Representation of inter-patient relations within electronic healthcare record architectures

Georg Duftschmid, Walter Gall
University of Vienna, Department of Medical Computer Sciences,
Spitalgasse 23, A-1090 Vienna, Austria
{georg.duftschmid, walter.gall}@akh-wien.ac.at
www.akh-wien.ac.at/imc/

Address requests for reprints and correspondence to:
Georg Duftschmid
University of Vienna, Department of Medical Computer Sciences,
Spitalgasse 23, A-1090 Vienna, Austria
Tel.: +43-1-40400 / 6696
Fax.: +43-1-40400 / 6697
Email: georg.duftschmid@akh-wien.ac.at

Keywords (MeSH): Family Relations; Interpersonal Relations; Models, Organizational;
Medical Record Linkage; Medical Records Systems, Computerized;
Information Storage and Retrieval;

Abstract

Inter-patient relations are relevant in numerous areas of medicine, such as in the examination of genetic disorders, environmental causes of diseases, and in epidemiology. Therefore, it is essential that inter-patient relations be well integrated into the electronic health care record (EHCR). In the present paper we will show how inter-patient relations can be modelled within the three important EHCR architectures CEN ENV 13606, HL7 Clinical Document Architecture, and GEHR. We will use a general model for the specification of inter-patient relations as our reference model, which covers genetic and non-genetic kinship relations as well as temporary communities of persons.
1 Introduction

Inter-patient relations (IPRs) are relevant in numerous areas of medicine, such as in the examination of genetic disorders, environmental causes of diseases, and in epidemiology. Depending on the nature of the medical problem, different types of IPRs have to be considered. The most commonly addressed IPR in the medical domain is the consanguinity relation. This kind of relation is needed to understand genetically determined familial disease patterns, genetic risk factors in would-be parents, and the effects of complications during pregnancy, to name a few areas [1-3]. Non-genetic kinship relations are also relevant in certain medical questions [4]. As an example, the partner relationship is frequently referred to in the context of sexually transmitted diseases [5]. Temporary communities of persons, such as residence, working place, or a shared hospital room, constitute a third kind of IPR that plays a role in the medical domain [6]. For instance, being able to retrieve all members of a household can help the family practitioner to protect the individuals from a contagious disease: A patient with a disorder that compromises the immune system, such as leukaemia or AIDS, will receive only limited protection from vaccination. Vaccinating all members of the household may, however, reduce the likelihood of the immunocompromised patient being exposed to the infectious agent [7]. To cite another example, the ability to retrieve spatial contacts within large hospitals can greatly enhance the effectiveness of infection control [8].

In clinical routine, IPRs are currently only documented in specific contexts, such as birth clinics (mother’s and child’s identifiers are marked as belonging together), genetic counselling clinics (data of would-be parents are linked in specific ways to assess their chances of reproduction), and hypertension clinics (to explore inherited disposition as an important risk factor). Sometimes, the derivability of IPRs is an inadvertent spin-off that was never envisaged in the original design. In transplantation surgery, for example, IPRs are documented because it is obviously advisable to use the organs of consanguineous relatives for reasons of histocompatibility. Thus, the documented donor-recipient relation and other information such as last name or address serve as a basis to derive the fact, and sometimes even the closeness, of kinship. Apart from the medical domain, numerous registers of interpersonal relations exist. Some of these are even accessible over the internet, such as Family Search (http://www.familysearch.org/), Ancestry.com (http://www.ancestry.com/), or RootsWeb.com (http://www.rootsweb.com/).
The focus of this paper will be to examine existing electronic health care record (EHCR) standards for their preparedness to implement IPRs. Currently, the three most important standards or quasi-standards in this domain are the CEN ENV 13606 [9-12], HL7 Clinical Document Architecture (CDA) [13], and GEHR (http://www.gehr.org) architectures. All three approaches are concerned with the exchange of (parts of) EHCRs between institutions. The transmission of IPRs becomes necessary in several communication scenarios, such as the transfer of data from multicentre genetic studies. In this case, the health data of each examined family will be acquired by one of the study sites. These data, together with the information as to how the patients are related, must then be transferred from the acquiring site to the site managing the central study database. Another example is the communication of EHCR data used by family practitioners, for whom IPRs are of particular importance [7, 14].

