The Ninth International Conference on Global Health Challenges
GLOBAL HEALTH 2020 October 25, 2020 to October 29, 2020 - Nice, France

Special track: eHealth: Patient-centric eHealth Services

Modelling and Management of ePrescriptions on openEHR Platform in Bulgarian eHealth

Petko Kovachev, Evgeniy Krastev

Faculty of Mathematics and Informatics,

Sofia University St. Kliment Ohridsky, Sofia, Bulgaria

Presenter

Petko Kovachev:

PhD student in Mathematics and Computer Science
at Sofia University St. Kliment Ohridsky,
Faculty of Mathematics and Informatics
M.Sc. in Pharmacy
M.Sc. in BioMedical Informatics

Scientific areas of interest:

BioMedical Informatics,
Health Informatics,
Database Management
Object Oriented Programming,
Web Application Development

Presenter

Evgeniy Krastev:

Professor, PhD in Mathematics and Computer Science
at Sofia University St. Kliment Ohridsky,
Faculty of Mathematics and Informatics
ORCID 0000-0001-8740-5497
IEEE member number 93376282

Scientific areas of interest:

Robotics and Mechatronics,
Object Oriented Programming,
Health Informatics,
Database Management,
System Analysis and Design,
Information System development

Structure

1. **Introduction**
2. **Sources**
3. **Material/Methods**
   - 3.1 openEHR description
   - 3.2 openEHR reference model
   - 3.3 EHRServer description
   - 3.4 Analysis of XSD models
   - 3.5 Computationally modeling of archetype and Operative Template
   - 3.6 Development of an INSTRUCTION archetype
   - 3.7 Development of EHR Operative template
   - 3.8 Software realization of a client for creation and retrieval of EHRs
   - 3.9 Creating of EHR contribution type ePrescription
   - 3.10 Extraction and visualization of an EHR document type ePrescription
4. **Conclusions**

1. Introduction

Purpose:

The need for improved quality of health services is one of the main reasons for adopting prescriptions in electronic format (ePrescription) as a preferred way for purchasing medicinal products. The objective of this paper is to propose a methodology for modelling and management of ePrescriptions using openEHR specifications.

Tasks:

1. Research of existing international health information standards to ensure semantic interoperability of heterogeneous data.
2. Analysis of W3C XML schema definitions used to report claims of pharmacies to the NHIF for reimbursed drugs
3. Computationally modeling of archetype and openEHR operative template to met the requirements for electronic health record for drug therapy and compatible with NHIF requirements.
4. Installation and configuration of EHRServer instance and turn on into production environment.
5. Load the created operational template into the running instance of EHRServer and create basic health records for patient identifiers.
6. Development of a prototype client application / module for creating and retrieving an electronic health record for drug therapy in accordance with the developed operational template.

2. Sources

1. openEHR, „3. The EHR Information Model,“ The openEHR Foundation, December 2018. [Онлайн]. Available: https://specifications.openehr.org/releases/RM/latest/ehr.html#_the_ehr_information_model. [Отваряно на 4 May 2019].
2. openEHR Foundation, „10. Archetypes and Templates,“ openEHR, December 2018. [Онлайн]. Available: https://specifications.openehr.org/releases/BASE/latest/architecture_overview.html#_archetypes_and_templates. [Отваряно на 4 May 2019].
3. CaboLabs, „CloudEHRServer,“ 2019. [Онлайн]. Available: https://cloudehrserver.com/. [Отваряно на 10 Apr 2019].
4. P. P. Gutiérrez, „Towards the Implementation of an openEHR-based Open Source EHR Platform (a vision paper),“ в MEDINFO 2015: EHealth-enabled Health: Proceedings of the 15th World Congress on Health and Biomedical Informatics, São Paulo, Brazil, 2015.
5. Ocean Health Systems, „Archetype Editor,“ 2015.
6. Ocean Health Systems, „Template Designer,“ [Онлайн]. Available: https://oceanhealthsystems.com/products/template-designer.
7. Национална Здравна Осигурителна Каса, „Формат на XML файл за отчитане на исковете на аптеките-договорни партньори на НЗОК - в сила от 01.04.2019 г.,“ 2019. [Онлайн]. Available: https://www.nhif.bg/get_file?uuid=86CAD15F5F432255E05400144FFB42AE.
8. E. Krastev, P. Kovatchev и S. Abanos, „Knowledge Management with openEHR Server,“ в Трета Национална конференция „Общественото здраве – капиталът на бъдещето“, Пловдив, 2019.

3. Material/Methods

The proposed ePrescription model is a template composed of openEHR archetypes corresponding to clinical concepts in existing National Health Insurance Fund (NHIF) prescriptions.

