International 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.

Studies in Health Technology and Informatics (HTI) series 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.

Volumes in the HTI series are submitted for indexing by MEDLINE/PubMed; Web of Science: Conference Proceedings Citation Index – Science (CPCI-S) and Book Citation Index – Science (BKCI-S); Google Scholar; Scopus; EMCare.

Series Editors:

Volume 285

Recently published in this series

Vol. 284 M. Honey, C. Ronquillo, T.-T. Lee and L. Westbrook (Eds.), Nurses and Midwives in the Digital Age – Selected Papers, Posters and Panels from the 15th International Congress in Nursing Informatics

Vol. 283 R. Röhrig, T. Beißbarth, J. König, C. Ose, G. Rauch, U. Sax, B. Schreiweis and M. Seidlmaier (Eds.), German Medical Data Sciences 2021: Digital Medicine: Recognize – Understand – Heal – Proceedings of the Joint Conference of the 66th Annual Meeting of the German Association of Medical Informatics, Biometry, and Epidemiology e.V. (gmde) and the 13th Annual Meeting of the TMF – Technology, Methods, and Infrastructure for Networked Medical Research e.V. 2021 online in Kiel, Germany


ISSN 0926-9630 (print)
ISSN 1879-8365 (online)
pHealth 2021
Proceedings of the 18th International Conference on Wearable Micro and Nano Technologies for Personalized Health
8–10 November 2021, Genoa, Italy

Edited by
Bernd Blobel
Medical Faculty, University of Regensburg, Germany
Chair, Scientific Program Committee

and

Mauro Giacomini
Department of Informatics, Bioengineering, Robotics and System Engineering,
University of Genoa, Genoa, Italy
Chair, Local Organizing Committee

IOS Press
Amsterdam  Berlin  Washington, DC
Preface

pHealth 2021 is the 18th conference in a series of scientific events that has brought together expertise from medicine, technology, politics, administration, and social domains, and even from philosophy and linguistics. It opens a new chapter in the success story of this series of international conferences on wearable or implantable micro and nano technologies for personalized medicine.

Begun in 2003 as a Dissemination Activity in the framework of a European Project on Wearable Micro and Nano Technologies for Personalized Health with personal health management systems, pHealth conferences have evolved to become truly interdisciplinary and global events. As comprehensively represented in the conference series, pHealth also covers technological and biomedical facilities, legal, ethical, social and organizational requirements and impacts, as well as the basic research necessary for the enabling of future-proof care paradigms. It thereby combines medical services with public health, prevention, social and elderly care, wellness and personal fitness to establish participatory, predictive, personalized, preventive, and effective care settings. In this way, it has attracted scientists, developers, and practitioners from various technologies, medical and health disciplines, legal affairs, politics, and administration from all over the world. The conference brings together health-service vendor and provider institutions, funding organizations, government departments, academic institutions, professional bodies, and also patients and citizens representatives.

Smart mobile systems, such as microsystems, smart textiles, smart implants, sensor-controlled medical devices, and innovative sensor and actuator principles and techniques, as well as related body, local and wide-area networks up to cloud services, have become important enablers for telemedicine and ubiquitous pervasive health as the next generation of healthcare services. Social media and gamification have added even further knowledge to pHealth as an eco-system.

The OECD has defined four basic areas on which to focus in the new care model: addressing the challenges of big data; fostering meaningful innovation; understanding and addressing the potential new risks; and supporting a concerted effort to un-silo communities for a virtual care future. The benefits of pHealth technologies offer enormous potential for all stakeholder communities, including patients, citizens, health professionals, politicians, healthcare establishments, and companies from the biomedical technology, pharmaceutical, and telecommunications domain, not only in terms of improvements in medical quality and industrial competitiveness, but also for the management of healthcare costs.

