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Exchanging Appointment Data Among Healthcare Institutions

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Abstract. The introduction of national electronic patient records such as the electronic patient dossier EPD in Switzerland provides a new basis for digitizing healthcare processes at a national level. One process however, that is currently neglected within the Swiss EPD, is the scheduling process in healthcare. The objective of this work is to analyze the appointment scheduling process and the involved IT systems in order to develop an appointment data structure and a concept for cross-institutional exchange of appointment data. The analysis showed that various outpatient and inpatient information systems support appointment booking through proprietary solutions. A true standard for appointment data exchange is missing. We suggest an appointment data structure and a corresponding data exchange process based on the FHIR standard. In its current implementation, the Swiss EPD does not support this proposed appointment scheduling process. We discuss how potential additions such as the IHE Care Services Discovery (CSD) profile can provide better compatibility.

Keywords. appointment, scheduling. cross-institutional data exchange, FHIR

1. Introduction

Switzerland launches a national electronic patient record named electronic patient dossier (EPD) in 2020 [1]. The EPD supports document based, patient-related, cross-institutional data exchange based upon IHE (Integrating the Healthcare Enterprise) using profiles such as XDS (Cross-Enterprise Document Sharing) and XCA (Cross-Community Access) [2]. The EPD content will be a patient-related collection of CDA (Clinical Document Architecture) documents. For semantic interoperability, various Swiss CDA document types are currently defined, e.g. CDA-CH-EMED to support the medication process [3].

Scheduling and appointment making is an essential process in in- and outpatient care. For inpatient care, scheduling is typically supported with HL7 V2.x messages [4] or, within radiology departments, with DICOM and IHE. DICOM provides sophisticated workflow management among RIS (Radiology Information System), modalities and PACS (Picture Archiving and Communication System) using DICOM Modality Performed Procedure Steps (DICOM MPPS) [5]. DICOM MPPS standardizes procedure step states such as “planned”, “scheduled”, “active”, “completed” etc.

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In comparison, scheduling and appointment making across institutions, e.g. the general practitioner (GP) schedules an X-ray examination at a nearby hospital, is still far from being standardized. Many proprietary individual solutions, e.g. hospital specific web portals exist [6] and are perceived by patients as a positive innovation [7]. There are no possibilities to include such scheduling data into the EPD.

A national standardization for the digital appointment process could provide various advantages. For example, the no-show rate (patients who do not appear for an appointment) could be reduced [8, 9] and the workload for booking appointments in healthcare institutions could be reduced [6]. Therefore, the aim of this work is to define a foundation for an open and national cross-institutional standard for the exchange of appointment data. This task splits into two parts. First, a generic data structure for appointments is proposed and second, the process and the corresponding data exchange methods are defined.

2. Material and Methods

Our starting point was the development of a mobile patient navigator app [10] which enables a patient to look up his current appointments which may be altered by his healthcare professionals.

In a following step, we examined some exemplary inpatient [11] and outpatient [12] information systems with regard to appointment data exchange with such a navigator app. In addition, several online outpatient appointment booking tools were searched and analyzed, namely Medicosearch.ch, Docbox.ch, Doctena.ch, Samedi.de. The objective of this analysis was to identify the data types that are stored in these systems with respect to an appointment. Based on the results, we could identify common data types to derive an appointment data structure.

Next, a Medline literature review was carried out with following search terms: Computerized appointment scheduling, Cross institution appointment scheduling, Cross sector AND appointment, Cross sector AND scheduling, Web based appointment scheduling. The aim of retrieval was to identify existing solutions for cross-institutional appointment communication. The results of the search were filtered for publications dealing with the scheduling process. There were no restrictions on the publication date.

In a fourth step, the existing standards for scheduling in healthcare were surveyed to check whether they are appropriate to be used in a comprehensive and cross-institutional appointment scheduling solution. Thus, we analyzed the Appointment Resource of FHIR [13], the HL7 V2.x SIU messages [4], and IHE profiles dealing with appointment booking and the EPD. The derived data structure was then compared with the exchange standards mentioned above and supplemented when necessary.

3. Results

3.1. Existing standards for appointment data

We were unable to detect any publication reporting on a nationwide standardized electronic medical appointment booking system. The analysis showed instead, that various in- and outpatient clinical information systems support some kind of appointment booking. But, implementation and the necessary data to be collected varied. This was

particularly evident in the area of possible appointment types. The pre-defined values differ in their degree of detail among systems. This can lead to difficulties in cross-institutional communication. Links between appointments within or beyond an institution or aggregation of appointments to a treatment episode were missing.

