Preface

Medicine-Based Informatics and Engineering is now available after a major regional Congress (Fig. 1) one week prior to the outbreak of COVID-19 pandemics in Latin America. The plenary and semi-plenary speakers of the 700 strong SABI2020 Regional Meeting were invited to write a chapter while preparing their presentations and their—sometimes canceled—trip to Piriápolis, Uruguay. The SABI2020 Biomedical Engineering and Medical Informatics Congress was a special occasion

Fig. 1 SABI2020 Congress held in Piriápolis, Uruguay March 4–6, 2020, one week before the COVID-19 pandemic reached the Country. Plenary and semi-plenary speakers at SABI2020 were invited to contribute a chapter for this book

to discuss new devices and software to foster medical care and patient–physician relationship, as well as interdisciplinary approaches or social motivations.

Technology has evolved to such a multiplicity of possibilities, and the software can perform so many different functions, that only meaningful applications should be considered for development and clinical use. The mere fact that a physiological parameter can be measured or a function can be performed is not by itself a reason for engineering to suggest a clinical device. To fulfill such adherence of development efforts to clinical needs, interdisciplinary work is necessary to put forward combinations of medical and technological knowledge to feed the Biomedical Engineering research agenda. This line of thought was the first motivation for the authors to contribute chapters for this book.

Within modern technology, information and communication (ICT) are increasingly associated and sometimes included in specific hardware technical solutions. Therefore, the classical distinction between "systems engineering" or "software engineering/computer science" on one side and classical engineering (mechanical, electrical, materials, etc.) on the other side is no longer valid.

Throughout the book, two concepts are present: (i) Medicine should drive the development of Biomedical Engineering (BME) and Medical Informatics (MI) from available and new technology. Since the limitations of technology are reduced, technology "per se" is no longer the privileged starting point of research. Today, the development of biomedical devices, software and systems can almost freely stem from clinical wish lists and desiderata. (ii) The second idea treated implicitly in the book is that BME and MI should merge into a single body of knowledge to better follow the demanding clinical challenges of modern medicine. Having mastered the problems to be solved for survival, physiological compensation, repair and pain reduction, BME+MI are now asked to start from bedside or living milieu to develop ever more sophisticated tools for increasing cohorts of aging populations to contribute to their quality of life: should we call it "Medical Engineering" to include BME+MI?

Within this framework, the book includes chapters addressing these ideas from each author own point of view and expertise. The range of fields in the book is wide enough to give the reader an overview of what to expect in the coming decades in Medical Engineering, concerning new medical software systems, pervasive medicine, wearable devices, prosthesis, intelligent follow-up and anticipatory medicine, as well as the impact of instrument-connected electronic clinical record (ECR) with knowledge derived from the use of artificial intelligence (AI) data analysis.

Chapter "Medicine Based Engineering and Informatics to Foster Patient Physician Relationship" by Franco Simini describes interdisciplinary work within a University Hospital, with details of lessons learned with the development of new devices and of innovative Medical Informatics, such as clinical record systems and chronic condition patient follow-up applications. The translation of software systems from other activities into medicine is described as the possible cause of delayed adoption of ECR when patient–physician relationship is valued and respected. Part of the chapter mentions Technology Transfer to allow a timely

dissemination of BME+MI benefits within health care systems, involving licensing to industrial and commercial companies.

Chapter "Statistical Gait Analysis Based on Surface Electromyography" by Valentina Agostini and coworkers is on Statistical Gait Analysis, a contribution to a new way to study gait—a basic human motor task—from an Electromyography (EMG) perspective. By processing surface EMG, this chapter introduces Inertial measurements (IMU—inertial measuring unit) to detect muscle activation gait phases in a simple way, robust to repetitions. The follow-up of entire cohorts of patients in the future will depend on the methods and devices derived from this research, optimizing health care system resources.