This article is organized as follows: Section 2 provides an overview of related work about the implementation of IPRs. Section 3 presents a general model for the representation of IPRs, which we will use as a reference model. Three important EHCR architectures, namely the CEN ENV 13606, HL7 CDA, and GEHR approaches will be analysed in section 4 for their suitability to represent IPRs. In section 4.1, a corresponding model will be presented, which we composed from components of the CEN architecture. As will be shown in section 4.2, IPRs can be represented within the HL7 CDA. In section 4.3 we will examine a third model for the specification of a patient’s family history, which was developed in the course of the GEHR project. Section 5 presents a comparison of the three models, while the conclusions are summarised in section 6.

2 Related work

First hypotheses about genetic linkage were formulated in 1865 by Gregor Mendel, also known as Mendel’s laws [15]. Since genetic linkage analyses are now supported by several computer programmes, a theoretical background and general understanding of the subject are necessary [16]. Apart from the medical domain, corresponding efforts have been made within many other research areas such as sociology or anthropology, where the anatomy of family relations is being analysed since a long time [17].

An early proposal for computerized records to specify the IPRs mother, father, and marriage, as well as suitable retrieval functionalities was made in [18]. It allows the definition of dates for four different events, namely marriage, divorce, birth, and death. The records are inserted
in a pointer structure according to their temporal sequence. A limitation of the approach is that the same data structure is suggested for the definition of the properties of a person as well as of a marriage, thus ‘reusing’ the birth and death attributes to specify the dates of the marriage and its separation. This requires any procedure that processes the data structure to foresee a case distinction.

In [19] Newcombe examines approaches aimed at automatic linkage of different entries referring to the same individual within large files of personal records based on certain demographic identifiers. As only distributed data of the same person are to be connected here, it is essential to avoid linking entries of different persons with similar demographic identifiers, such as members of the same family or household. Newcombe identifies three typical sources of problems for unwanted linking and provides suggestions to encounter these problems.

The specification of family relations between patients facilitates research on family health [20, 21] and provides various advantages for family practices [22]. Tzeng-Ji Chen recommends a data model for this purpose, which allows the definition of relationships between two patients [14]. The ‘reverse’ relation (e.g. son or daughter as the counterpart of father) is automatically added in this approach.

3 A general model for the representation of inter-patient relations

An essential first step towards the integration of IPRs in medical documentation is the existence of an appropriate formal model for their specification. In [23] we suggested a corresponding general model (see figure 1) for the representation of genetic and non-genetic kinship relations, as well as temporary communities. Three different kinds of relations between patients may be expressed, which we name consanguinity, temporal kinship and temporary membership relations. With reference to this model, we will examine the suitability of three important EHCR architectures to represent IPRs (see section 4). Figure 1 and all subsequent figures use standard UML notation.

[Insert figure 1 about here]

The class Consanguinity specialises the abstract class Directed Association, which allows the expression of directed one-to-one relations between two persons. The actual type of relation is
specified by means of the associated class Relation Type, for which the class Consanguinity prescribes a list of allowed terms. Term lists for the class Relation Type can be extended without having to change the model itself.

Temporal Kinship equally is a subclass of Directed Association. It further inherits time attributes from the abstract Episode class. These are used to specify the time interval during which the temporal kinship relation was valid. The type of relation may be selected from a list that is predefined by the class Temporal Kinship.

Temporary Membership is a subclass of the abstract Association class, which allows the grouping of two or more instances of the class Person by binding them to a common instance of the class Community. Each person may be member of any number of communities, such as common residences, hospital rooms, or working places. Each membership may be temporally constrained by an individual time interval.