For inpatient care, HL7 V2 supports Scheduling Information Unsolicited Messages (SIU) [4]. SIU supports 14 different trigger events to notify applications of appointment changes. All events use a common message format. SIU-S12 for example is the event for notification of a new appointment. The SCH segment contains information regarding the date such as IDs, reason, duration, etc. It also shows who booked the appointment and its status. In the TQ1 segment, the times are displayed in more detail. Thus, an appointment can also have a repetition, i.e. an appointment can be booked weekly. Different segments specifying patients, services, devices, rooms and service providers for an appointment may be added.

Fast Healthcare Interoperability Resources (FHIR) [13] is an emerging standard hosted by HL7.org where appointments are mapped with the appointment resource. An appointment resource contains fields for start and end time, duration, location and the participants of an appointment. Using additional FHIR resources such as the Slot and the Schedule resources, the whole booking process can be addressed in FHIR. Furthermore, through the use of the Subscription resource, FHIR supports that different participants can be automatically notified about the change of a resource. The communication between FHIR endpoints is realized through a REST API and the transmitted data can be either XML or JSON formatted. Therefore, FHIR not only addresses the data structure itself but also the communication through which the data is exchanged. However, the FHIR standard is not a document-based standard and is therefore not directly compliant to the EPD.

The so-called CDA-CH standard, a Swiss adaptation of the CDA, is used for the EPD. CDA is part of the HL7 V3 standard. In the current CDA-CH document v.2.0.3, the term "Appointment" is not at all mentioned [15]. CDA-CH together with the XDS.b profile of IHE provides a document-based infrastructure for the Swiss EPD. An appointment is currently not considered as document.

A specific use case for the communication of event data via the XDS.b profile has not yet been defined by IHE. The Eye Care Appointment Scheduling (ECAS) profile demonstrates the process for scheduling appointments [16]. This profile can serve as a possible basis for the implementation of cross-institutional appointment data communication. However, if this profile is to be implemented across institutions, the transactions should be adapted or redefined. Various transactions originate from the Radiology Framework of IHE (RAD-1, RAD-12, ...) that use the standard HL7 V2.x. This is not optimal for cross-institutional communication. Furthermore, this profile would have to be integrated into an XDS environment without the loss of dynamic communication. For cross-institutional communication, it is essential to detect the appropriate service provider in order to book an appointment. With the IHE CSD Profile [17], this search process can be supported. CSD provides a register with the available service providers. A query could, for example, return all orthopedists in the area of Berne in Switzerland.

The results of this analysis demonstrate that there is no off-the-shelf solution available for cross-institutional appointment data exchange. However, existing standards can provide some foundations.

3.2. Requirements for appointment data structure

In previous work [10], we collected requirements for an appointment format. They comprise three mandatory criteria: The appointment format must be 1) suited to be used across institutions, 2) support outpatient and inpatient appointments and 3) must be of benefit for patients, i.e. patient-supporting applications should be enabled using the format. The appointment data structure should be able to map the information given in Table 1. For the types of appointment, appointment status and prioritization, specific catalogue values should be defined to ensure a normalized labeling. An appointment can be linked to one or more patients, care providers, rooms, devices, documents and services. Each of these items must also have a status that indicates whether the appointment was accepted or rejected (e.g. whether a room could be blocked for an appointment or a specific physician was scheduled for the appointment).

Table 1. Appointment data structure.

Name	Data type / Pointer	Required
Appointment date with time	Date	Yes
Appointment duration in minutes	Integer	No
From	Date (Time)	Yes
To	Date (Time)	No
Type of appointment	String	Yes
Appointment status	String	Yes
Prioritization	String	No
Reason of visit	String (freetext)	No
Patient	Pointer to PatientID	Yes
Care provider	Pointer to CareProviderID	Yes
Room	Pointer to RoomID	No
Medical device	Pointer to DeviceID	No
Documents	Pointer to DocumentID	No
Service	Pointer to ServiceID	No
Institution	Pointer to InstitutionID	Yes
Description	String	No

According to our analysis, the FHIR Appointment Resource is suitable for implementing this data structure because it completely maps the proposed appointment data structure for an individual appointment. In addition to the definition of an individual appointment, two supplementary data structures should be defined through which individual appointments can be linked with each other. These additional structures serve the following purposes:

- illustration of an inpatient case
- mapping of an entire treatment episode

The data structure for the inpatient case should contain the following information: date of entry, date of discharge, patient, institution, subordinated appointments, room the patient stays in and the department. The individual appointments that take place during the inpatient case can then be subordinated to this data structure. The second additional data structure should include the possibility to represent a treatment episode of a patient as for example a total hip endoprosthesis. Therefore, the data structure is a list to which the different individual appointments and inpatient cases can be mapped.