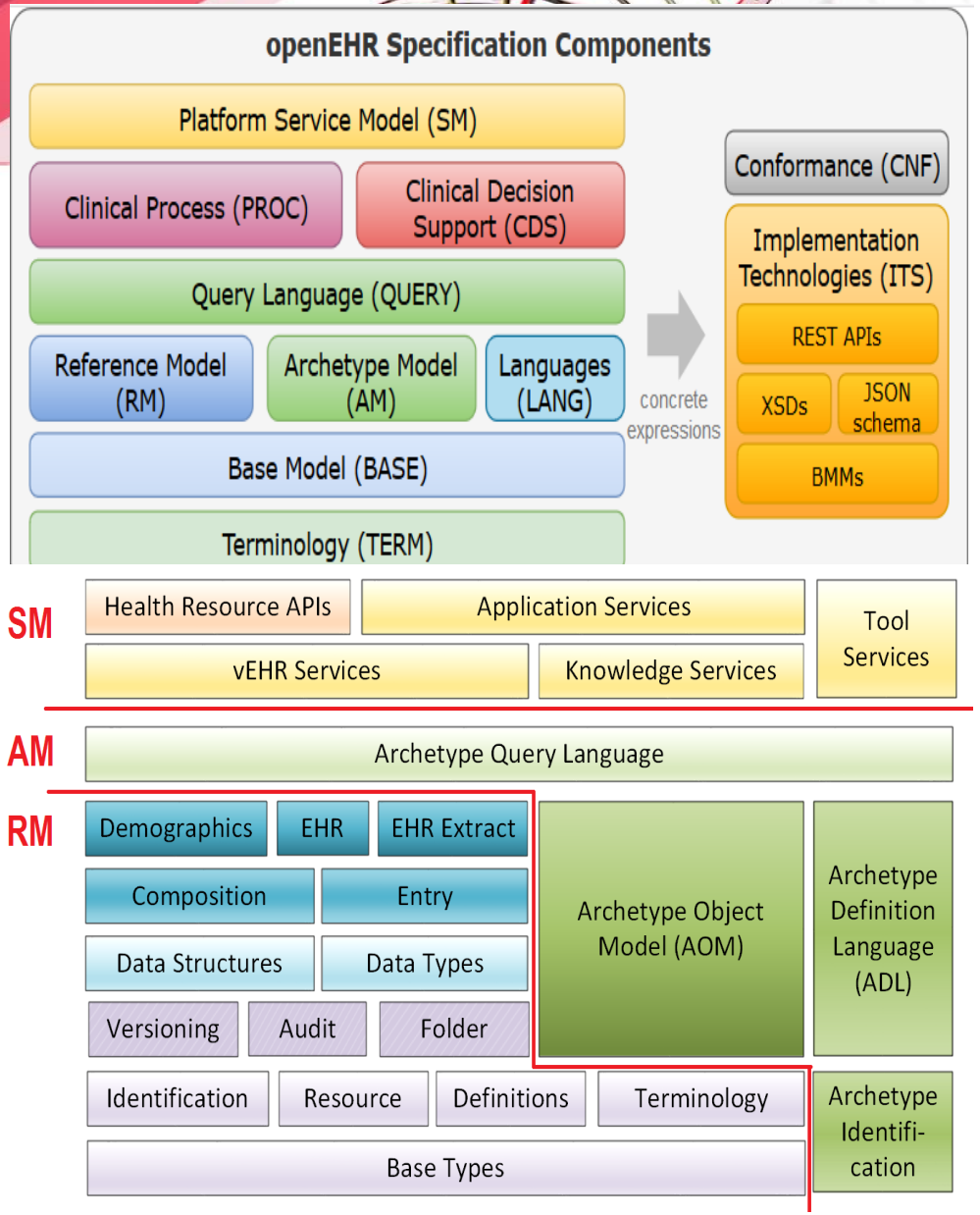
An open source openEHR platform is configured for evaluation the practical implementation of basic functional requirements of the model.

HTML/PHP/JavaScript web application has been developed to demonstrate functionalities for creating, modifying and extracting of EHR records type e-prescription

3.1. openEHR Description

openEHR - https://www.openEHR.org/ is an free open standard specification https://specifications.openehr.org/ in health informatics that describes the management and storage, retrieval and exchange of health data in electronic health records (EHRs). In openEHR, all health data for a person is stored in a "one lifetime", vendor-independent, person-centric EHR. openEHR specifications are vendor independent and are maintained by the openEHR Foundation. The openEHR specifications[4] include information and service models for the EHR, demographics, clinical workflow and archetypes.
openEHR architecture uses this logical models for grouping and describing of health records components:

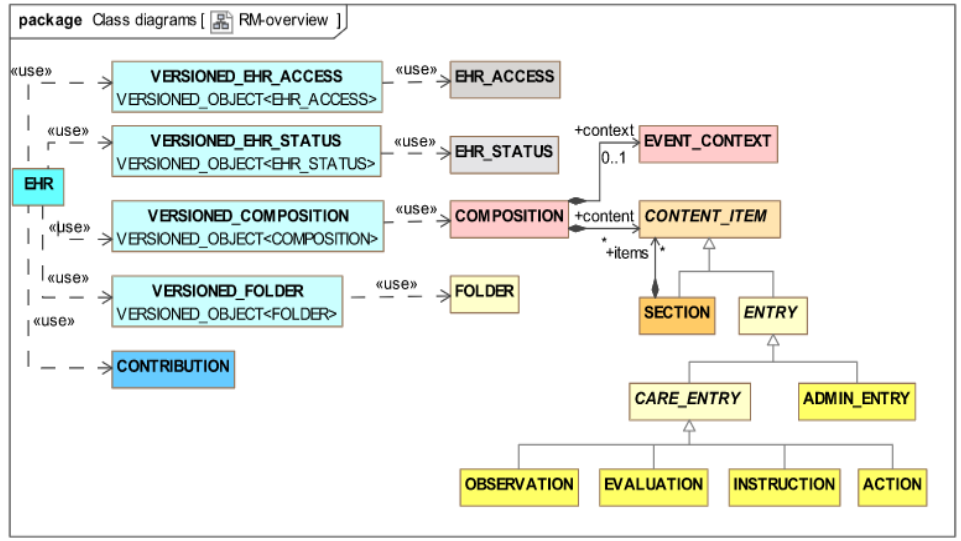
- **Platform Service Model SM** – In this modes are grouped all services which communicates each other.
- **Archetype Model AM** – In this logical model are grouped methods, technologies and languages for creation modeling and maintenance of archetypes like ADL, AOM, AQL и OPT
- **Reference Model RM**– Object oriented model designed to present all properties and structures of every HER and relations between them.

