ГОДИШНИК НА СОФИЙСКИЯ УНИВЕРСИТЕТ „СВ. КЛИМЕНТ ОХРИДСКИ“
ФАКУЛТЕТ ПО МАТЕМАТИКА И ИНФОРМАТИКА
Том 110

ANNUAL OF SOFIA UNIVERSITY “ST. KLIMENT OHRIDSKI”
FACULTY OF MATHEMATICS AND INFORMATICS
Volume 110

MODELING AND CLINICAL DATA EXCHANGE IN REGISTRATION OF INFECTIOUS DISEASE CASES

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The registration of communicable disease cases aims to limit their prevalence. The Ordinance on the Procedure for Registration, Notification and Reporting on Communicable Diseases, issued by the Ministry of Health, determines the rules for the implementation of the registration procedure in Bulgaria. Currently, this information is communicated by phone, email or on paper, and then the data is manually re-entered. This significantly complicates the exchange of information between health care participants. In addition, valuable information to produce reports noting disease prevalence levels is lost or fragmented. This paper aims to resolve these problems by the means of information technologies and ensure efficient storage, processing and management of data registration for patients with communicable diseases. The business process for the implementation has been studied in detail. The main roles, resources and sequence of activities at each stage of the application of the regulation have been determined. A relational database model is created for centralized storage, processing and management of data for registered patients and their contacts. An algorithm is developed and implemented for the automated determination of cases based on the symptoms of each disease specified in the regulation. ICD-10 is used, thus, creating the possibility of exchanging the collected data with international centers for tracking the spread of the disease. A three-tier application is created where web services perform the activities of registration, communication and reporting of communicable cases. The obtained results were tested with real data, consulted with experts from the health inspections and demonstrate the advantages of the developed software for fulfilling the requirements of the provisions in national legislation.

Keywords: eHealth, interoperability, clinical data exchange, clinical information models, communicable diseases, disease prevention

CCS Concepts:

- Software and its engineering~Software creation and management~Designing software~Software design engineering;
- Information systems~Data management systems~Information integration~Data exchange

DOI: 10.60063/GSU.FMI.110.7-23

1. INTRODUCTION

Electronic health (eHealth) is defined by the World Health Organization (WHO) as “cost-effective and secure use of information and communications technologies in support of health and health-related fields, including health-care services, health surveillance, health literature, and health education, knowledge and research” [11]. This includes the exchange of a wide range of health information, including the use of electronic health records (EHR) [5], telemedicine [3], digital tools and patient information management and exchange systems. eHealth has the potential to revolutionize the way health care is delivered, offering patients a more efficient, accessible and personalized system. The integration of technology, particularly the Internet and electronic devices, into the health care system enables instant communication and the exchange of large volumes of information between health care providers and patients. Using the capabilities of these technologies, eHealth provides patients with access to health services remotely and at any time through the use electronic devises; enables the automation of many healthcare processes, reducing the time and resources needed to provide care; gives patients greater access to their health information, allowing them to take a more active role in their health care and make informed decisions about their health; allows healthcare provides access to a more complete and accurate picture of a patient’s health, leading to more informed decision-making and better health outcomes; has the potential to optimize healthcare costs by reducing the need for expensive and time-consuming procedures, such as duplicate tests and unnecessary hospital visits.

The lack of standardization in eHealth systems can lead to difficulties in the exchange of information, resulting in fragmented patient records, duplicated tests and procedures, increasing the work of healthcare specialists, respectively reducing the time they could devote to the patient and an overall deterioration of the quality of health care. The use of heterogeneous and specific software solutions and systems by different healthcare organizations can also pose challenges in data exchange, leading to difficulties, fragmentation and a lack of access to important information.

Despite its many potential benefits, the implementation of eHealth is not without its challenges. One of the most significant of which is the lack of interoperability [4]. It is the ability of different electronic systems and devices to communicate with each other and to exchange and receive information, understanding it in its semantic context. In the healthcare industry, interoperability is critical to delivering high-quality patient care and improving the healthcare experience. The goal of interoperability is to enable native exchange of health information between different systems and among healthcare participants, such as hospitals, clinics, health insurance companies and patients, without loss of data meaning and functionality. In the context of eHealth, interoperability can be divided into several levels, among them, the most important for efficient data exchange is semantic interoperability [6]. It allows systems to exchange data and information using compatible meanings and definitions. This layer of interoperability ensures that data exchanged between systems has the same meaning and context. For example, two systems may use different terminologies or vocabularies to describe the same concept. Semantic interoperability ensures that data is processed correctly, taking into account the underlying semantics and business rules. This is achieved through the use of standardized medical terminologies, such as SNOMED-CT [8] and LOINC [7]. With ongoing efforts to improve and standardize health information exchange, interoperability and its foundation [9] have the potential to revolutionize the way healthcare providers and organizations share information and deliver care. Since healthcare providers are under increasing pressure to provide patient-centered care that is safe, effective and timely, interoperability is critical to accessing information and making informed decisions. This ability of heterogeneous systems to exchange and understand the received data without any ambiguity helps reduce the risk of medical errors as well as reducing the work of healthcare professionals, which leads to overall improved patient outcomes.

