potential deployment domains (N = national service, R = regional or local shared service, C = included in local core EHR / ADT applications, D = included in departmental / specialized systems, I = decision of implementation on this level has been made at least in one of the involved organizations, * = plans for implementation on this level have been made at least in one of the involved organizations)

Name of SOA Service or Application Role	N	R	C	D
Centralized EPR archive	I			
Document composition service		*	I	I
Document transmission service		*	I	*
Entry composition service		*	I	*
Event information repository	*	*	I	
Document retrieval service	I	*	I	I
Information query service	I	*	I	*
Content producer			I	I
Content consumer		*	I	*
Controller of the patient administrative process		*	I	
Integration infrastructure for service events		I		
Context manager		I	*	

In addition to these functional and architectural results, user storyboards and example scenarios, conceptual and ontological analysis models and specifications of shared information models related to service event management were produced. In addition, architectural diagrams for various migration phases were specified. The main results were published in a 107-page report in Finnish.

4. Discussion and Conclusions

The results of this work were quickly taken up by other national projects. The National Insurance Institution Kela who is responsible for the national IT services used the results in an HL7 interface specification project for service event integration and the specification project for the architecture of lab and imaging integration. In addition, the national Viila and TAPAS projects used the results for harmonization of architectures.

The resulting specifications of the service event work of SOLEA were evaluated using a survey which was sent to the participants of the workshops and users of the results. The eight respondents saw summaries such as those in Table 2 and detailed task specifications to be very useful for system integrations and implementations.

Consistent information classification and organization is crucial for documentation management supporting seamless care in distributed healthcare networks. A key success factor is the support for information processing tasks in everyday healthcare workflows through EPR and administrative systems. This can be supported by analyzing healthcare acts and tasks and by using a combination of application services. Many of these tasks can also be automated, at least partially. Similar or identical concepts and services have been identified and specified in projects initiatives such as LuMiR [13] and Canada Health Infoway [2]. The uniform vocabulary, consistent service and interface specifications and shared reference models for tasks and functions provide a coherent basis for flexible application systems. This, in turn, supports the improvement and reorganization of care processes in networked care.

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