Apart from the static components described above, our model comprises a dynamic layer. The dynamic layer adds functionality to the model, providing services such as the handling of missing relations or checking newly inserted relations for consistency with existing ones (see [23]). This functionality is useful when IPRs are managed within a database. For the purpose of communicating IPRs, which is the focus of this paper, it is of minor importance. Therefore, the dynamic layer of our model will not be addressed in this article.

4 Representing inter-patient relations within EHCR architectures

Of the different EHCR architectures that exist today, the CEN ENV 13606, HL7 CDA, and GEHR approaches deserve particular attention. Based on object-oriented and component-oriented technology, they provide sophisticated models to support EHCR exchange. A comparison and evaluation of the three architectures can be found in [24]. In this section we will examine the three approaches for their suitability to represent IPRs. We will refer to the general model of IPRs presented in section 3. Of the three approaches, we will concentrate on the CEN ENV 13606 architecture.
4.1 The European Prestandard ENV 13606

The European Prestandard ENV 13606 is entitled Electronic Healthcare Record Communication and consists of four parts: Extended architecture [9], Domain term list [10], Distribution rules [11], and Messages for the exchange of information [12]. It was approved by CEN in June 1999 as a prospective standard for provisional application. Currently, the Prestandard is undergoing a review and revision process that might finally lead to its adoption as a formal standard in 2004. As indicated by the general title, ENV 13606 is concerned with how to communicate parts of, or an entire, EHCR between systems. For this purpose, it provides a set of architectural components (see figure 2) from which an EHCR communication may be constructed. Conformance to ENV 13606 can be formally checked on the basis of a set of conformance clauses which are specified in the Prestandard.

[Insert figure 2 about here]

Figure 2 shows a selection of architectural components and relations from ENV 13606 which are relevant for our purpose. Attributes we do not use in the context of IPRs are omitted for reasons of simplicity. In the following, we will give a short overview of the semantics [9-12] of the architectural components shown in figure 2:

- Architectural Component: This is an abstract class which captures the associations and attributes common to all of the main components within the Architecture.
- EHCR Root Architectural Component: This class represents the component which contains the electronic healthcare record of the subject of care.
- Record Component: It is an abstract class and represents the generalization of all the classes of components which act as data or structural entries within an EHCR.
- Link Item: It links an instance of Architectural Component (nominated as the source component) with another instance of Architectural Component (nominated as the target component).
- Original Component Complex: It is an abstract class that provides for its members an organization / a structure.
- Selected Component Complex: This class is similar to the Original Component Complex but has as its members references to Record Components which are not its direct descendants. This allows ‘views’ to be created, i.e. where original data may be viewed in another context.
• Folder OCC: It is used as a high-level subdivision of the entire EHCR for a subject of care, usually grouping entries over long time spans within one organization or department, or for a particular health problem.

• Composition OCC: It is used as the preferred specialization of OCC when it contains a set of record components relating to one time and place of care delivery, a single session of recording, or a single document included in the EHCR.

• Data Item: It is the Record Component which represents the smallest structural unit into which the content of the EHCR can be broken down without losing its meaning. Data Item is an abstract class which is manifested as one of its sub-classes which differ in their content type.

• Patient related Party Data Item: Information about a person or organization who plays a role in relation to the patient’s care other than as a healthcare agent.

• Related Location Data Item: Information about a location, including associated information.

• Component name structure: A coded descriptor, title, heading or label which represents the primary focus of nature of the information conveyed by an Architectural component.

• Composite code: A class used to specify coded information based on the attributes ICSI (International Coding Scheme Identifier), the coded element itself, and a textual representation of its meaning.

• Identifier: A general purpose identifier, based on the attributes type of entity that is identified and the identifier value itself.

• Related date: A date that is related to an Architectural component.

• Term list value: A code value and optional code meaning derived from a table in [10].

• Coded: A code with a textual description. Analogous to the class Composite code.

• Location details: Information about a geographical location or type of location, expressed without a formal postal address.

• Address: An address expressed in a structured or unstructured form.

• Bed location: A location expressed as a combination of a room and ward.