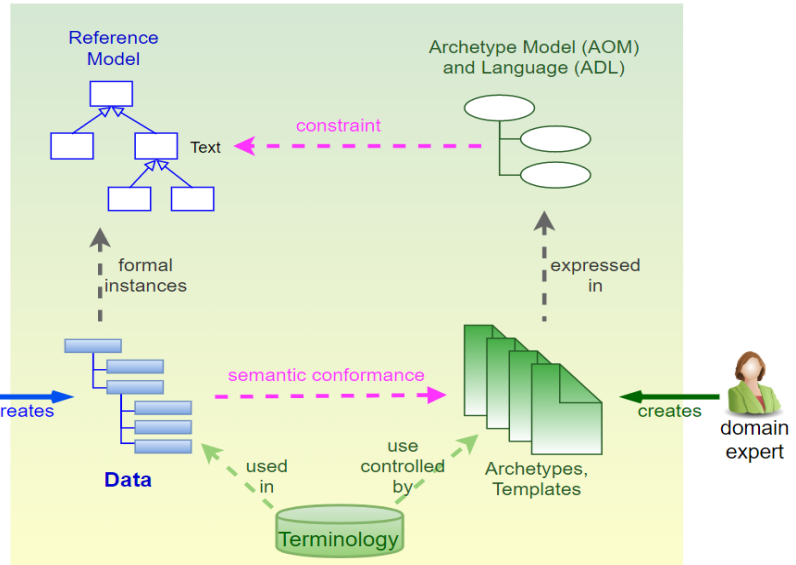


3.2. openEHR Reference Model

EHR is main subject of the openEHR reference model, where are stored all health records related with current subject /patient/.
With **ENTRY** object of reference model in openEHR are defined various clinical documents related with health records and their properties.It's member objects are ADMIN_ENTRY, which holds administrative data и CARE_ENTRY, which holds archetypes with clinical data members ot these child classes:

- **OBSERVATION** – Contains clinical records that happens in past or in present like measurement of indicators /blood pressure, blood sugar/ or events reported by the patient like pain, insomnia etc.
- **EVALUATION** – Contains information about evaluation of current patient's condition
- **INSTRUCTION** – Contains instructions to patient or health workers for actions that should be preformed in the future.
- **ACTION**– Contains information for documenting of action made in the past with option for define and conduct workflow actions and results.





3.3. EHR Server description

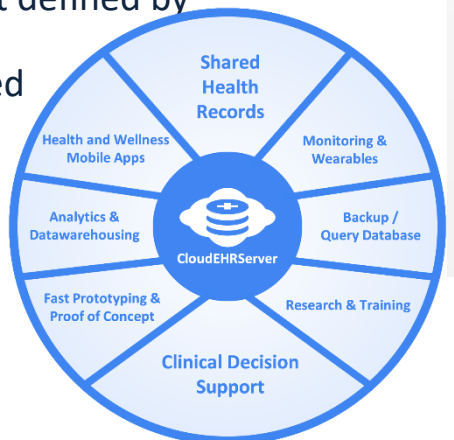
EHRServer is an open source, service-oriented, openEHR clinical data repository.

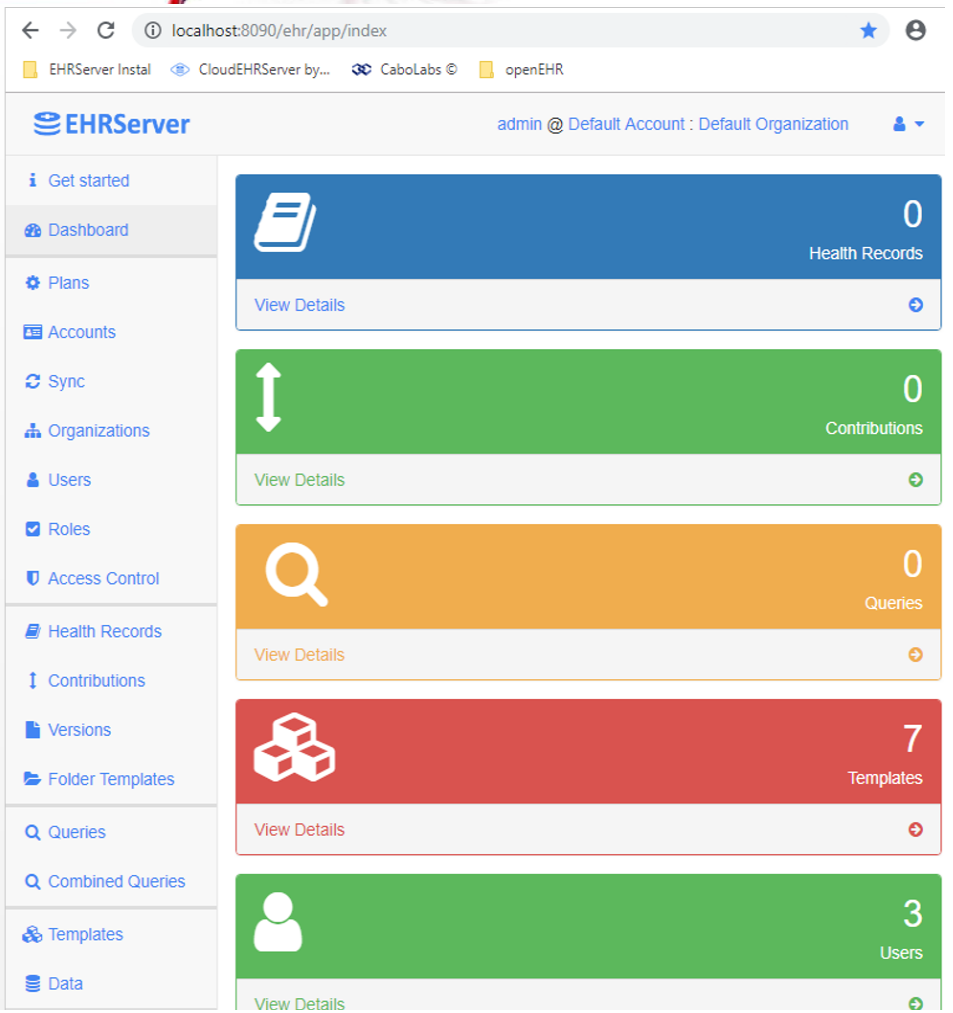
EHRServer terms and concepts:

- Organization – Logical organization with users, health records ,operational templates.
- User – System user with login and password.
- Roles – groups of access permissions .
- Subject – Identifier of person/patient/ for which health records are made. Base principal is in EHRServer to be stored only subject ID and all other personal data to be stored on other server due to privacy and security reasons
- Health Record – Main health record in EHRServer, which contains all clinical records for one subject in organization. Corresponds to HER class in Reference Model
- Contribution – Collection of 1 or more compositions which are submitted together to EHRServer's REST API.
- Composition – Composition of clinical records data in format defined by Operational Template
- Version – On update new version of health record are created

EHRServer components:

- Data storage of EHR based on MySQL DB.
- REST API access, create and modify EHRs
- Administrative web console of EHRServer

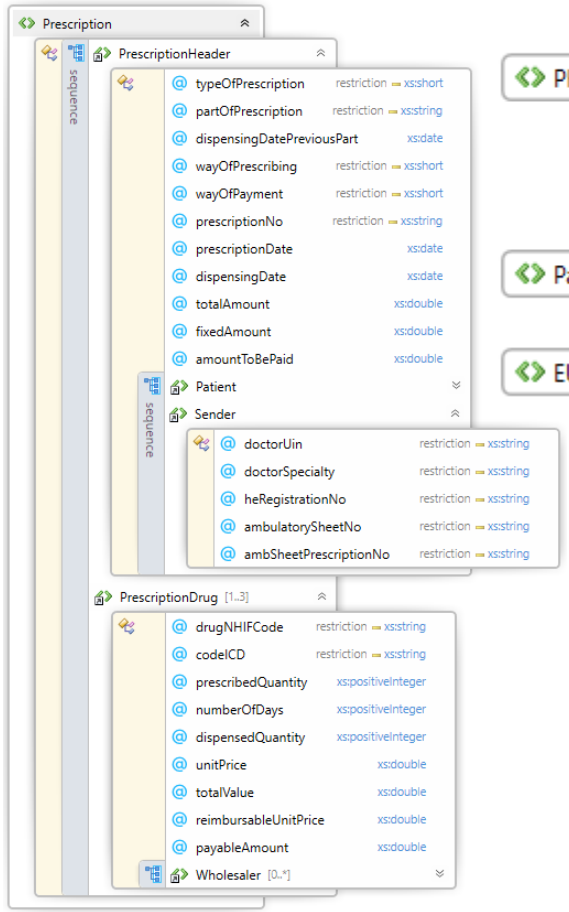


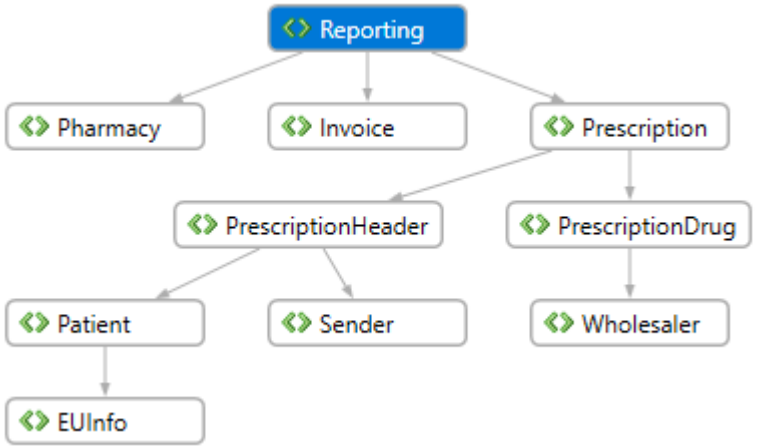


3.4. Analysis of XSD models

NHIF publishes on address
https://www.nhif.bg/page/145
XML schema file format for reporting of the claims of the pharmacies to the National Health Insurance Fund for reimbursed medicines.

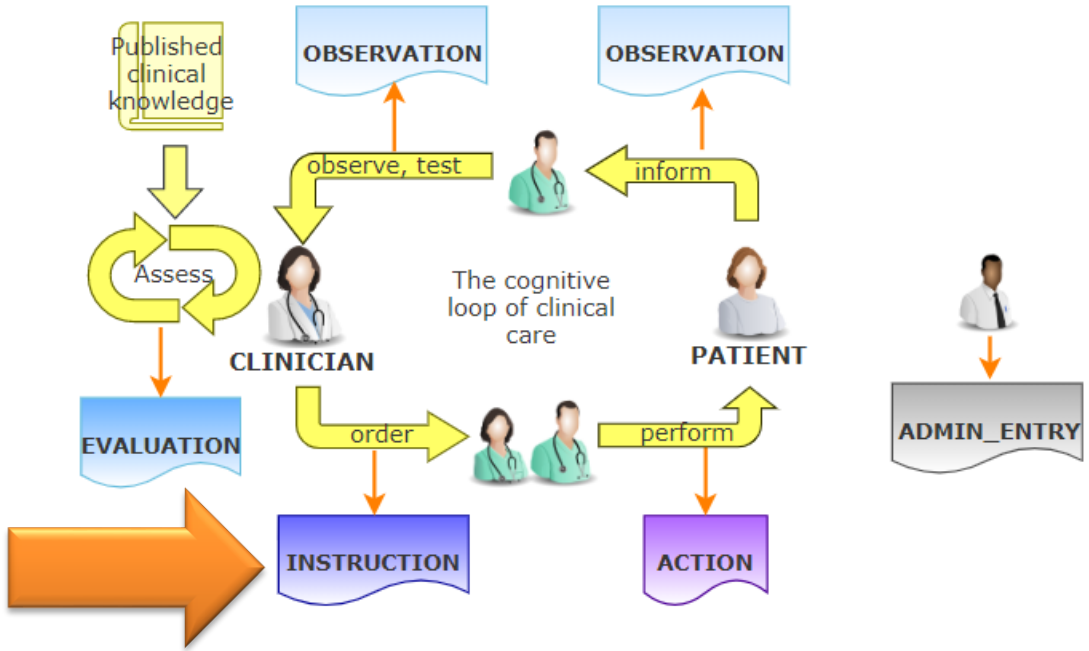
After processing and detailed analyzing XSD data, we extract the structure and the names and properties of the elements in order to create an archetype with the same structure. Because we will develop a model of an electronic prescription written by a medical specialist, we are interested in the basis class **Prescription** .