The individual appointment, the inpatient case and the treatment episode can then be linked with each other in a tree structure as depicted in figure 1.

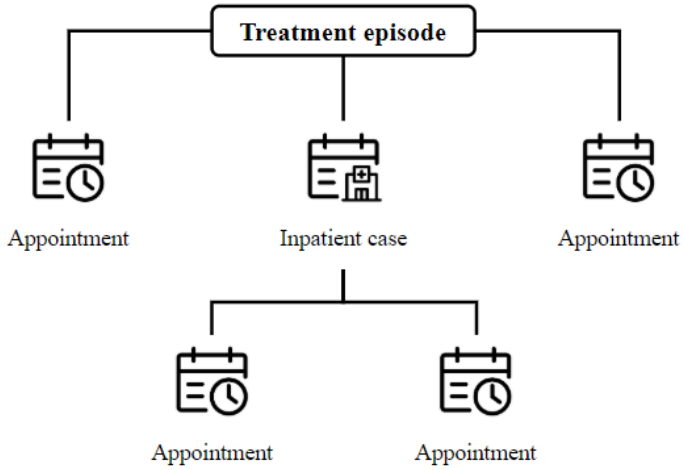

Figure 1. Tree structure comprising several appointments, either individual or appointments in an inpatient case, aggregated in a treatment episode

3.3. Appointment booking process

This section describes a possible process for the communication of appointment data. As already considered in the mentioned FHIR resource, during the scheduling process, the appointment can adopt various states. These states serve as the basis for this conceptual communication process (fig. 2).

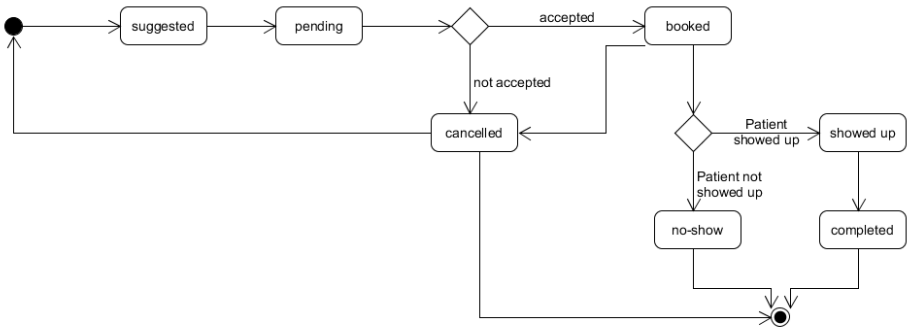

Figure 2. Defined process of an appointment booking process using the various states of an appointment

We propose a minimum of seven states for an appointment: Suggested, pending, booked, showed up, cancelled, no-show, completed. As soon as a request is made for an appointment, the appointment assumes the state “suggested”. A provisional date is proposed, which can still be adjusted by the other parties involved. After defining the basic data of the appointment, its state is set to “pending”. For a “pending” appointment all key data is defined and all participants are invited. If all required participants agree to

the appointment, it will be changed to state "booked". If not, the appointment will be "cancelled".

For "booked" appointments the date is fixed. If the patient checks in at the providing institution, the state is altered to "showed up". Once the appointment is finished the state is set to "completed". If one of the participants is no longer able to attend, he should "cancel" in advance. The state "no-show" indicates that the appointment is scheduled, but the patient did not appear and did not cancel the appointment in advance.

During the scheduling process, the defined conditions are monitored and influenced by four different actors (table 2).

Table 2. Actors involved in the appointment booking process

Actor	Description
Participant	All entities participating in an appointment. This can be a person such as a patient and a health professional but may also include other entities such as an MRI or an operating room.
Requester of appointment	Participant who starts the initial appointment process by making a suggestion of an appointment
Healthcare institution	Institution where the appointment takes place
EPD Community	Refers to the community to which the healthcare provide belongs

Communication between the various actors is divided into individual steps. Each step represents the exchange of data between two actors. Standards and IHE profiles are proposed for realizing the various steps. The state of the appointment is also changed in some steps. In figure 3 the individual communication steps are shown graphically and explained in more detail in the following.

