Updates about TC-25: The Technical Committee on Biological and Medical Measurements

Eulalia Balestrieri, Sabrina Grassini, Voicu Groza, and Sergio Rapuano

The Technical Committee on Biological and Medical Measurements (TC-25) aims at establishing, developing, promoting and supporting cooperation among researchers in the different fields of biological and medical measurements. Sensors for the measurement of clinical and/or biological parameters, instrument and procedure characterization, instrument interoperability and interconnection, and data processing are some of the topics of interest to the TC-25. To those aims, the technical committee designs and realizes joint activities, like study groups aimed at standardization, such as the Subcommittee on Blood Pressure Measurement (SCOBPM); conferences or special sessions, such as the IEEE International Symposium on Medical Measurements and Applications (MeMeA); and several special sessions during the annual IEEE Instrumentation and Measurement Technical Conferences. TC-25 is also continuously engaged to maintain liaisons with other committees, groups, societies and organizations working on topics related to the TC scope. This paper presents the latest updates about the main activities of the TC-25. Some information about the TC-25 activities and targets is briefly presented, then the objectives and the efforts of the SCOBPM are summarized, and finally, the history and latest updates of our main conference, the MeMeA Symposium, are reported.

Biological and Medical Measurement Activities

Accuracy in diagnosis and in the effectiveness of treatment as well as the reliability of medical devices and instruments are strictly related and dependent on measurement. Information provided by measurement of patient-related variables such as physiological, physical and biochemical quantities are essential for decision making in clinical practice as well as for medical research, biomedical technology development and its use. Therefore, metrology has always had and will have an increasingly critical importance in medical applications. However, there still exist poor knowledge concerning the measurement theory, the adopted terms and units, the methods and their implementation as well as the correct interpretation of the results obtained by medical instruments and devices. As a consequence, many metrological misunderstandings can arise and have a negative impact on medical activities.

The TC-25 was born in response of these problems [1]. It comprises an international group of electronics engineers, mathematicians, and physicists with representatives from national metrology laboratories, national science institutions, and medical instrument manufacturers. Within the TC-25 test instrumentation field, industry, academia, and users work together to address the medical application needs related to the correct use of metrology concepts, methods and instruments. The topics of interest and targets for the TC-25 cover a large area including the development of new, more accurate, less invasive and less costly sensors to measure clinical and/or biological parameters. The TC-25 also focuses on new data processing, either conventional or non-conventional, for complex equipment, as for example computed axial tomography (CAT) and nuclear magnetic resonance (NMR), to pull out the most important exam features in a reliable, accurate and easy way. Instrument and measurement procedure characterization is another objective of the TC-25, taking also into account the involvement of human beings in some instruments and procedures and the lack of documentary standards. Instrument interoperability and interconnection is another important requirement in the medical measurement field, and area of interest of TC-25 members, due to the fact that most diagnoses come from the combination of tests results acquired by different instruments [1]–[8].

Moreover, the continuous and rapid evolution of technology in the medical field on one hand offers new possibilities and advantages for the for the protection of human health, but on the other hand, it introduces new challenges from the metrological point of view. The advances in digital processing, in micro and nanotechnology, as well as the Internet of Medical Things (IoMT) systems [1], [2], [4] are only some examples of the technologies to which the TC-25 pays close attention since they require appropriate measurement, accuracy and reliability.

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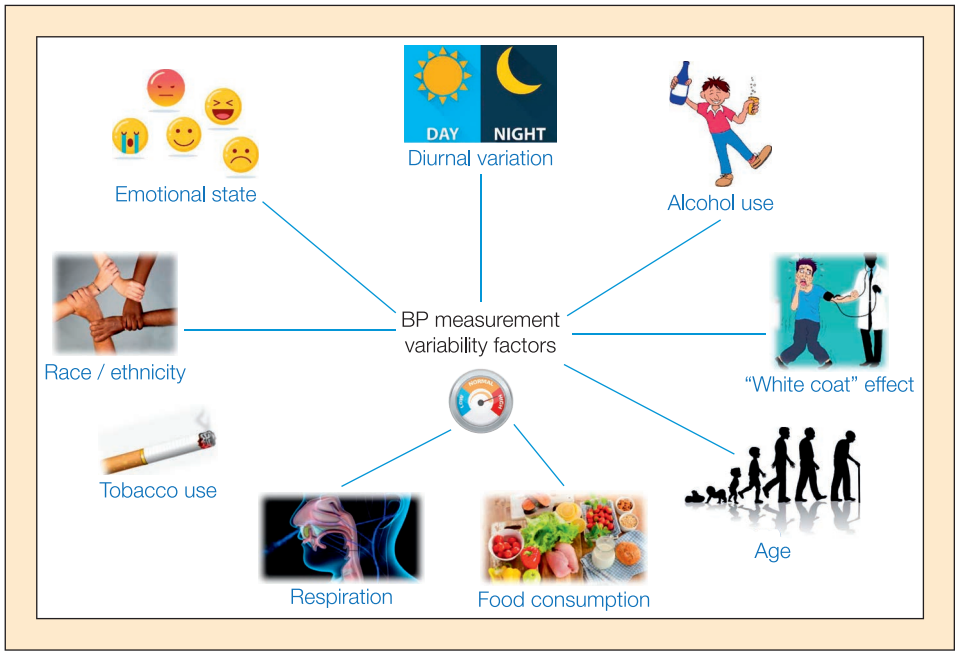

Fig. 1. Some factors affecting blood pressure measurements.