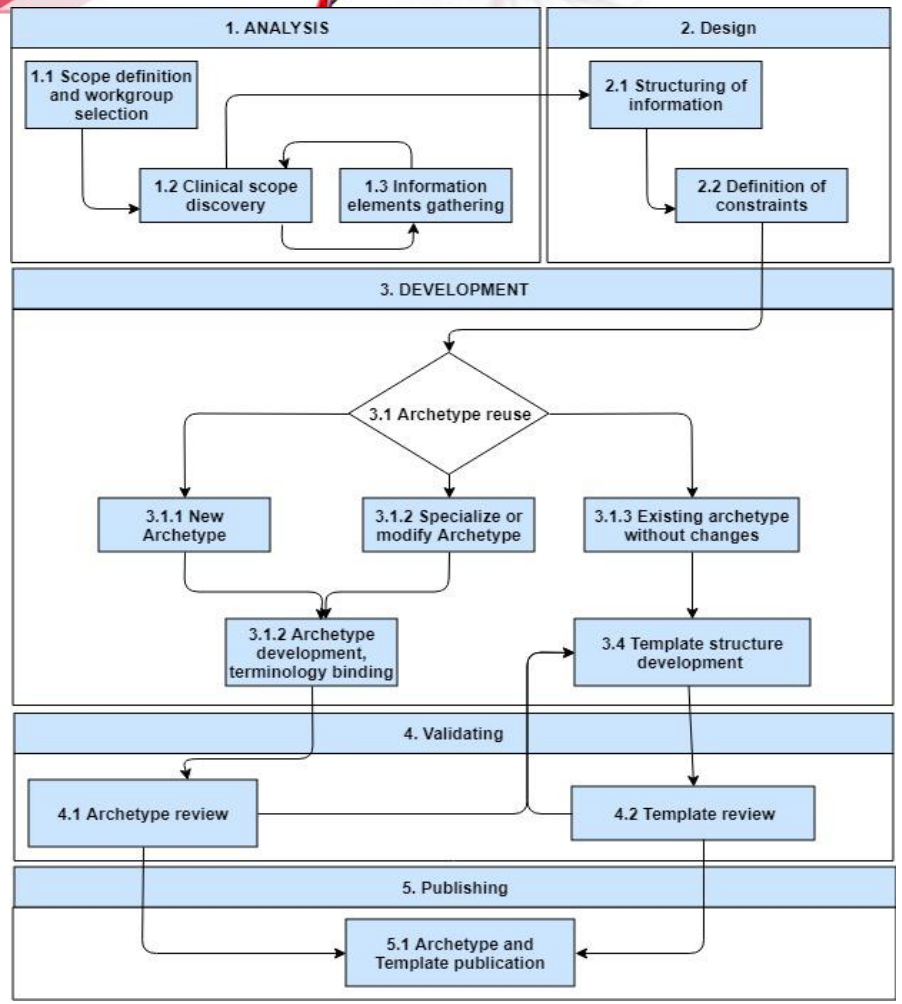




3.5. Modeling of Archetype and Operative Template

Archetype modeling methodology

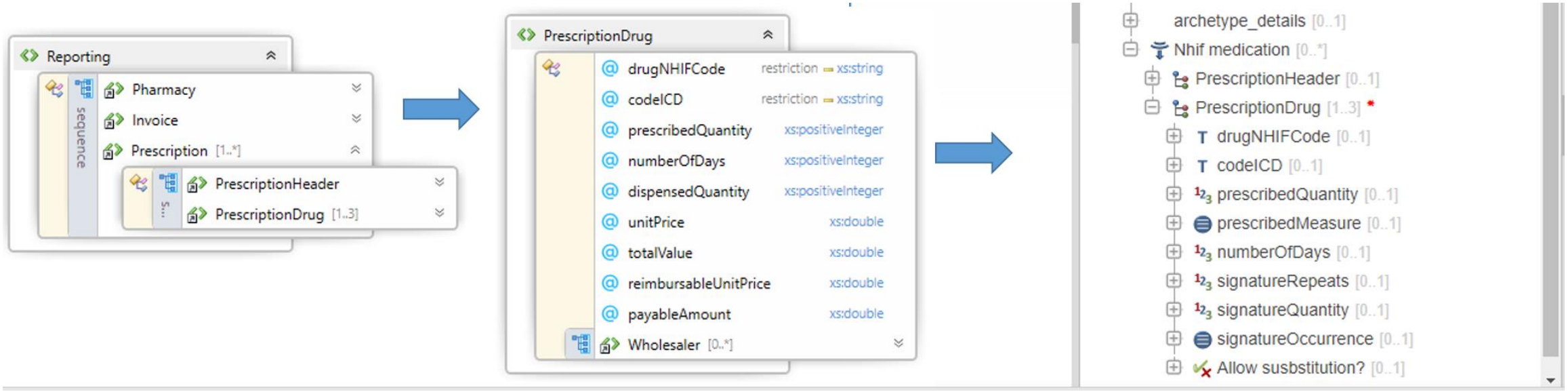




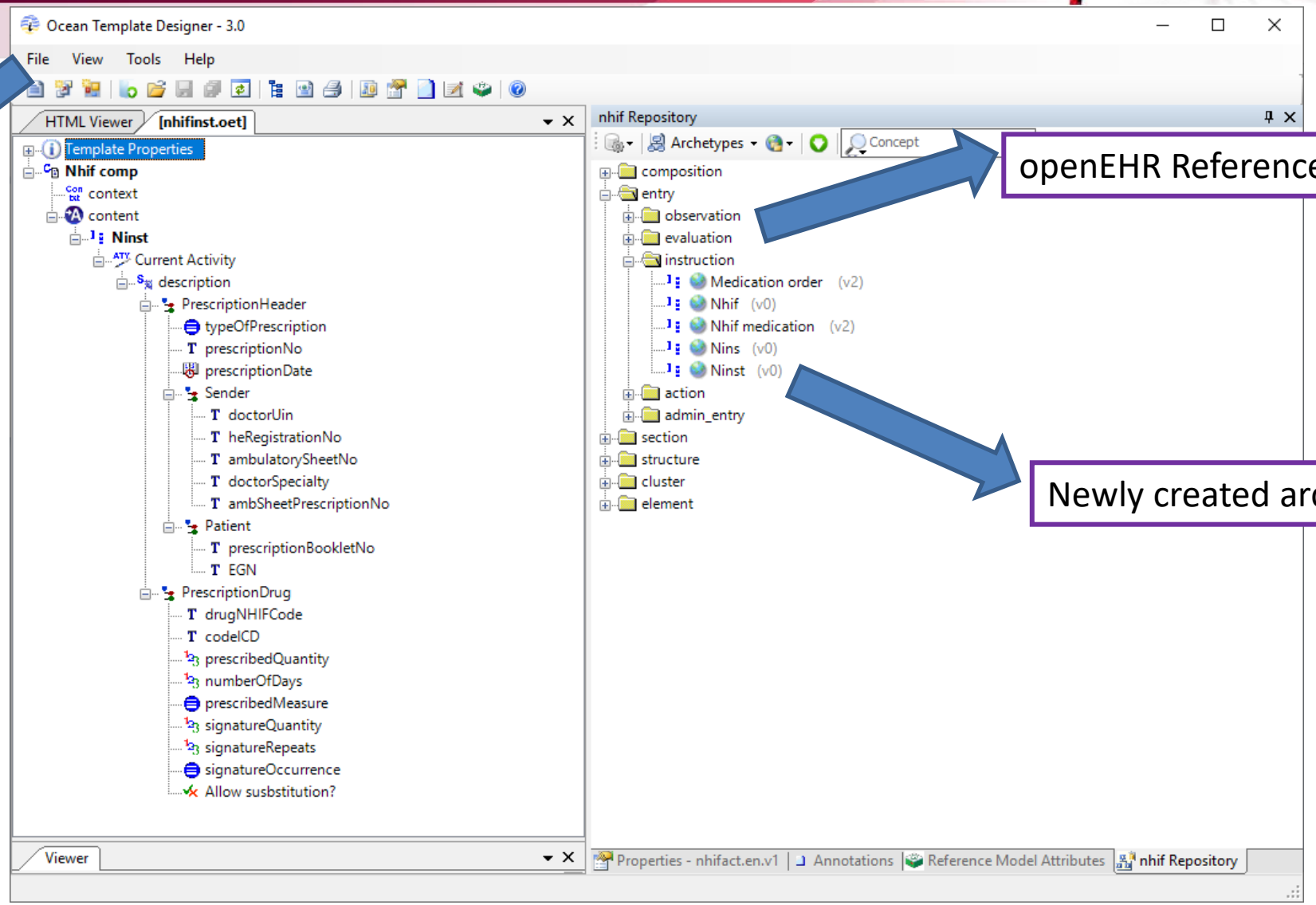
Algorithm for creating of archetype and Operative Template

3.6. Development of INSTRUCTION archetype

Using the **Archetype Editor** software, an archetype named **nhif** of type INSTRUCTION is created. The W3C XML Schema (XSD) for reporting the claims of pharmacies-contracting partners of the NHIF is used for modeling the structure and types of data. This W3C XML Schema defines the file format for interoperability across software products for processing NHIF prescriptions.