The prevention of disease outbreaks is an important part of eHealth's goals. Effective procedures for registration, notification and reporting on communicable diseases are critical to achieving this objective. Timely and accurate reporting of communicable diseases can help healthcare officials detect outbreaks early and respond quickly to prevent further spread of the disease. It can also aid in identifying infected individuals and isolating them, including their contacts, thereby preventing transmission. Furthermore, disease reporting data can be used to plan and allocate resources for disease prevention and control, while regular analysis of disease data can help identify trends and patterns, allowing healthcare officials to implement targeted prevention strategies.

The Bulgarian Ministry of Health sets out a comprehensive description of the rules and procedures for registration and reporting of communicable diseases in Ordinance No. 21 on the Procedure for Registration, Notification and Reporting on Communicable Diseases (suppl. No. 55/2022) [2]. The ordinance mandates health service providers to report the cases but does not address the problems with ineffective data exchange, delays and the diversity of information systems in health care domain. The current situation in Bulgarian healthcare lacks the necessary interoperability between the disparate medical information systems, which leads to unnecessary repetitive work, delays, incomplete data and errors. To effectively control and prevent communicable diseases in Bulgaria, there is a need for a comprehensive and interoperable information system that supports real-time data exchange, monitoring and reporting of disease outbreaks. The system must allow integration with other systems and alternative ways for information input and output, for example, alternative input of laboratory results through an XML file based on a defined XSD schema.

The objective of this paper is to implement the wide set of requirements of Ordinance No. 21 for registration, notifying and reporting of patient cases with infectious disease. In the process of modeling and developing a software solution, terminologies and nomenclatures related to standardization and normalization of health data are reviewed, emphasizing the models providing semantic interoperability in data exchange and more specifically those enabling the unambiguous exchange of diseases and conditions like the International Classification of Diseases (ICD) [10]. These are fundamental to the exchange of medical data between heterogeneous information systems, both at the national and cross-border levels, and are invariably present in solutions that successfully provide semantic interoperability.

The following tasks arise from the described objectives:

1. Resolve eHealth issues related to lack of interoperability and research best practices for modeling and sharing clinical data.
2. Examine the requirements of the Bulgarian Ministry of Health, in connection with the procedures for registration, notification and reporting on communicable diseases.
3. As a result of the above, a solution proposal in the form of a three-tier application.

After considering the objectives set, a model is proposed and a concept is implemented for effective clinical data exchange in the context of the requirements of Ordinance No. 21 on the procedures for registration, notification and reporting on communicable diseases.

This paper is structured in four parts. Section 1 defines goals and objectives, introduces basic concepts and defines the problem area and hence the motivation for the proposed solution. Section 2 consists of an overview of the methodology for the proposed solution, architecture, and database model, including the specified requirements of Ordinance No. 21 on the procedures for registration, notification and reporting on communicable diseases. Based on the research carried out and the detailed study of the requirements in the regulation, Section 3 describes a proposed solution in the form of a three-tier web application, comprehensively covering the requirements issued by the Bulgarian Ministry of Health. Section 4 draws a conclusion, summarizes the results of the completed tasks and presents future perspectives.

2. METHODS

This Ordinance No. 21 on the Procedure for Registration, Notification and Reporting on Communicable Diseases, issued by the Bulgarian Ministry of Health, outlines the steps required to register, notify, and report individuals who have infectious diseases, those who have been in contact with them, and carriers of such diseases. It also specifies the list of infectious diseases that require mandatory registration, notification, and reporting, together with a comprehensive list of criteria for each disease and based on those specific criteria, the rules by which the communicable disease case level is determined.

The disease criteria can be categorized as clinical, laboratory and epidemiological.

Clinical criteria include common and practical signs and symptoms of the disease that alone or in combination represent a clear or suggestive clinical picture of the disease. Clinical criteria give a general description of the disease and do not necessarily indicate all the signs to make a specific clinical diagnosis.

Laboratory criteria consist of a list of the laboratory methods used to confirm the case. Usually only one of the specified tests is sufficient for laboratory confirmation. For some diseases, laboratory criteria should only indicate a probable case. It becomes clear that each communicable disease has its own rules for determining the classification of the case, which require complex business rules to be followed and implemented for the realization of a unified software solution.

Epidemiological criteria are considered to be met when an epidemic link can be established. During the incubation period, an epidemic relationship is present in certain cases for the specific disease, such as human-to-human transmission, animal-to-human transmission, exposure to a common source of infection, consumption of contaminated food or drinking water, exposure from the environment, including laboratory exposure.

The cases of each communicable disease in the ordinance can be classified as follows:

Possible. This is a case classified as "possible" for reporting purposes. It is usually a case in which the clinical criteria described in the case definition are present but for which there is no epidemiological or laboratory evidence of the disease in question. The possible case definition has high sensitivity and low specificity. It allows the detection of most cases, but some false positive cases will be included in this category.

