STUDIES IN HEALTH TECHNOLOGY AND INFORMATICS 305

Healthcare Transformation with Informatics and Artificial Intelligence

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IOS Press

Artificial intelligence (AI) is once again in the news, with many major figures urging caution as developments in the technology accelerate. AI impacts all aspects of our lives, but perhaps the discipline of Biomedical Informatics is more affected than most, and is an area where the possible pitfalls of the technology might have particularly serious consequences.

This book presents the papers delivered at ICIMTH 2023, the 21st International Conference on Informatics, Management, and Technology in Healthcare, held in Athens, Greece, from 1-3 July 2023. The ICIMTH conferences form a series of scientific events which offers a platform for scientists working in the field of biomedical and health informatics from all continents to gather and exchange research findings and experience. The title of the 2023 conference was *Healthcare Transformation with Informatics and Artificial Intelligence*, reflecting the importance of AI to healthcare informatics. A total of 252 submissions were received by the Program Committee, of which 149 were accepted as full papers, 13 as short communications, and 14 as poster papers after review. The papers cover a wide range of technologies, and topics include imaging, sensors, biomedical equipment, and management and organizational aspects, as well as legal and social issues.

The book provides a timely overview of informatics and technology in healthcare during this time of extremely fast developments, and will be of interest to all those working in the field.

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HEALTHCARE TRANSFORMATION WITH INFORMATICS AND ARTIFICIAL INTELLIGENCE

Studies in Health Technology and Informatics

Internationally, health informatics is driven by developments in biomedical technologies and medical informatics research that are advancing in parallel and form one integrated world of information and communication media and result in massive amounts of health data. These components include genomics and precision medicine, machine learning, translational informatics, intelligent systems for clinicians and patients, mobile health applications, data-driven telecommunication and rehabilitative technology, sensors, intelligent home technology, EHR and patient-controlled data, and Internet of Things.

The series Studies in Health Technology and Informatics (HTI) was started in 1990 in collaboration with EU programmes that preceded the Horizon 2020 to promote biomedical and health informatics research. It has developed into a highly visible global platform for the dissemination of original research in this field, containing more than 250 volumes of high-quality works from all over the world.

The international Editorial Board selects publications with relevance and quality for the field. All contributions to the volumes in the series are peer reviewed.

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Preface

This volume contains the papers accepted for the ICIMTH (International Conference on Informatics, Management, and Technology in Healthcare) for the year 2023. The Scientific Programme Committee presents to the academic and professional community of biomedical and health informatics, the scientific outcomes of the ICIMTH 2023 Conference, held from 1–3 July 2023 in Athens, Greece.

The ICIMTH 2023 Conference is the 21st annual conference in this series of scientific events, which gathers scientists working in the field of biomedical and health informatics from all continents. As last year, because the situation as regards the COVID-19 pandemic has improved and restrictions were lifted, the conference was held as a live event. To encourage all presenters to attend the conference, virtual sessions by means of teleconferencing were not offered.

The field of biomedical and health informatics is studied at this conference from a very broad perspective, with the participants presenting research and application outcomes of informatics from cell to populations, including several technologies such as imaging, sensors, biomedical equipment and management and organisational aspects, including legal and social issues. Essentially, data science, informatics, and technology inspire health professionals and informaticians to improve healthcare for the benefit of patients. As was expected, a significant number of papers were still related to the COVID-19 pandemic, but this year we saw an increased influx of submissions in AI studies and applications in healthcare. We wanted this to be reflected in the theme of the conference and the title of the proceedings.

It should be noted that the proceedings are published as an open access eBook with e-access for ease of use and browsing without the loss of any of the advantages of indexing and citation in the biggest scientific literature databases, such as PubMed/Medline and Scopus, that the series of Studies in Health Technology and Informatics (HTI) of IOS Press provides.

At the end of the deadline we had more than 252 submissions, from which, after review, we accepted 149 as full papers, 13 as short communications, and 14 as poster papers.