3.7. Development of EHR Operative template



Export as operative template

openEHR Reference model

Newly created archetype

3.8. Software realization of a client for creation and retrieval of EHRs

PHP class EHRServer

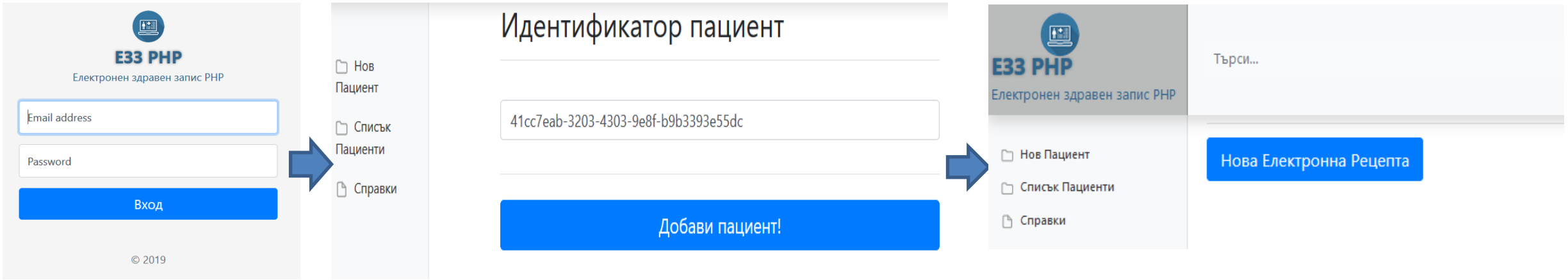
EHRServer
- $token : - $base_url :
+ __construct() + login() + set_token() + is_authenticated() + get_ehrs() + create_ehr() + get_queries() + execute_query() + get_templates() + get_template() + get_compositions() + get_composition() + commit_composition() + get_contributions()