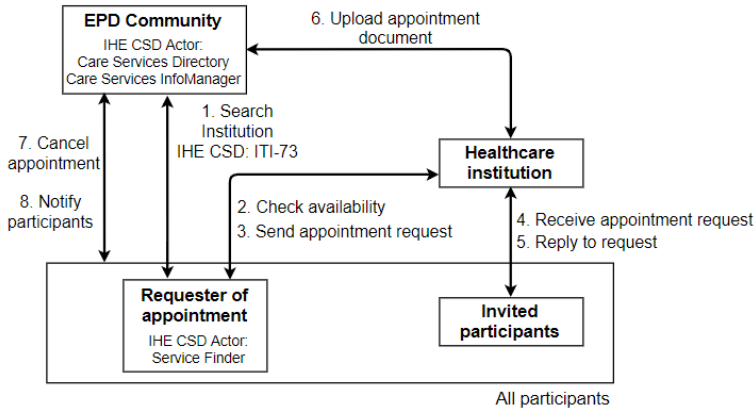

Figure 3. Communication among the various actors during an appointment booking process

(1) Through the IHE CSD profile the requesting person (Service Finder) uses the ITI-73 transaction against the EPD Community (Care Services InfoManager) to search an institution and receive corresponding information including the FHIR endpoint. To realize this, the EPD functionality would have to be extended by the IHE Care Service Discovery (CSD) profile. (2) The availability schedule of the institution and, if necessary, of other required participants will be retrieved using the FHIR schedule and slot resources. (3) When a free slot has been found, an appointment request will be sent.

In this step, the actual FHIR appointment resource is created and sent to the institution. (4) All participants will be informed about the appointment request. (5) The individual participants can confirm or reject the appointment request using the FHIR AppointmentResponse resource. (6) In the previous steps, the appointment communication was carried out via a system of the corresponding institution. Once the state is set to booked, the FHIR Appointment Resource can be converted to a CDA-CH document and uploaded to the EPD community. (7) If a "booked" appointment can no longer be attended by a participant, it should be "cancelled". A new version of the appointment document with the status "cancelled" will be created and uploaded to the corresponding community. (8) In order to notify all participants of the cancellation, the EPD must be extended with the IHE Document Metadata Subscription (DSUB) profile.

4. Discussion

Our initial thinking started with the upload of scheduling documents within the EPD. We detected quickly, that this approach causes several challenges: Every change in the date of an appointment as well as every response of a participant result in a new document version. Moreover, every appointment change requires a complete download of the whole document and the upload of the modified version. In the current state of the EPD, patients can only read their documents and not actively manipulate them. Thus, a patient would be unable to suggest or confirm a date for an appointment. Furthermore, within the Swiss EPD architecture, it is impossible to upload documents that are not directly patient-related. Therefore, healthcare providers and other possible participants could not provide their availability in form of an own schedule.

For this reason, we propose the (combined) use of FHIR as a potential alternative to the direct document-based mirroring of the scheduling process within the EPD. We are fully aware that the additional use of FHIR implies a significant additional effort. Every healthcare institution will be required to provide her own FHIR endpoint with the schedules of the bookable resources. Because of this additional effort, the whole national scheduling process in the suggested form should be considered as an optional extension which institutions can freely choose to implement and use.

An additional effort is necessary to convert the FHIR appointment resource to a CDA document as soon as the appointment is booked. The scheduling process itself could be performed without the conversion of the document and its upload to the EPD. For this reason, the question should further be analyzed if and when the appointment is uploaded to the EPD during this process. Once the upload is completed, the patient is no longer able to actively manipulate the appointment because of mentioned limitations of the EPD. Nevertheless, possible benefits of persisting an appointment as a document in a national patient record concern the reuse of the appointment data. Documents resulting from an appointment could be directly linked to this visit, providing an additional opportunity to sort and search documents of a patient. On the other hand, the total number of EPD documents grows considerably.

The proposed inter-sectorial appointment scheduling process has been designed for integration with the Swiss EPD. We did not explicitly examine the compatibility with other national health record implementations. During analysis of the Swiss EPD infrastructure and the corresponding standards it turned out that such integration requires additions such as the integration of the IHE CSD profile and the IHE DSUB profile. Although the IHE CSD profile would also provide the possibility to check the availability

of a service by using the transaction ITI-75 based on CalDAV (RFC 4791), we decided to use the IHE CSD profile to retrieve the FHIR endpoint. The main reason for this decision lies in the possibility to include further FHIR resources in the process in future steps. For example the questionnaire resource could be utilized to request further information.

This concept provides the foundation for a possible solution to digitalize the cross-institutional appointment booking process. FHIR is still a new and emerging standard and further work is required to demonstrate the practicability of our proposal. The next step is the validation through experts and the implementation of a proof of concept. This should include at least an implementation for one institution. This proof of concept can provide further information that can be used to parametrize the FHIR resources and the possible appointment document for a national standardization. It also should be evaluated if there is a need for the upload of the appointment document once the appointment is booked. In parallel, the integration of the IHE CSD profile to a national patient record infrastructure such as the Swiss EPD should be considered.

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