The pHealth 2021 conference benefits from the experience of and the lessons learned by the organizing committees of previous pHealth events, particularly 2009 in Oslo, 2010 in Berlin, 2011 in Lyon, 2012 in Porto, 2013 in Tallinn, 2014 in Vienna, 2015 in Västerås, 2016 in Heraklion, 2017 in Eindhoven, 2018 in Gjøvik, 2019 in Genoa, and 2020 in Prague. The 2009 conference raised the interesting idea of having special sessions focusing on a particular topic and organized by a mentor/moderator. The Berlin event in 2010 initiated workshops on particular topics taking place before to the official start of the conference. Lyon, in 2011, launched so-called dynamic demonstrations which allowed participants to demonstrate software and hardware...
solutions on the fly without the need for a booth. Implementing pre-conference events, pHHealth 2012 in Porto gave attendees a platform for presenting and discussing recent developments and provocative ideas that helped to animate the sessions. The highlight of pHHealth 2013 in Tallinn was the special session on European project success stories, and also presentations on up and coming paradigm changes and challenges associated with Big Data, Analytics, Translational and Nano Medicine, etc. Vienna, in 2014, focused on lessons learned from national and international R&D activities and practical solutions, particularly from Horizon 2020, the new EU Framework Program for Research and Innovation. Alongside reports about technology transfer support and building ecosystems and value chains to ensure better time to market and higher impact of knowledge-based technologies, the acceptability of solutions, particularly considering security and privacy aspects were presented and deeply discussed. pHHealth 2015, held in Västerås, addressed mobile technologies, knowledge-driven applications and computer-assisted decision support, as well as apps designed to support the elderly and chronic patients in daily and possibly independent living. The fundamental scientific and methodological challenges of adaptive, autonomous, and intelligent pHHealth approaches, the new role of patients as consumers and active parties with growing autonomy and related responsibilities, as well as the requirements and solutions for mHealth in low- and medium-income countries were also considered. The 2016 pHHealth conference was aimed at the integration of biology and medical data, the deployment of mobile technologies through the development of micro-nano-bio smart systems, the emphasis on personalized health, virtual care, precision medicine, big bio-data management and analytics. The pHHealth 2017 event in Eindhoven provided an inventory of the former conferences by summarizing requirements and solutions for pHHealth systems, highlighting the importance of trust, and focused afresh on the behavioral aspects of designing and using pHHealth systems. A specific aspect addressed was the need for flexible, adaptive and knowledge-based systems, as well as decision intelligence. pHHealth 2018 established national and European satellite workshops, so complementing the more theoretical consideration of the majority of the papers with organizational and practical experiences. Borrowing good experiences from former events, pHHealth 2018 responded to the national and regional need for advancing healthcare systems and their services to citizens and health professionals. pHHealth 2019 placed a particular focus on artificial intelligence (AI) and machine learning (ML) and their deployment for decision support, and ethical challenges and related international manifests were discussed in depth in that context. pHHealth 2020 – organized as a virtual event – addressed AI and robots, bio-data management and analytics for health and social care, security, privacy and safety challenges, integrated care, and also the intelligent management of specific diseases including the Covid-19 pandemic. The 2021 edition of the pHHealth conference series – again a virtual event – focuses on digital health ecosystems in the transformation of healthcare towards personalized, participative, preventive, predictive precision medicine (5P medicine). The deployment of mobile technologies, micro-nano-bio smart systems, bio-data management and analytics, autonomous and intelligent systems, as well as the Health Internet of Things (HIoT) for personalized health, systems medicine, public health and virtual care are thereby especially considered. The conference also addresses new potential risks for security and privacy as well as safety chances and challenges, trustworthiness of partners and processes, and the motivation and empowerment of patients in care processes. The multilateral benefits of pHHealth technologies offer enormous potential for all stakeholder communities, not only in terms of improvements in medical quality
and industrial competitiveness, but also for managing health care costs and, last but not least, improving patient experiences.