Chapter "Brain-Computer Interfaces with Functional Electrical Stimulation for Motor Neurorehabilitation: From Research to Clinical Practice" by Carolina Tabernig and coworkers deals with brain-computer interfaces and specific rehabilitation applications, as developed from clinical practice and described in an interdisciplinary approach. Clinical needs clearly drive this research field.

Chapter "Biopotential Acquisition Systems" by Enrique Spinelli and coworker is an electrical engineering breakthrough contribution to the design of electronic circuits for biopotential amplification. It includes next generation configurations and state of the art designs to obtain the best possible signal to noise ratio in human signal capture for all kinds of biomedical devices.

Chapter "Wearable Bioimpedance Measuring Devices" by Pedro Bertemes-Filho describes a very special kind of signal derived from biological tissues: bioimpedance as used for wearable devices. There is an immense potential behind the availability of non invasive time series to monitor (and therefore the opportunity to act upon) diverse physiological parameters, in intensive care, rehabilitation and assistive devices. Bioimpedance is the modern low cost "general purpose" technology to tackle unsolved problems from a medical perspective with simple non invasive clinical applications.

Chapter "Predictive Cardiovascular Engineering: Transforming Data into Future Insights on Cardiovascular Disease" by Ricardo Armentano leaves behind decades of cardiology and associated palliative pharmaceutical approach to introduce arterial biomechanics to keep us in good health. This is a tremendous "back to the basics" of Medicine made possible by Biomedical Engineering interdisciplinary development stemmed from a profound understanding of cardiovascular physiology. It is a new approach to arterial biomechanics which allows to act with preventive medicine before any symptoms appear later in age.

In Chapter "Engineering Special Medical Devices for Vulnerable Groups", Martha Ortiz and coworker bridge the gap toward vulnerable groups. Biomedical Engineering and Medical Informatics hold the key to develop special medical devices for all, following WHO recommendations.

Chapter "Serious Games and Virtual Reality for Rehabilitation and Follow up of Wheelchaired Persons" by Marta Bez and coworkers describe the development of serious games with virtual reality for rehabilitation and follow-up of wheel-chaired persons, opening the way for interdisciplinary work by clinicians and engineers.

Chapter "Society 5.0 and a Human Centred Health Care" by Violeta Bulc and coworkers is a bold introduction to think health and technology in a new way, with cooperation from industry, politics, business and scientific research to foster better medical devices and software applications. This synergy empowers individuals, firms and government to a yet to be reached level of connection between clinical needs, societal potential and health care system.

Chapter "Clinical Practice, Patient-Physician Relationship and Computers" by Alvaro Díaz Berenguer is a warning to avoid deteriorating the patient–physician relationship with misuses of information and communication technology. Computer technology does not always respect the delicate empathy necessary to fulfill the basic medical functions. Medical Engineering and Medical Informatics can add considerable efficiency, error reduction, follow-up capacity, but should neither hinder nor replace the human species intrinsic patient–physician relationship.

Chapter "Interdisciplinary Collaboration Within Medicine-Based Informatics and Engineering for Societal Impact" by Bianca Vienni and Franco Simini considers Medical Engineering and Medical Informatics from an epistemological point of view. Intrinsically interdisciplinary, the subject matter of the book is analyzed in this chapter from the point of view of "Science, Technology and Society." It is argued that engineering and medicine are also part of the STEMM conglomerate along with mathematics. Reading this chapter will allow the reader to see the links to societal change, as a consequence of ever more sophisticated devices, better (and longer) life spans and closer communications. Medicine and clinical knowledge cannot evolve unconnected to engineering development of devices and software systems.

This book is a contribution to an up-to-date approach to Biomedical Engineering and Medical Informatics from an interdisciplinary point of view, to help the reader put forward new ideas and goals. Within this book, diverse clinical applications, technologies and approaches will help the reader adopt criteria to tackle projects starting from clinical problems and using all available technology.

We wish the reader a pleasant and exciting experience in direct contact with the authors, through their carefully written texts, all meant to foster Medical Engineering!

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