[Insert figure 3 about here]
Figure 3 shows our model for the representation of IPRs within ENV 13606. It exclusively uses components that were prescribed in [9-12]; no additional classes have been introduced (compare figure 2).

Connecting the records of related patients by means of link items seems to be an obvious approach for the representation of IPRs within an ENV-13606-conformant EHCR. However, we decided to use patient ids instead for the following reason: The ENV 13606 is concerned with the communication of the EHCR (or parts thereof) of a single, individual patient. This is underlined by the general message description of the EHCR message (from which all other messages of the ENV 13606 are derived), which contains a mandatory attribute patient matching information with cardinality one [12]. When using link items to connect the EHCRs of related patients, however, more than one EHCR would have to be included in one message.

Therefore, instead of linking EHCRs by means of actual link items, we use ids to connect them. All Consanguinity and Temporal kinship relations (see figure 1) of a patient A are specified by adding the ids of the related patients to a set of Patient related party data items within patient A’s EHCR. All Temporary membership relations (see figure 1) of a patient A are specified by adding the ids of the corresponding communities to a set of Related location data items within patient A’s EHCR. For storing the relations within a database, they may be transformed to direct links between EHCRs after the ENV 13606 message is mapped to the data model of a local database.

As the root container for the specification of IPRs we use an instance of the Folder OCC class. The folder is designated by a Component name structure, using a suitable code within its name original code attribute. Table A.2 of ENV 13606 [10] contains the identifier-name pair ‘DTH02 – Non-Patient History’ for the architectural component Headed Section, which may be used to denominate containers for ‘information recorded about persons other than the patient’. We refrained from using this concept because of the containment rules prescribed for Headed Sections [9]: Headed Sections may only be applied as components of Composition OCCs or other Headed Sections. At this level they would not have been helpful for our model. As is reflected by cardinality 0..3, we use a separate Composition OCC for each of the three relation types consanguinity, temporal kinship, and temporary membership. The compositions are designated by Component name structures, using a suitable code within their name original code attribute. Each composition may hold any number of two particular
specialisations of Data item, namely Patient related party data items and Related location data items.

Patient related party data items may be used to specify consanguinity and temporal kinship relations between patients. Only the Identifier of the related person is included in the message using the attribute id of patient related party of the Patient related party data item. The EHCR of the related person itself can be communicated in a separate message. The relation type is specified within the attribute component name category of the Patient related party data item, using the code-value pairs defined within table E.4 of part 2 of ENV 13606 (e.g. ‘13-parent’, ‘20-sibling’, ‘31-partner’, …) [10]. For temporal kinship relations, the Patient related party data item can be associated with up to two Related dates (as expressed by cardinality 0..2) to specify the starting and end points of the time interval when the relation persisted. For the attribute role of the Related dates, the entries ‘81-date procedure began’ and ‘82-date procedure ended’ of table E.6 of part 2 of ENV 13606 may be used.

For the representation of temporary memberships we apply Related location data items. As with temporal kinship relations, they may be associated with up to two instances of Related date to specify the period of the membership. For the representation of a location, the three classes Address, Location details, and Bed location are provided. Table E.11 of part 2 of ENV 13606 contains a predefined list of location types, including the code-value pairs ‘03-working place’, ‘01-patient’s residence’, and ‘42-room’ [10]. When mapping the message to a local database, the locations expressed as Related location data items and shared by several patients may be transformed to a single instance of a class community within the local data model, which is directly linked to the EHCRs of the concerned patients. Figure 4 shows a possible instantiation of the CEN ENV 13606 IPR model shown in figure 3, comprising all three types of IPRs.