The conference is organized under the patronage of the City of Genoa and the Liguria Regional Authority, the University of Genoa and the Department of Informatics, Bioengineering, Robotics and System Engineering (DIBRIS) in particular, and Healthtrophy srl as a University of Genoa’s Spin-Off. Following a long-standing tradition, the Working Groups “Electronic Health Records (EHR)”, “Personal Portable Devices (PPD)”, “Security, Safety and Ethics (SSE)”, and “Translational Health Informatics” of the European Federation for Medical Informatics (EFMI) have also been actively involved in the preparation and realization of the pHealth 2021 event.

Neither the pHealth 2021 Conference nor the publication of the pHealth 2021 Proceedings by IOS Press would have been possible without the aforementioned financial and spiritual supporters and sponsors. This also includes the Italian Scientific Society of Biomedical Informatics, the IEEE Engineering in Medicine and Biology Society (EMBS), the Camber of Engineers Genoa, and the European Federation for Medical Informatics (EFMI) and standard-setting organizations such as HL7 International, ISO/TC215 or CEN/TC251.

The editors are also grateful to the Members of the international Scientific Program Committee, but especially for the dedicated efforts of members of the Local Organizing Committee and their supporters for the careful preparation and the smooth operation of the conference.

Bernd Blobel, Mauro Giacomini
(Editors)
pHealth 2021 Committees and Reviewers

pHealth 2021 Scientific Program Committee

Bernd Blobel, Medical Faculty, University of Regensburg, Regensburg, Germany (Chair)
Eric McAdams, INISA, Lyon, France
Dag Austen, SINTEF ICT, Oslo, Norway
Mauro Giacomini, Dept. of Informatics, Bioengineering, Robotics and System Engineering (DIBRIS), University of Genoa, Genoa, Italy
William Goossen, Results4Care, Amersfoort, The Netherlands
Lenka Lhotská, Czech Institute of Informatics, Robotics and Cybernetics and Faculty of Biomedical Engineering, Czech Technical University in Prague, Prague, Czechia
Maria Lindén, School of Innovation, Design and Engineering, Mälardalen University, Västerås, Sweden
Diego Mauricio Lopéz-Gutierrez, Faculty of Electronic Engineering and Telecommunications, University of Cauca, Popayan, Colombia
Andreas Lymberis, European Commission, DG Connect, Brussels, Belgium
Stefan Sauermann, University of Applied Sciences Technikum Wien, Vienna, Austria
Filipe Sousa, Fraunhofer Portugal-AICOS, Porto, Portugal
Marc Schurr, Ovesco Endoscopy AG, Tübingen, Germany
Bian Yang, IIK, NTNU, Gjøvik, Norway

pHealth 2021 Local Organizing Committee

Mauro Giacomini, Dept. of Informatics, Bioengineering, Robotics and System Engineering, University of Genoa, Genoa, Italy (Chair)
Viola Lanza, Healthropy srl, Savona, Italy
Laura Pastorino, Dept. of Informatics, Bioengineering, Robotics and System Engineering, University of Genoa, Genoa, Italy
Silvana Quaglini, Dept. of Electrical, Computer and Biomedical Engineering, University of Pavia, Pavia, Italy
Carmelina Ruggiero, Dept. of Informatics, Bioengineering, Robotics and System Engineering, University of Genoa, Genoa, Italy

pHealth 2021 Reviewers

Sun-Ju Ahn, Sungkyunkwan University, Suwon, Korea
Arriel Benis, Holon Institute of Technology, Holon, Israel
## Contents

**Preface**  
*Bernd Blobel and Mauro Giacomini*

**pHealth 2021 Committees and Reviewers**

### Keynote

**Autonomous Systems and Artificial Intelligence – Hype or Prerequisite for P5 Medicine?**  
*Bernd Blobel, Pekka Ruotsalainen and Mathias Brochhausen*

### Invited Papers

**The International Patient Summary and the Summarization Requirement**  
*Stephen Kay*

**Communicating About Mortality in Health Decision Support: ‘What and Why and When, and How and Where and Who’**  
*Jack Dowie, Mette Kjer Kaltøft and Vije Kumar Rajput*