The organisers would like to thank Dr. Spyros Zogas and Prof. John Mantas for the design of the cover illustration and of the entire conference series. This year the cover illustration signifies the reflection of AI applications in healthcare, as Hygeia faces her mirror automaton image, indicating the possible dangers to healthcare which exist during this extremely fast digital-transformation era of the healthcare system.

The Editors would like to thank the Members of the Scientific Programme Committee, the Organising Committee, and all Reviewers, who performed a very professional, thorough and objective refereeing of the scientific work to achieve a high-quality publishing achievement for a successful scientific event.

Athens, 26.05.2023
The Editors,
John Mantas, Parisis Gallos, Emmanouil Zoulias, Arie Hasman, Mowafa S. Househ, Martha Charalampidou and Andriana Magdalinou.

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A Computational Infrastructure for Analyzing Tuberculosis Research Data in Brazil

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Abstract. Tuberculosis (TB) is one of the infectious diseases that currently causes the most deaths, with 6.4 million new cases recorded in 2021. Although it is a curable disease, drug-resistant strains emerge due to a lack of hygiene and low-quality or inappropriate medications, among other factors. With this in mind, the World Health Organization initiated the End TB Strategy campaign to improve the health system in the fight against tuberculosis. For this, reliable and high-quality health data is necessary to create effective public policies. However, despite technological advancements such as emerging concepts like Big Data and the Internet of Things, generating health information faces several obstacles. Therefore, the present work aims to describe a pipeline for TB research in Brazil to contribute to obtaining high-quality data.

Keywords. Tuberculosis, Data Science, Research data

1. Introduction

Tuberculosis (TB) is the second highest cause of death caused by a single infectious agent, surpassing HIV/AIDS. Despite being a curable and preventable disease, in 2021, 6.4 million new cases were recorded, resulting in 1.4 million deaths among HIV-negative individuals and 187,000 deaths among HIV-positive individuals [1]. The emergence of drug-resistant strains can be attributed to low-quality medication, poor hygiene, use of inappropriate medication, and delayed treatment approaches [2].

Drug-resistant TB, which is expensive and requires a long treatment period, needs new, affordable, and effective diagnostic tools that guarantee quality and proven efficacy to be rapidly implemented [3]. In addition, health services should incorporate new information systems to aid decision-making. The World Health Organization launched the Stop TB Strategy in 2006, followed by a new strategy in 2015 with more ambitious goals and a greater focus on research and innovation. Although both

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approaches have significantly reduced TB cases in high-burden countries, multidrug-resistant tuberculosis remains a global problem [4].

Data reliability is critical for improving health service quality and creating effective public policies. However, generating health information is faced with barriers such as problems with patient data documentation, data interpretation difficulties, and organizational issues [5]. In TB research, a large amount of complex data is produced from dispersed sources with low integration and varying accuracy levels. It impedes knowledge extraction and data analysis, making it challenging to provide decision support in operational and administrative processes and scientific research [6].

Currently, data coordination between TB stakeholders parties can be messy, prone to delays, subject to manipulation, and obscure. Thus, this work aims to describe a computational pipeline and the infrastructure needed for analyzing TB research data, assisting in establishing a high-quality data source in Brazil.

2. Methods

2.1. Brazilian Tuberculosis Research Network Ecosystem

The most used diagnostic methods for TB consider bacteriological, radiological, histopathological, and immunological approaches. The bacteriological tests consist of bacilloscopy and culture. Clinical materials such as sputum, bronchial and bronchoalveolar lavage, and other samples that can be taken from the respiratory tract are used for TB research [2].

The clinical laboratory has a fundamental role in the health system, given that most medical decisions are made using the information provided by laboratory processes. Quality assurance in a clinical analysis laboratory is built on all process stages, from the material collection (pre-analytical) to the result (post-analytical) delivery. Clinical samples sent to the laboratory for TB diagnosis must comply with a series of general conditions on which the quality and efficiency of the test results depend. It is essential to control the data quality from local centers belonging to the Brazilian TB research network, which covers 65 institutions and researchers [3].