[Insert figure 4 about here]

4.2 Health Level Seven

Health Level Seven (HL7) (http://www.hl7.org) is a standardisation consortium that has released a series of standards for the exchange of healthcare information. Their newest work item is entitled HL7 Version 3 [25] and is currently still a draft. One of the characteristics of Version 3, which is in contrast to earlier versions, is the application of a single shared
information model, the so-called Reference Information Model (RIM), from which the components of all healthcare messages have to be drawn. The CDA standard [13] which is also part of Version 3, focuses on the representation and exchange of clinical documents and may be used to communicate EHCR data. It provides a set of specifications for the representation of documents, which are organized in a hierarchy of three levels with increasing semantic expressiveness. Levels two and three which are currently still in the planning phase will refer to the RIM to build the components of clinical documents and, thus, EHCR data.

In the following we will show how particular classes of the RIM may be used to represent IPRs (see figure 5 (a)). The RIM provides the general concept Person and realizes the more specific concept Patient as a Role of Person. Hereby, it is also possible to represent ‘inter-personal relations’, regardless of whether these persons are actually patients. The class Role comprises, amongst others, the attribute effectiveTime which allows the specification of a time interval during which the role is effective. It further contains the attribute code, which allows a specification of the type of role. By associating two instances of Person with one Role instance, it is possible to define consanguinity and temporal kinship relations. Directionality is expressed by the names (player and scoper) of the two associations. Temporary membership relations can be specified by linking a Person with a Place.

Figure 5 (b) shows an instance diagram based on an extract of the HL7 RIM V2.01 (http://www.hl7.org/Library/data-model/RIM/modelpage_non.htm) that describes the same scenario as in figure 4. If persons a, b, and c should be marked as patients, one would simply attach the role Patient to the corresponding instances.

4.3 The Good Electronic Health Record

The Good Electronic Health Record (GEHR) (http://www.gehr.org) which was developed from the Good European Health Record project [26, 27] pursues a similar goal as the ENV 13606 standard. GEHR provides an open information architecture that formally expresses a set of requirements about EHCRs. One objective of GEHR is to support the exchange of EHCRs between institutions. The GEHR methodology is based on two different tiers of modelling, namely the GEHR object model (GOM) and the GEHR archetypes. All elements of an EHCR are instances of the GOM. The archetypes constrain the possible instantiations of
the GOM by describing predefined valid combinations of instances. In other words, for each clinical concept that is to be included in the EHCR (e.g. blood pressure), a corresponding archetype may be defined, which prescribes how to apply the classes of the GOM to represent this concept. Among a set of existing archetypes, one has been defined for the concept family history (http://www.gehr.org/gpcg/Archetypes/List_archetypes.htm). This archetype permits the documentation of health issues of a patient’s family and considers genetic as well as non-genetic (partnered and adoptive) relations. For each health issue, the name of the corresponding family member and his/her relationship to the patient can be specified. Further, a list of medical problems can be documented, each with the attributes date onset, date diagnosed, status, and comment. It is assumed that the health issues of a patient’s family which are considered relevant for the patient are added to the latter’s EHCR.

5 Discussion

Table 1 provides a comparison of the three approaches of representing IPRs within the CEN ENV 13606, the HL7 CDA, and the GEHR architecture. The models based on CEN ENV 13606 and HL7 CDA have very similar characteristics. The GEHR archetype family history primarily differs from the other two models in the fact that it represents IPRs by storing the data of health problems from related persons within the patient’s EHCR instead of keeping references to the EHCRs of related persons. As a result, the GEHR archetype records the time of occurrence and diagnosis of the related persons’ health problems, as opposed to the other two models which focus on the time interval during which a particular non-genetic relation persists. Finally, the GEHR archetype concentrates on members of the patient’s family and does not consider temporary communities of patients, such as common residences or shared hospital rooms.

[Insert table 1 about here]

The CEN ENV 13606 and HL7 CDA models presume that EHCRs exist for all persons who should be documented as being related to the current patient, and that these EHCRs are uniquely addressable. Although this includes EHCRs of those external systems whose identifiers or objects may be mapped to the local system, EHCRs outside of the local system’s address space will not be integrated. This is a barrier to complete documentation of IPRs. The GEHR model has the advantage of not being dependent on the existence and address-ability of related persons’ EHCRs. Documentation of IPRs, and even of related persons’ data will,
however, be equally incomplete: Only those data of selected related persons are recorded, which are considered relevant by the documenting person for a particular medical question. These data will be rarely usable in other contexts.