**How a Service User Knows the Level of Privacy and to Whom Trust in pHealth Systems?**  
*Pekka Ruotsalainen and Bernd Blobel*

**Towards Personalized Medication**  
*Míchal Huptych, Jirí Potucek and Lenka Lhotská*

**eHealth Turning Points as Forced by the Covid-19 Dramatic Experience**  
*Francesco Pinciroli*

### Data and Knowledge Management and Methodologies

**Sentiment Analysis on USA vs. New Zealand on Health and Safety Mandates During Early Stages of COVID-19 Pandemic**  
*Joshua Dales, Farhaan Mirza and Amr Adel*

**The Building Blocks of Information Are Selections – Let’s Define Them Globally!**  
*Wolfgang Orthuber*

**ContSOnTo: A Formal Ontology for Continuity of Care**  
*Subhashis Das and Pamela Hussey*
Predicting the Aortic Aneurysm Postoperative Risks Based on Russian Integrated Data
Iuliia Lenivtceva, Sofia Grechishcheva, Georgy Kopanitsa, Dmitry Panfilov and Boris Kozlov

An Unsupervised Approach to Structuring and Analyzing Repetitive Semantic Structures in Free Text of Electronic Medical Records
Varvara Koshman, Anastasia Funkner and Sergey Kovalchuk

Statistical Inference for Clustering Results Interpretation in Clinical Practice
Alexander Kanonirov, Ksenia Balabaeva and Sergey Kovalchuk

A Modeling Framework for Decision Support in Periprosthetic Joint Infection Treatment
Vasiliy N. Leonenko, Yulia E. Kaliberda and Vasily A. Artyuk

Predictive Modeling of COVID and non-COVID Pneumonia Trajectories
Nikita Mramarov, Ilya Derevitskii and Sergei Kovalchuk

Data-Driven Modeling of Complex Business Process in Heterogeneous Environment of Healthcare Organization with Health Information Systems
Alexander Kshenin and Sergey Kovalchuk

Reinforcing Health Data Sharing Through Data Democratization
Yuhang Wang and Bian Yang

Dynamic Aortic Aneurism Risk Factors
Oleg Metsker, Georgy Kopanitsa, Olga Irtyuga and Vladimir Uspenskiy

A New Paradigm for Ensuring Digital Drug Care Quality Monitoring Based on Ontology Tools
Tatiana Lugovkina, Sergey Gorshkov and Evgeniy Svalov

Digital Phenotypes for Personalized Medicine
Carlos Molina and Belén Prados-Suarez

A Multilayer LSTM Auto-Encoder for Fetal ECG Anomaly Detection
Inna Skarga-Bandurova, Tetiana Biloborodova, Illia Skarha-Bandurov, Yehor Boltov and Maryna Derkach

A NLP Pipeline for the Automatic Extraction of Microorganisms Names from Microbiological Notes
Sara Mora, Jacopo Attene, Roberta Gazzarata, Giustino Parruti and Mauro Giacomini

Understanding the Gap Between Information Models and Realism-Based Ontologies Using the Generic Component Model
Mathias Brochhausen, Sarah J. Bost, Nitya Singh, Christoph Brochhausen and Bernd Blobel

Machine Learning Based Metagenomic Prediction of Inflammatory Bowel Disease
Andrea Mihajlović, Katarina Mladenović, Tatjana Lončar-Turukalo and Sanja Brdar
Personal Health Records, Patient-Centered Data Management, and Cloud Services

Toward an Agile System: Iranian Information System for Covid-19-Affected Patients Data Collection from Iranian Hospitals
Somayeh Abedian, Pirhossein Kolivand and Hamid Reza Lornejad

Prerequisites of Personal Health Record for Chronic Kidney Disease: A Scoping Review and Evaluation of the Content Validity
Fatemeh Salehi, Peivand Bastani, Leila Ahmadian, Katayoon Samadi, Azita Yazdani and Roxana Sharifian