Probable. This is a case classified as "probable" for reporting purposes. It is usually a case where the clinical criteria and an epidemic relationship as described in the case definition are present. Laboratory tests for probable cases are specified only for some diseases.

Confirmed. This is a case classified as "confirmed" for reporting purposes. These cases are laboratory-confirmed and may or may not meet the clinical criteria described in the case definition. The definition of a confirmed case has high specificity and low sensitivity, meaning most of the cases collected will be genuine, although some might be missed.

Bulgarian healthcare requires the mandatory registration, notification and reporting of a large number of communicable diseases (currently 67). Each of these diseases has different case type delineation requirements, which demand complex and hard to track and enforce business rules for categorizing the cases of infectious disease. In addition, there is a need for rapid and reliable communication between multiple health care actors in the communicable disease disclosure (Figure 1), as well as eliminating the need to repeatedly enter the same information, for example, in multiple information systems and in the communicable disease book. Reliable storage and automated retrieval of various statistics filtered by area, time intervals and a particular disease or category of diseases are also required. The information

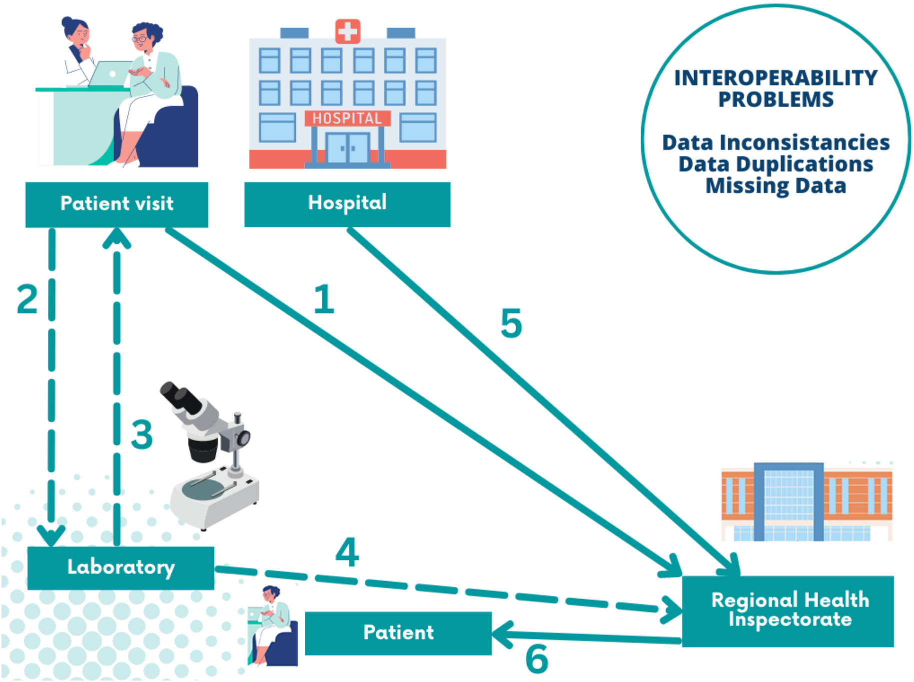


Figure 1. Data exchange model for registering a communicable disease

collected in this way can allow for more effective control in cases of quarantine and epidemics.

When registering and reporting an infectious disease in the Bulgarian healthcare system, participants typically follow a model for data exchange activities with the following sequence:

1. A patient visits his general physician (GP), the doctor evaluates the patient's condition and, provided the health state of the patient matches a rule for "possible", "probable" or "confirmed" statements for a communicable disease in the Ordinance, he creates an Express notification for the respective disease. This notification is sent for processing to the Regional Health Inspectorate (RHI). A direction for additional Laboratory tests is issued in the case of a "probable" or "confirmed" (Activities 1 and 2 in Figure 1).

2. In case the Laboratory exams confirm the communicable disease, the Laboratory creates an Express notification for the respective disease with a "Confirmed" statement both to the GP and the RHI office (Activities 3 and 4 in Figure 1).

3. When a communicable disease is established in a hospital, the Hospital creates an Express notification for the respective disease and sends it for processing to the Regional Health Inspectorate (Activity 5 in Figure 1).

The sequence of activities in Figure 1 demonstrates that the registration and reporting processes for communicable diseases in Bulgarian healthcare require multiple exchanges of information between various participants and heterogeneous systems.

A centralized information technology solution based on the three-tier architecture could significantly facilitate the complex processes related to the registration, exchange and storage of information as per the requirements of the ordinance. A three-tier architecture is a widely used model for developing applications that can provide several benefits for the procedures for registration, notification, and reporting on communicable diseases. This architecture separates the presentation layer, application logic layer, and data storage layer, which enables independent scalability, improves maintainability, and enhances security (Figure 2). Furthermore, the three-tier architecture facilitates fault tolerance, code reusability, and performance optimization, which can significantly enhance the overall efficiency and effectiveness of the system, including satisfying the possibility of integration with other systems. These benefits of the three-tier architecture make it a suitable choice for developing an information system for registration and reporting of communicable diseases, ensuring a robust and secure system that can handle the demands of public health emergencies.