2.2. Data Gathering, Infrastructure, Curation, and Analysis Pipeline

The TB Network conducts studies that require the collection and management of data in scientific, clinical, and managerial/epidemiological domains. The Research Electronic Data Capture (REDCap) platform is used for this purpose, which is a web-based application that allows the creation of case report forms, surveys, and research databases. REDCap is an open-source application that provides several tools for exporting data in multiple formats, including the CSV standard that facilitates compatibility with other third-party tools.

The collected data are categorized and segmented inside the network through the projects, and participants have restricted access based on the network policies. Data are automatically anonymized to ensure ethical, legal, and confidential issues, and their confidence rate level can be chosen. Before analysis, the data undergoes pre-processing to identify and treat missing and abnormal values and duplicate and redundant data. Validations are also carried out to ensure the types of variables and transformations, such as normalization and discretization.

The exploratory analysis is the next step in the analysis pipeline, where the data's distribution and amount are better understood. Descriptive statistics such as the mean, median, and standard deviation are calculated. Graphics such as bar and scatter charts and visual elements such as presentations and images are used to understand the results better. Regression and clustering calculations can also be used to find patterns and relationships in the data that are not easily identifiable.

2.3. Auxiliary Tools

The collaboration scripts for developing machine learning and artificial intelligence algorithms are developed in Google Colab, a Jupyter Notebook-based platform. It provides an accessible and readily available environment for developing Python programs. Python is popular due to its high-level nature and simplicity, which enables portability across different platforms, and it has a vast developer community and numerous libraries. Specific Python libraries used in programming tasks include Numpy for mathematical functions such as linear algebra, Pandas for data analytics functions, and Scikit-learn for machine learning algorithms. Streamlit, a Python-based data visualization platform that allows data transformation into shareable pages without prior knowledge of other programming languages, was adopted for data visualization. Streamlit can be easily integrated with Python applications, requiring minimal adaptation to receive Python outputs, and is an efficient way to display data without using large tables.

2.4. TBWeb Application for TB Analysis

A research network developed a web application to validate statistical analyses related to project data. The portal can connect to any database and offers real-time statistical analysis of clinical data through data visualization techniques. Researchers can monitor all updates in the data in real time.

3. Expected Outcomes

The expected primary outcomes of this work are tools and a curated knowledge basis for frameworks that can promote clinical data quality within the Brazilian tuberculosis stakeholders through a national research network. Over the medium time, we expect to also encourage new models of data sharing (e.g., safe data havens, data lakes, data hubs) and innovative privacy-preserving and processes analytical methods. Also, it is expected, in the long term, to obtain positive health outcomes, such as developments in public health indicators, a better understanding of health services processes, improved research outcomes, and new approaches to ethical and legal issues.

Although the final goal is to implement this pipeline to the national network in Brazil, in phase 1, it will be first deployed and validated in 7 research centers, leading to different data types. Data from several government sources will be gathered to build a test database for the computational tool and validate data sharing among peers. Our success indicators will be based on the following parameters: adoption of the tool by the TB Network entities; the volume of data available and used; and perception of

usefulness for academic, clinical, and managerial audiences. After defining these parameters, a validation process for an official implementation as a national tool for TB will be carried out with the TB experts independently committee.

Based on a well-established process and robust evidence, we hope we can compare our results with the source documents of each center. It will allow checking the validity of a sample of the data entered on the form and define intervention, such as visiting the local centers to improve the data culture and promote continuous education. We expect also to be enabled to compare our solution with consolidated approaches like the Observational Health Data Sciences and Informatics (OHDSI) tools and the FAIR Principles.

4. Conclusions

It is expected to successfully build a high-quality data source to provide a basis for developing new decision-support tools. We hope to advance scientific research and establish new diagnosis algorithms and optimized operational models toward better patient care and managerial decisions. In the long term, it is expected to achieve positive health outcomes such as improved public health indicators, a better understanding of health service processes, and new approaches to ethical and legal issues.

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