Solutions for Personalized Care

A User-Centered, Integrated Model to Improve Medication Prescription, Administration and Adherence in Switzerland
Katherine Blondon and Frederic Ehrler

Lifestyle Cancer Survival Predictors: Influence of Vegetarian Diet on the Relapse of Endometrial Cancer
Georgy Kopanitsa, Oleg Metsker, Ekaterina Bolgova and Sergey Kovalchuk

Gait Analysis Platform for Measuring Surgery Recovery
Marc Codina, Manuel Navarrete, Ashkan Rezaee, David Castells-Rufas, Maria Jesús Torrelles, Stefan Burkard, Holger Arndt, Sabine Drevet, Medhi Boudissa, Jerome Tonetti, Isabelle Marque, Alexandre Moreau-Gaudry, Armand Castillejo and Jordi Carrabina

The Effectiveness of Telemedical Monitoring Program DiabCare Tirol for Patients with Gestational Diabetes Mellitus
Gihan El Moazen, Bernhard Pfeifer, Agnes Loid, Peter Kastner and Christian Ciardi

A Web Based Tool to Support a Personalized Therapeutic Path Through the Use of Psychological Tests
Elena Lazarova, Sara Mora, Davide Armanino, Alessandro Poire, Fabio Furlani and Mauro Giacomini

Challenges and Solutions in Health Education and Training

Development of a Didactic Online Course Concept for Heterogeneous Audience Groups in the Context of Healthcare IT
Matthias Katzensteiner, Stefan Vogel, Jens Hüsers, Jendrik Richter, Johannes Hölken, Natalia Lesniewska and Oliver J. Bott

mHealth Applications

Social Media Chatbot for Increasing Physical Activity: Usability Study
Dillys Larbi, Elia Gabarron and Kerstin Denecke
A Mobile App to Improve Patient Management in Emergency Departments: Caregiver Needs Analysis, Design and Early Technology Acceptance Assessment
Frédéric Ehrler, Carlotta Tuor, Robin Rey and Johan N. Siebert

Assessment of mHealth Solutions Applied to Fall Detection for the Elderly
Fellipe Soares de Oliveira, Camila Carvalho da Silva, Talita Santos Pinheiro, Larissa Mayumi Yokoi, Pablo Deócleia dos Santos, Harki Tanaka and Priscyla Waleska Simões

Continuous Stress Detection of Hospital Staff Using Smartwatch Sensors and Classifier Ensemble
Muhammad Ali Fauzi and Bian Yang

Security, Privacy, Safety, and Ethics Issues in pHealth
Implementation of Privacy and Security for a Genomic Information System
Jaime Delgado, Silvia Llorente and Guillem Reig

Regulation Modelling and Analysis Using Machine Learning During the Covid-19 Pandemic in Russia
Egor Trofimov, Oleg Metsker, Georgy Kopanitsa and David Pashoshev

Association Between Physical Activity and Osteoarthritis of Knee with Quality of Life in Community-Dwelling Older Adults
Nachalida Yukalang, Niruwan Turnbull, Wisit Thongkum, Adisorn Wongkongdech and Kukiat Tudpor

Posters
Factors Predicting Sexual Risk Behaviors of Adolescents in North-Eastern Thailand
Athiwat Butdabut and Pissamai Homchampa

Conceptual Model for Behaviour Change Progress – Instrument in Design Processes for Behaviour Change Systems
Helena Lindgren and Saskia Weck

Automatic Extraction and Decryption of Abbreviations from Domain-Specific Texts
Michil Egorov and Anastasia Funkner

Mapping of OpenEHR Archetypes to FHIR Resources in Use Case Oncology
Abdul Mateen Rajput and Ina Brakollari

Detection of COVID-19 from Chest CT Images Using CNN with MLP Hybrid Model
Sakthi Jaya Sundar Rajasekar, Vasumathi Narayanan and Varalakshmi Perumal