In the context of developing an appropriate solution, choosing the appropriate type of database is a very important decision. Relational and non-relational databases have different strengths and weaknesses, and the choice depends on the requirements. Experiments have been performed with non-relational database but at this stage, a relational database is more suitable as most of the data is structured, well related and complex queries are required. This means that the data is stored in tables with predefined relationships between them. The database model behind the proposed solution consists of several tables that are interrelated through various types of relationships (Figure 3).

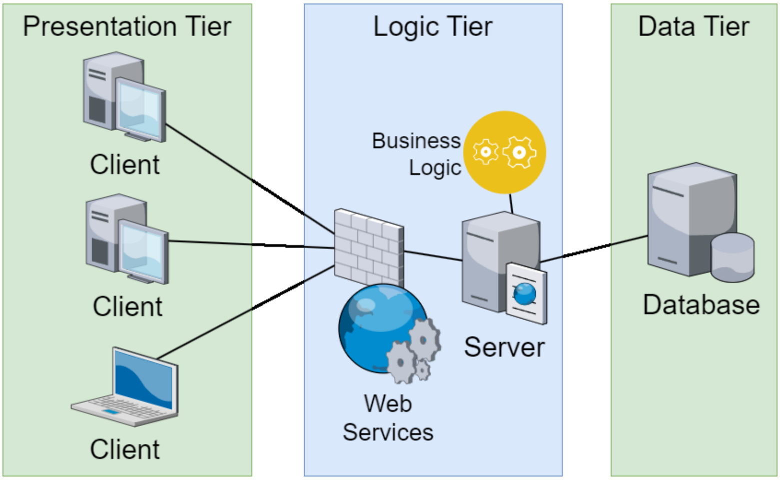


Figure 2. Architecture overview of the proposed information System

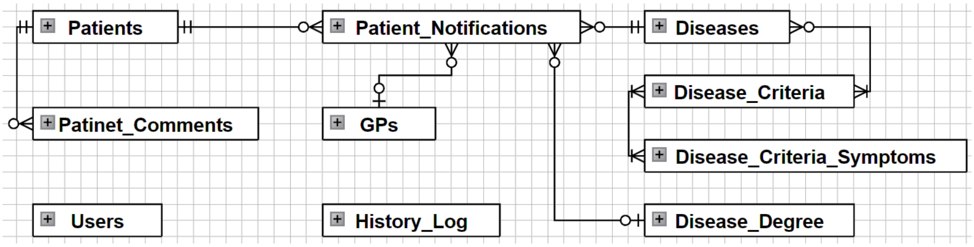


Figure 3. Relational database model view

Table `Users` contains the participants of the system, including managers, physicians, referrals and guests. Each user is assigned a unique identifier and access type. The table contains fields for user credentials, such as username and password, and additional fields to store user profile information.

Table `Patients` manages patient-related data, such as patient names, addresses, contact information, and other patient-specific entries. Each patient is assigned a unique identifier, and the table contains fields for demographic information, medical history, and other relevant data.

Table `Patient_Comments` is auxiliary and is used to store additional data related to the patient. It is linked to the `Patients` table in a many-to-one relationship, as each patient may have zero or multiple comments associated with them, where no comment could exist without an assigned patient to it. The table contains fields for comment text, date, author, and edit history.

Table `Patient_Notifications` is central table as it manages the disease notification data filled out by the physician for a specified patient and specified disease. The table contains multiple fields related to the procedure for registering communicable disease, including data for criteria symptoms such as clinical, laboratory, and epidemiological. Each notification is assigned a unique identifier and the table is linked to the `Patients` table in a many-to-one relationship, as each patient may have zero or multiple notification where no notifications could exist without an assigned patient to it.

Table `GPs` contains information about the general practitioner of the patient. It is linked to the `Patient_Notifications` table in a one-to-many relationship, as each notification may be associated with a specific general practitioner, where a GP may be linked with zero or multiple notifications. The table is not linked with `Patients`, as a patient is free to change its general practitioner. The table contains fields for general practitioners names, unique identifier numbers, addresses, contact information, and other relevant data.

Table `Diseases` contains a list and properties of each communicable disease defined by the Bulgarian Ministry of Health through Ordinance No. 21. It is linked to the `Patient_Notifications` table in a one-to-many relationship, as each notification is necessarily associated with a specific disease and a disease can be associated with multiple notifications. The table contains fields describing the disease name and its properties, symptoms, quarantine, and other relevant data.

Table `Disease_Criteria` stores specific criteria for each disease. The table contains fields for criteria name, description, and other criteria-relevant data.

Table `Disease_Criteria_Symptoms` contains a comprehensive list of all symptoms defined in the ordinance, such as diagnostic tests, symptoms, and other clinical indicators.

Table `Disease_Degree` is auxiliary and contains the type of communicable disease case, as determined by the ordinance. It contains fields for type names and descriptions. This information is stored in the database to ensure that the system is up-to-date with the latest regulatory requirements and to support future changes in the ordinance through the system interface without the intervention of programmers and need for code changes.