The usage of references to EHCRs of related persons, as provided by the models based on ENV 13606 and HL7, must remain conformant to the security concepts of the EHCR system. We presume the existence of a general system component which controls data access and treats access to EHCRs by means of references to related persons in an equal manner as any other kind of EHCR access.

Concerning the immediate accessibility of data from related persons at the receiver side of an EHCR exchange, GEHR requires less effort of transmission than the CEN ENV 13606 and HL7 models: As the data of persons related to patient X are stored within the latter’s EHCR, only patient X’s EHCR has to be transmitted. The CEN ENV 13606 and HL7 models only store references to the related persons’ EHCRs within patient X’s EHCR. Therefore, they require the additional transmission of all related persons’ EHCRs to make their data available to the receiver of an EHCR exchange. This additional effort, however, allows the receiver to access all (not otherwise protected) data of the related persons, as opposed to GEHR, where accessibility is limited to those data which were presumed to be relevant and were therefore stored in patient X’s EHCR.

6 Conclusion

In this paper we have examined three important EHCR architectures for their suitability to represent IPRs, namely the CEN ENV 13606, HL7 CDA, and GEHR approaches. Our investigation was based on the following three steps:

- We created a model for the representation of IPRs, which we composed from components of the CEN ENV 13606 architecture.
- We describe a model which builds an extract of the HL7 RIM and can be used to represent IPRs within the HL7 CDA.
- We have discussed an existing model for the specification of a patient’s family history, which is based on the GEHR architecture.
We used a general model for the specification of IPRs as our reference model, which covers genetic and non-genetic kinship relations as well as temporary communities of persons. In the following we will summarise the characteristics of the three models:

As the models based on ENV 13606 and the HL7 RIM are functionally very similar, we will handle them together: (1) By recording only references to the related persons’ EHCRs, the duplication of data, which complicates data consistency and maintenance, is avoided. It is also not necessary to decide in advance what data of related persons could be relevant for any future investigation and should therefore be stored. Instead, all data can be retrieved from the related persons’ EHCRs when a corresponding query is executed. (2) Both data models permit the association of a group of patients with a location, such as a common residence, working place, or a shared hospital room. This kind of relation may be used to identify the source of an infection, for example. (3) Using the references to related persons, it is possible to automatically initiate preventive measures, such as reminders for vaccinating every member of a household after the occurrence of a contagious disease. (4) The retrieval of data from related persons requires holding access rights to their EHCRs. For scientific analyses, such as statistics prepared in the course of clinical studies, this does not pose a major restriction, as the retrieved data are usually rendered anonymous. General practitioners, in particular family physicians, will also not be affected by this circumstance, as they will have unrestricted access to the data of all patients within their EHCR system.

The GEHR archetype family history may be characterised as follows: (1) It is assumed that the health issues of a patient’s family which are considered relevant for the patient are added to the latter’s EHCR. This has the advantage of allowing access to family data without having to go through other EHCRs. (2) At the time point of a query, all data stored within the family history section can be retrieved without access restrictions. The question as to whether the data of a related person may be stored within a patient’s family history must be decided when the data are entered. (3) Storing data of members of a patient’s family within the patient’s EHCR has some drawbacks. If EHCRs also exist for the family members, some of their data will most likely be duplicated. Second, it appears difficult to know in advance exactly what data of a related person are relevant for all possible future queries of a patient, and should therefore be placed in the family history section of the patient’s EHCR. As the EHCRs of family members are not linked, retrieving any data that are not stored in the family history at the time point of a query is rendered complex, if not impossible. (4) Focusing on the problems of related persons instead of the relations themselves will result in recording only relations to
those persons with a known medical problem that concerns the patient. This excludes automatic initiation of preventive measures concerning related persons.