Steps for the EHR creation

Login with user and password
`login.php`

Creating of base EHR – patient identifier
`ehr_create.php`

Open a form for creating ePrescription.
`ehr_list.php`

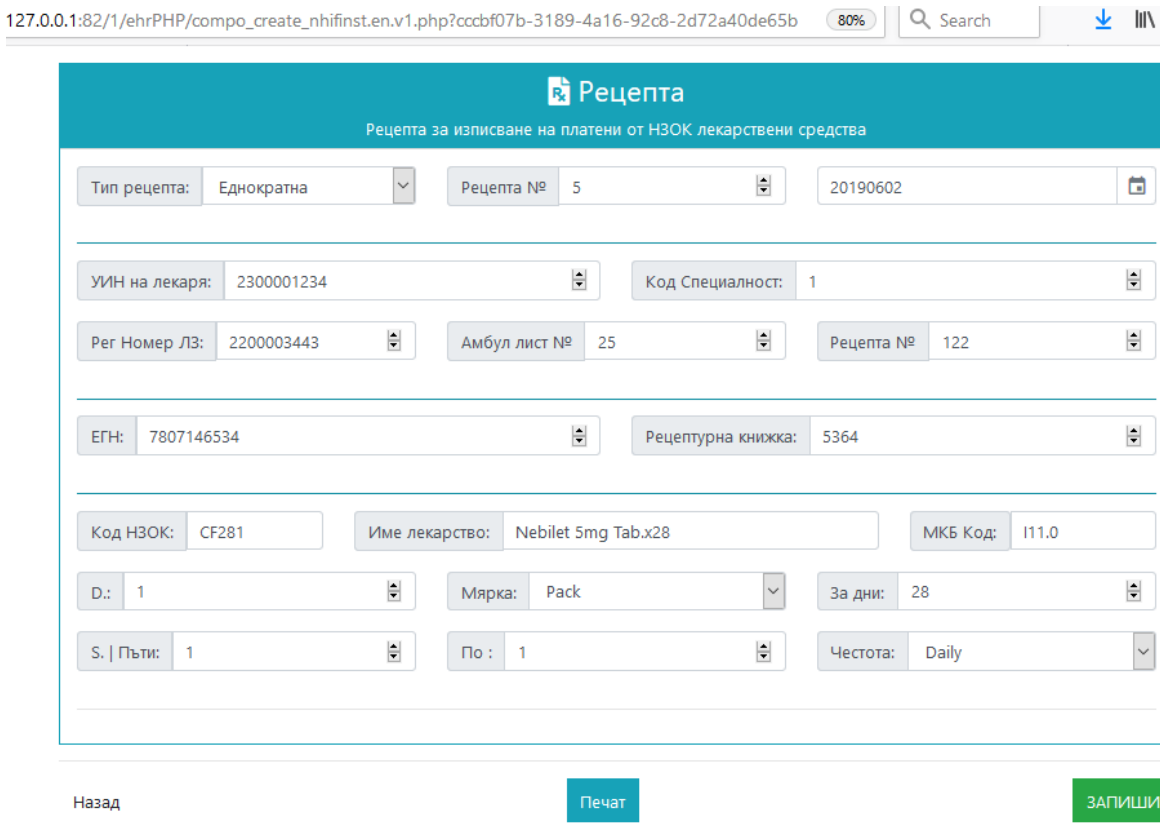


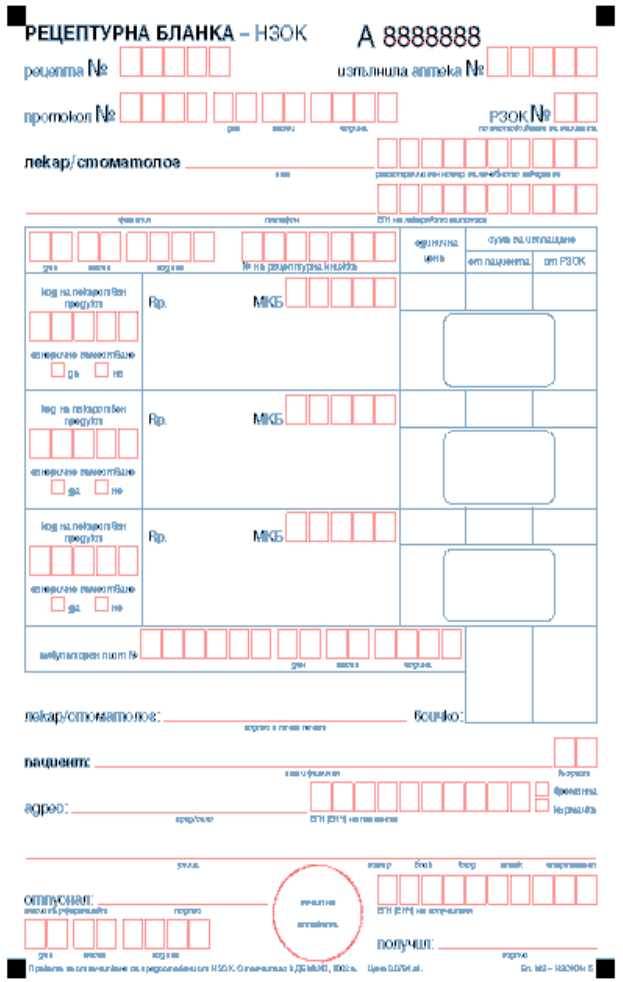
Video demonstration: https://www.youtube.com/watch?v=Z9KUrou16cc