The applied cardinality restrictions on the relations of the described above tables are essential to ensuring compliance with business logic and rules. Cardinality restrictions define the types of relationships that can exist between entities in a database and specify the number of instances of one entity that can be associated with another entity. By enforcing cardinality restrictions, the database management system ensures that the relationships between entities are well-defined and adhere to the business logic of the system. This not only ensures the accuracy and consistency of the data but also helps to prevent errors and inconsistencies in the system.

3. Results

On the basis of the ordinance examined and best practices and standards in clinical data exchange, it becomes clear that an Information System for Registration and Reporting of Communicable Diseases (ISRRCD) in the form of a three-tier web application with a centralized database can provide several benefits in addressing the lack of interoperability between healthcare actors in relation to the process of registration of communicable diseases. These benefits include:

Improved efficiency. Facilitate the exchange of data between healthcare actors, reducing the need for manual and duplicated data entry and increasing efficiency. This can help healthcare providers save time and resources, enabling them to focus on patient care.

Enhanced accuracy. Ensure that the data entered is accurate and up-to-date. This can help improve the accuracy of disease tracking and reporting, and reduce errors in the reporting process.

Better communication. The three-tier web application can provide a platform for better communication between healthcare actors. The system can facilitate real-time data sharing, making it easier for healthcare providers to collaborate and coordinate efforts in addressing disease outbreaks.

Improved disease surveillance. Improve disease surveillance efforts by providing a comprehensive view of disease incidence and prevalence. This can help healthcare providers identify trends and patterns, enabling them to take appropriate actions to address disease outbreaks.

Enhanced public health outcomes. The solution can help improve public health outcomes by providing better data for public health decision-making. The system can help identify high-risk populations and facilitate the development of targeted interventions to reduce disease transmission.

Increased healthcare cost savings. Reduce healthcare costs by improving efficiency, reducing the need for manual data entry and duplicate testing, and enabling early detection and prompt treatment of communicable diseases.

The actors in the use case are as follows:

Managers. Responsible for managing the information that the physicians will be working with. This includes overseeing data entry, monitoring data quality, generating reports, and analyzing data to make informed decisions. They have full access to the system and are able to perform a wide range of tasks, such as creating and managing user accounts, defining data entry requirements, setting up workflows and approval processes, and monitoring system usage.

Physicians. Responsible for registering and reporting the communicable disease cases, updating patient records, and managing patient information within the system. Physicians have access to the application tier of the software, which includes the generated graphical interface based on a selected disease, logic and business rules that govern data entry and validation. Physicians are able to view and edit patient information as needed and are able to generate reports and other outputs related to patient care.

Referrals/Guests. The third category of participants have read-only access to the system, which means they are able to view patient records and other data but can not edit or modify any information. This access level is intended for external stakeholders, such as referral partners or external consultants, who need to view patient data for analysis or decision-making purposes but do not need to interact with the system on a daily basis.

The following use case for managing communicable disease case can be considered based on the actors described above:

A user of type *Manager* (a Regional Health Inspectorate specialist) logs into the system using their user account credentials. The manager can create and administer user accounts for the other participants and set access levels. Main task for the manager is to define the complete set of communicable diseases in Ordinance No. 21, which may be subject to change over time (adding new diseases), including the definition of symptoms and symptom criteria and the rules for each disease that define the case (possible, probable or confirmed). The Manager can also monitor system usage and generate reports to analyze and extract data.

A user of type *Physician* that can log in to the system using their user account credentials. The physician can register a communicable disease patient case, based on automatically generated graphical user interface for a selected disease. Furthermore, the Physician can view and edit patient information as needed to ensure data accuracy. The Physician also has access to generating reports and other outputs related to patient cases, such as lab results or treatment plans.

A user of type *Referral/Guest* can also access the system using their user account credentials. These users can view patient records and other data for analysis or decision-making purposes but cannot edit or modify any information in the system.

The following modular functionalities can be highlighted in the proposed information system for registration and reporting of communicable diseases:

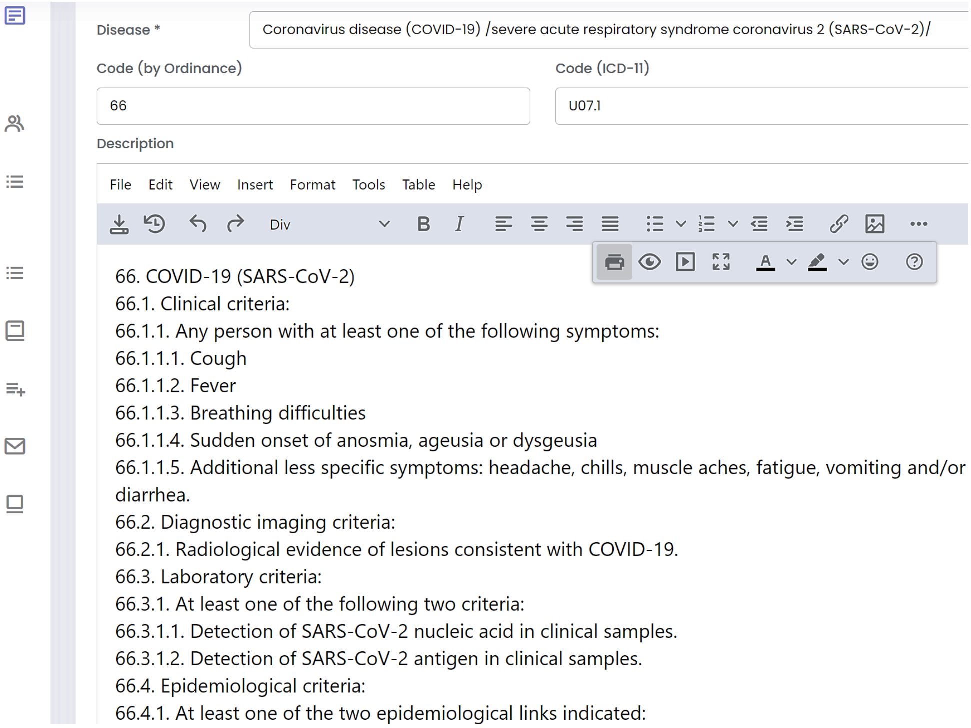
Organizational module

This module is an essential component of the system and is designed to manage work-related data, particularly the data in the context of disease management. This module is responsible for generating and managing the necessary data required for the purposes of registering and reporting communicable disease cases.

Disease management. One of the key responsibilities of the organizational module is to manage disease-related data (Figure 4). This includes collecting and storing information for all diseases defined in Ordinance No. 21. This information is essential for the required processes for registration, notification and reporting.

Criteria and symptom management. The criteria and symptom management allow users to define the specific data required for the diagnosis and management of different diseases. The criteria can include various symptoms, laboratory results, or other factors that help determine the severity of a particular case. By defining these criteria, users can ensure that the system accurately assesses each case based on the relevant factors.

Management of the rules for case definition. Involves defining the specific rules that the system must use for determining the degree of a particular disease case. For example, the system may use a checklist of specific symptoms and laboratory results to determine whether a case is possible, probable, or confirmed. By defining these rules, users can ensure that the system accurately assesses each case based on the specific criteria defined for each disease. This process is automated so that the case is classified as soon as the registration is completed by the physician, and subsequently, the information and the case classification are automatically sent to the relevant participants in the health chain.



Disease *: Coronavirus disease (COVID-19) /severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2)/

Code (by Ordinance): 66

Code (ICD-11): U07.1

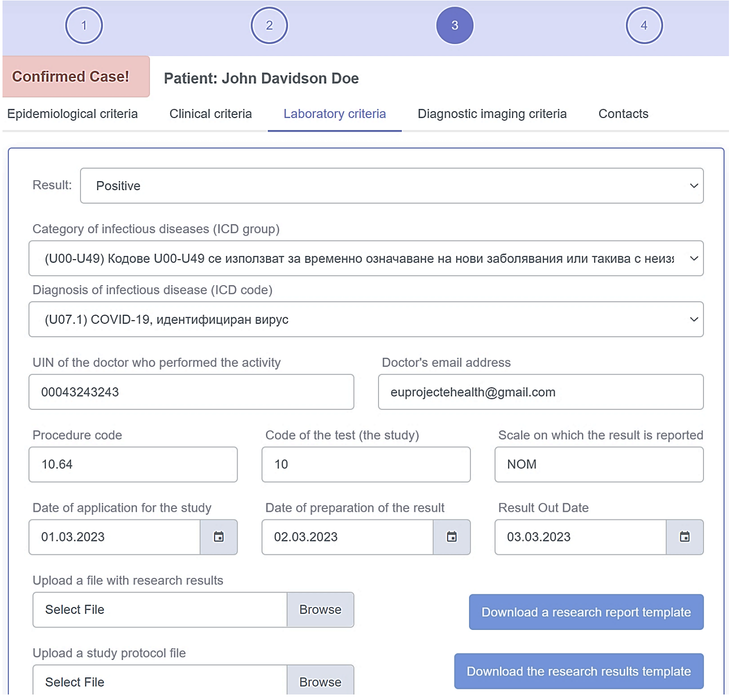
Description:

66. COVID-19 (SARS-CoV-2)
66.1. Clinical criteria:
66.1.1. Any person with at least one of the following symptoms:
66.1.1.1. Cough
66.1.1.2. Fever
66.1.1.3. Breathing difficulties
66.1.1.4. Sudden onset of anosmia, ageusia or dysgeusia
66.1.1.5. Additional less specific symptoms: headache, chills, muscle aches, fatigue, vomiting and/or diarrhea.
66.2. Diagnostic imaging criteria:
66.2.1. Radiological evidence of lesions consistent with COVID-19.
66.3. Laboratory criteria:
66.3.1. At least one of the following two criteria:
66.3.1.1. Detection of SARS-CoV-2 nucleic acid in clinical samples.
66.3.1.2. Detection of SARS-CoV-2 antigen in clinical samples.
66.4. Epidemiological criteria:
66.4.1. At least one of the two epidemiological links indicated:

Figure 4. ISRRCD organizational module – overview of disease management

PHYSICIAN'S MODULE

This module is a key component of the software system and is responsible for the registration and reporting of new communicable disease patient cases. The physician selects the specific disease from a pre-defined list of diseases. Once selected, the system automatically generates a graphical interface that includes a list of symptom criteria specific to the selected disease (Figure 5). This ensures that all relevant information is captured during the registration process. The Organizational module plays a key role in the Physician's module, as it defines the rules and symptom criteria for each disease. Based on these rules, the system automatically determines the degree of the case during the registration process. This ensures that cases are accurately classified as either possible, probable, or confirmed based on the specific symptom criteria for each disease described in Ordinance No. 21. Once the physician has completed the disease registration steps, the system automatically sends notifications to relevant parties (Figure 6), such as the regional health inspection, the Communicable Disease Book, the patient's GP, and the patient themselves (if their email is present). This helps to streamline communication and ensure that all relevant parties are informed of new cases without the need for manual data entry or notification. Export of the registration data to an XML file is provided so that it



Patient: John Davidson Doe

Result: Positive

Category of infectious diseases (ICD group): (U00-U49) Кодове U00-U49 се използват за временно означаване на нови заболявания или такива с неиз

Diagnosis of infectious disease (ICD code): (U07.1) COVID-19, идентифициран вирус

UIN of the doctor who performed the activity: 00043243243

Doctor's email address: euprojectehealth@gmail.com

Procedure code: 10.64

Code of the test (the study): 10

Scale on which the result is reported: NOM

Date of application for the study: 01.03.2023

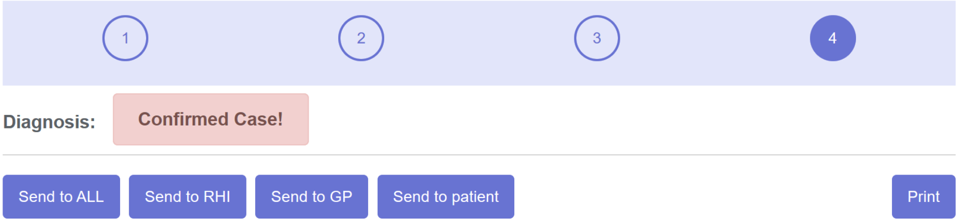
Date of preparation of the result: 02.03.2023

Result Out Date: 03.03.2023

Upload a file with research results: Select File

Upload a study protocol file: Select File

Figure 5. ISRRCD physician's module – registering a case of a communicable disease (from XML file)



Diagnosis: Confirmed Case!

Figure 6. ISRRCD physician's module – registering a case of a communicable disease (step 4)

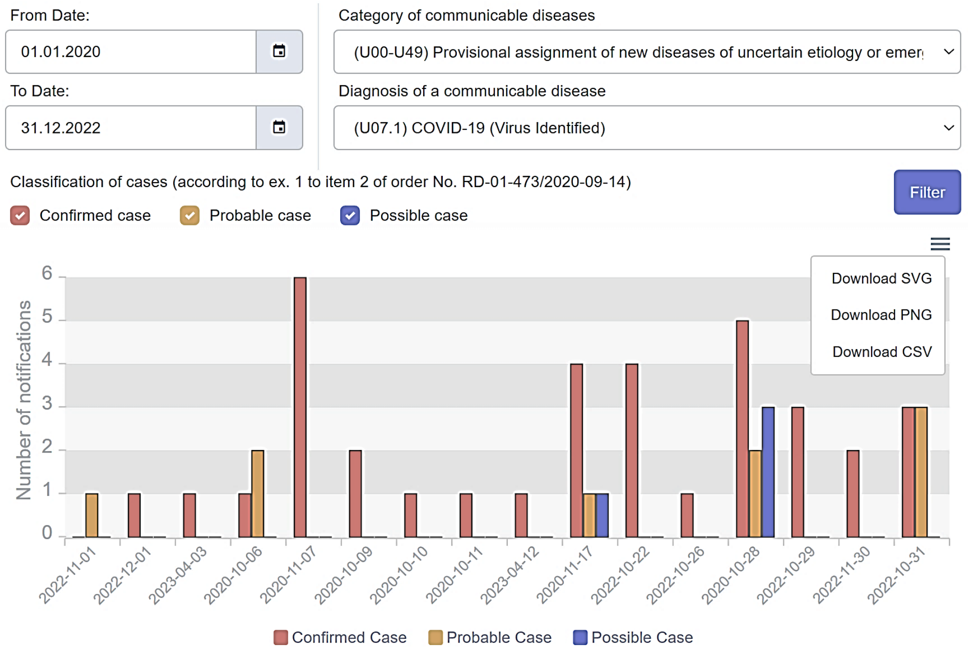
can be transmitted to other systems, thus achieving integration with external systems. The XML file schema might be subject to change according to the specific requirements of the foreign system.