A subject of future work might be to investigate ways of combining the two described approaches for the representation of IPRs, namely the recording of references to the EHRs of related persons as well as the storage of related persons’ data. The ISO technical specification ISO/TS 18308 Requirements for an Electronic Health Record Reference Architecture (EHRRA) [28] postulates that ‘the EHRRA shall support links to externally referenced data which cannot be stored within the EHR, providing patient safety is not compromised’ (requirement STR3.23). Storing data within a patient’s EHCR that already exist in the EHCRs of related persons is problematic, as these data would be duplicated. They could be more efficiently referenced by links. Original data, such as synopses of a related person’s medical history (e.g. summarising remarks about a parent’s history of lung cancer instead of references to individual details about the course of the disease), could be stored within the patient’s EHCR, which would make them immediately available without having to search other EHCRs. This could also be done in situations where the EHCR of a related person cannot be referenced (because it is located outside the local system’s address space), and the creation of a new EHCR in the local system is undesirable.

**Acknowledgements**
The authors wish to thank Wolfgang Dorda for his valuable suggestions and kind support of their work.
References


Figure 1
Figure 2
Term list value (value/meaning) = 
{(81/date procedure began), 
(82/date procedure ended)}

Composite code meaning = 
{consanguinity, temporal kinship, 
temporary membership}

Composite code meaning = 
inter-patient relations

Term list value (value/meaning) = 
{(13/parent), (18/child), (20/sibling), 
(16/grand-parent), (31/partner), ...}

Term list value (value/meaning) = 
{(81/date procedure began), 
(82/date procedure ended)}

Figure 3
Figure 4
Figure 5
<table>
<thead>
<tr>
<th>IPR model properties</th>
<th>CEN ENV 13606</th>
<th>HL7 CDA</th>
<th>GEHR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model description</td>
<td>Composition of ENV 13606 classes</td>
<td>Extract of HL7 RIM family history</td>
<td>Predefined archetype family history</td>
</tr>
<tr>
<td>Only predefined components were used</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Representation of IPRs through</td>
<td>storage of ids of related persons</td>
<td>storage of links to related persons</td>
<td>storage of data of related persons</td>
</tr>
<tr>
<td>Support for temporary communities</td>
<td>yes</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>Temporal annotations provided for</td>
<td>non-genetic relations</td>
<td>non-genetic relations</td>
<td>data of related persons</td>
</tr>
</tbody>
</table>
Figure 1. A general model for the representation of inter-patient relations. Text fields attached to individual classes contain constraints on the permitted values of the attribute term within the class Relation Type.

Figure 2. Excerpt of CEN ENV 13606 architectural components (adapted from [9]). Cluster OCC, Headed Section OCC, and all but the depicted two Data Item subclasses are not relevant for us and therefore not shown. The components incorporated in our model for the representation of IPRs (see figure 3) are shown in grey. All aggregation relations have the cardinality ‘0..*’.

Figure 3. Model for the representation of inter-patient relations, composed of components from CEN ENV 13606. To customise our model for the representation of inter-patient relations, we have further constrained permitted attribute values (see text fields attached to individual relations) and cardinalities (compare figure 2).

Figure 4. Instance diagram of inter-patient relations based on the model shown in figure 3. Patient ‘a’ is the husband of patient ‘b’ since 2-3-90 and the father of patient ‘c’. Further, patients ‘a’ and ‘c’ shared the same residence between 4-5-89 and 8-9-93. The EHCR of patient ‘a’ is shown in light grey whereas the EHCR of patient ‘c’ is shown in dark grey. The EHCR of patient ‘b’ is omitted. Term list meanings are abbreviated for easier legibility.

Figure 5. (a) Extract of the HL7 Reference Information Model (RIM) V2.01. (b) Instance diagram of inter-patient relations, describing the same scenario as in figure 4. For reasons of simplicity, association names are omitted and the roles isFatherOf, isHusbandOf, and livesAt are represented as the names of instances of the class Role. As no particular subclasses exist in the RIM for these roles, they would have to be represented as codes within the attribute code of class Role.