3.9. Creating of EHR contribution type ePrescription

Steps of data processing after form submission

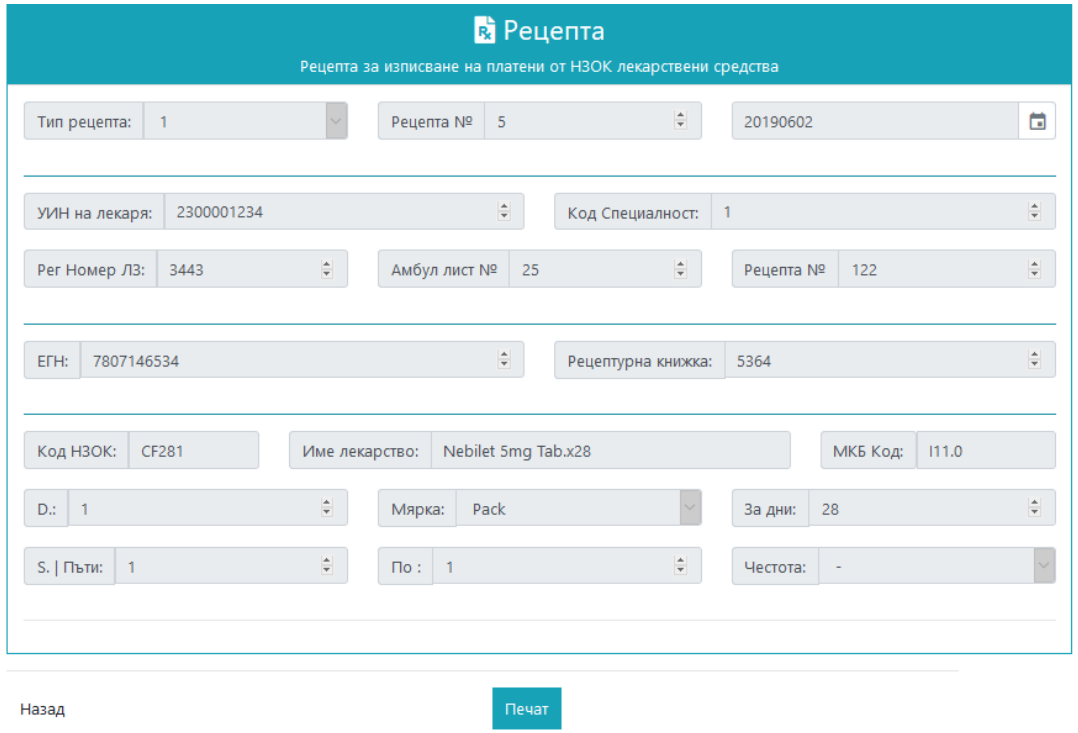
- Load xml file nhifinst.xml into XML object $doc.
- Load data submitted via HTML form into associative array $params.
- Creating associative array $mappings keys element names and values submitted parameters $params
- With PHP function str_replace() repleace all valuesв XML обект $doc, which keys are same as in the array $mappings with the relevant values.
- Generated xml code in $doc value are submitted with commit_composition( ) method of PHP class EHRServer into EHRServer's instance.
- After successful record creation, server responds with message 'AA' and relocates to page ehr_show.php?uid= c GET parameter HER record ID.



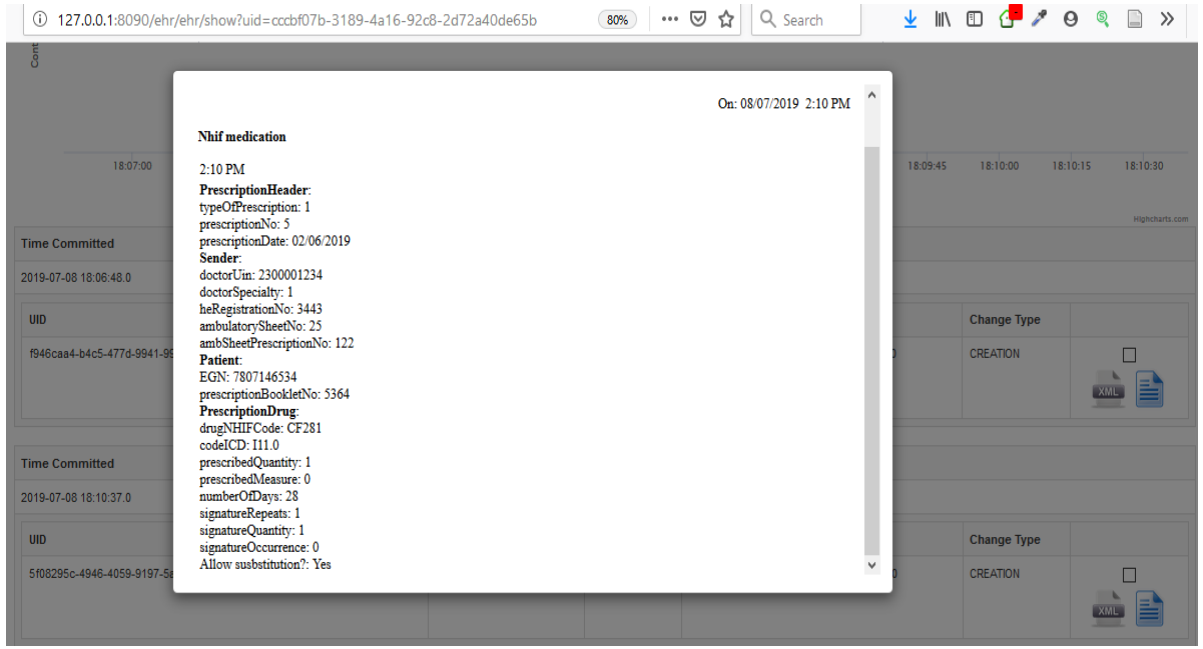


3.10. Extraction and visualization of a EHR document type ePrescription

Extraction and visualization from web client **`show.php?ehr_id=`**



Extraction and visualization of same record via EHRServer's web console.



4. Conclusions

- ✓ This proposed methodology allows to transform existing XML schema definitions used by the Bulgarian NHIF into archetype-based models with inherent semantic interoperability of clinical documents exchanged by other EU countries.
- ✓ The implementation of this methodology is novelty in the existing literature, where known ePrescription software applications allow basic functional interoperability of clinical documents.
- ✓ The application of the openEHR specification allows semantic interoperability between heterogeneous providers of clinical data.
- ✓ Using openEHR specifications with EHRServer server can be implemented to create, store and provide to client applications EHR documents type electronic prescription.
- ✓ Novelty in this paper is the complete implementation of ePrescription by of openEHR specification in the environment of openEHR server
- ✓ This model is fully aligned with EU activities to implement EU cross border ePrescription exchange for Smart Open Services of European Patients friendly format

4. Conclusions

Video demonstration:

P. Kovachev, Software implementation of e-prescription according NHIF spec. in Bulgaria 2020. [Online]. Available: https://www.youtube.com/watch?v=Z9KUrou16cc

5. Acknowledgement

This research is supported by the

National Scientific Program eHealth in Bulgaria

Thank you for your attention!