STATISTICAL MODULE

Statistical data is important in preventing disease outbreaks as it helps identify patterns and trends of disease occurrence, track the effectiveness of prevention measures, and predict future outbreaks. This information allows public health officials to make evidence-based decisions and take proactive measures to protect public health. Therefore, the statistical module is an essential part of the proposed software system, which allows participants, including Managers, Physicians and Referrals/Guests to gain valuable insights into communicable disease incidence and prevalence within a specific area and time period. By using various filters like time intervals, location, and a specified disease or group of diseases, the module generates statistical reports and visualizations that help to identify trends, patterns, and correlations in the data.

One of the key components of the statistical module is its ability to produce visualizations that highlight critical information (Figure 7). Users can view data in different formats, such as tables, graphs, and charts, which makes it easier to identify areas of high disease incidence, track disease outbreaks, and evaluate the effectiveness of prevention and control measures. For example, a heat map can show the geographical distribution of cases, which can assist the specialists in identifying regions with high disease incidence.

The statistical module supports various statistical analyses that can help the specialists recognize trends and patterns in the data, predict future disease incidence, and aid in decision-making around prevention, control, and treatment. Public health officials, epidemiologists, and other stakeholders involved in disease surveillance, management, and research can utilize the features of the module to gain valuable insights into disease incidence and prevalence. The module is user-friendly and accessible, allowing the easy generation of reports and visualizations.



From Date: 01.01.2020

To Date: 31.12.2022

Category of communicable diseases: (U00-U49) Provisional assignment of new diseases of uncertain etiology or emer

Diagnosis of a communicable disease: (U07.1) COVID-19 (Virus Identified)

Classification of cases (according to ex. 1 to item 2 of order No. RD-01-473/2020-09-14)

☑ Confirmed case ☑ Probable case ☑ Possible case

Figure 7. ISRRCD – statistical module view

Furthermore, the statistics module can provide valuable insights into the effectiveness of public health policies and interventions. By tracking disease incidence over time, healthcare providers and policymakers can evaluate the impact of different interventions and adjust their approach as necessary. This can lead to improved health outcomes for patients and reduced healthcare costs, as well as more effective public health policies and interventions. Ultimately, this can contribute to improved population health and well-being.

4. Conclusion

Based on the requirements in Bulgaria related to the registration and reporting of communicable diseases, reviewing the current situation in data exchange and after an extensive literature review, it becomes clear that solving the problems related to the lack of interoperability in Bulgarian eHealth is essential in the fight against communicable diseases, where quick and efficient information exchange is necessary to contain the spread of the disease.

The benefits of a centralized information system, which provides semantic interoperability and integration with other systems, are significant in contributing to improved public health outcomes by enabling earlier detection and more targeted interventions. The ability to monitor the epidemiological situation in real-time can help reduce the spread of disease and ultimately lead to better health outcomes for patients. The centralized system also allows for a more coordinated and efficient use of resources, reducing healthcare costs and increasing overall efficiency.

In conclusion, a well-designed information system for registration and reporting of communicable diseases with automated data exchange and statistical modules can make a significant contribution to public health by improving disease control and prevention efforts. It is therefore important to invest in such system to ensure that healthcare providers and policymakers have the tools they need to make informed decisions and effectively respond to disease outbreaks.

In the effort to solve these problems, the following achieved tasks can be summarized:

- A prototype of an Information System for Registration and Reporting of Communicable Diseases (ISRRCD) under Ordinance No. 21, issued by the Bulgarian Ministry of Health, has been modeled, developed and tested.
- Automated application of rules for classification of communicable disease cases.
- Registration of communicable disease cases in the Register of Infectious Patients in the Regional Health Inspectorate has been automated.
- The exchange of messages between participants in the process of registering communicable disease cases is automated, saving the time needed for data re-entry and thereby reducing errors.

- Visualization of statistics with summary data for the communicable disease cases stored in the database, preparation of reports by time interval, region, disease and other signs have been implemented.

The proposed software has been tested with real data and consultations have been carried out with specialists from the regional health inspectorates. A video demonstration of the current functionalities can be found on [1]. The software is at the prototype stage and the following directions for future work can be summarized: Further integration with other systems – alternative ways for entering data are provided, for example, through XML files according to a defined XSD scheme. These integrations are of significant importance in reducing the time required for duplicate data entry as well as reducing the possibility of errors in the process of integrating heterogeneous systems, for example, integration with various laboratory information systems.

The developed system can be transformed into a cloud-based data management platform, which will further eliminate human intervention in data entry and management when reporting cases of communicable disease patients. In this case, further research would be necessary in relation to requirements for the protection of personal data.

Acknowledgements

This work is supported by the Fund for Scientific Research at Sofia University "St. Kliment Ohridski" under Grant 80-10-8/11.04.2023.

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Received on April 13, 2023
Accepted on May 7, 2023

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