An example of the joint activities of TC-25 that address the impact of the latest hardware and software technologies on measurement terminology, biomedical instrument accuracy, calibration, and traceability, as well as the lack of documentary standards in the field, is the study group called Subcommittee on Objective Measurement of human arterial Blood Pressure (SCOBP). The accurate measurement of blood pressure (BP) represents a challenge in the metrology field, due to its variability that depends on several different and sometimes unpredictable factors, such as the patient's emotional state, age, race/ethnicity, food consumption, medical conditions (renal failure, diabetes, anaphylaxis, etc.), respiration, tobacco and/or alcohol use, sudden changes in patient's posture, diurnal variation, temperature, and the "white coat" effect [9], [10] (Fig. 1). Other sources of uncertainty can be related to the observer, in the case of manual measurement methods, with his/her bias or inaccuracy or to the used instrument itself, which may be inaccurate or damaged [9]. In the following section, the problems related to carrying out objective measurement of human arterial BP by looking at the oscillometric based measurements are presented, and the committee efforts in the field are briefly described.

Besides working to overcome the metrological challenges and to satisfy new and more and more stringent measurement requirements emerging in the medical field, TC-25 also operates to promote awareness of its activities and solicit involvement from interested people. To that end, in 2006 the committee started a series of conferences called IEEE International Medical Measurement and Applications Symposia (MeMeA) to allow people from academia, industry and medical fields to meet, confront, and discuss as well as create and strengthen collaborations [1]. The last section of this paper is devoted to present a brief history and accomplishments of MeMeA Symposia.

Objective Measurement of Systemic Arterial Blood Pressure in Humans

A wide range of clinical conditions needs accurate and reliable BP measurements, both to achieve a correct and timely diagnosis and to provide a suitable and effective treatment. Arterial BP measurement can be grouped in two main classes: invasive blood pressure (IBP) and non-invasive blood pressure (NIBP) measurement. In the first case, the BP measurement is carried out by means of a catheter that is inserted in the vascular system [9], [11]. In the second case, the BP measurement requires an inflatable cuff to be placed around the patient's upper arm. The artery under the cuff is occluded by inflating it, and then the cuff is deflated in a controlled manner. In this way, BP measurement can be carried out manually by listening to the arterial sounds (Korotkoff sounds) with the auscultatory method (Fig. 2) or automatically, based, for the most popular methods, on the detection of the variations in the pressure oscillations due to the arterial wall movement by means of the oscillometric method (Fig. 3) [9], [11]–[13].

Due to restrictions on the use of mercury in medical devices that undermined the use of mercury sphygmomanometers, until a few years ago considered the "gold" standard devices for measuring BP due to their simplicity and robustness, NIBP measurement instruments based on the oscillometric method have gained widespread use in the last 20 years, both inside and outside clinical environments, and they represent

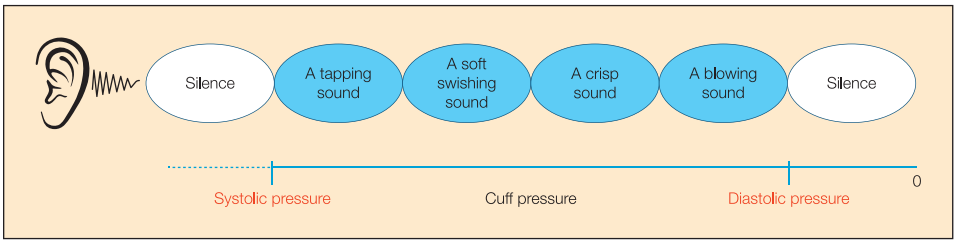

Fig. 2. Blood pressure measurements based on the Korotkoff sound auscultatory method.

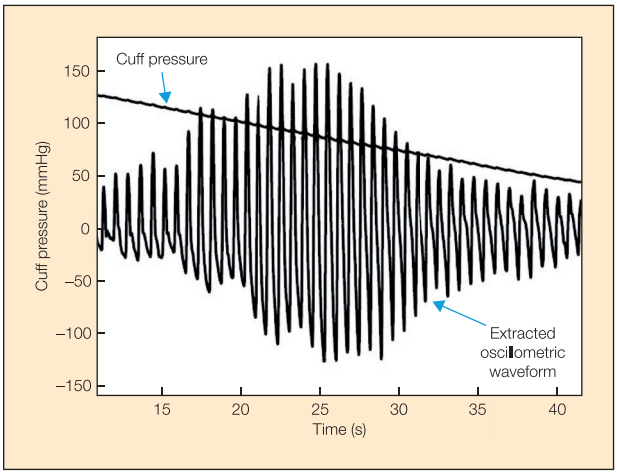

Fig. 3. Example of cuff pressure and extracted oscillometric waveforms by the oscillometric method (from [13], used with permission under Creative Commons Attribution License 3.0).

the majority of the available monitors on the market today [11], [14]. However, NIBP oscillometric instrument accuracy is the subject of discussion in the scientific field. This is due to several reasons: first, a unique implementation of the oscillometric method does not exist, and different secret legacy implementations are used from different manufacturers; NIBP oscillometric methods provide inaccurate measurements for certain patient groups (patients with arrhythmia or with excessive movement during measurement as well as with prolonged hypotension, diabetics); incorrect BP estimates can arise in presence of noise and artifacts [15]; and finally, usually cuff-based NIBP monitors are calibrated adopting methods with scarce reproducibility that take as reference manual auscultatory measurements carried out by applying the Korotkoff method [9]. As a consequence, BP monitors can pass the validation tests in the presence of clinically significant differences occurring in the BP estimated values in some individuals [9], [14]. The accuracy of NIBP measurement instruments based on oscillometric methods and their calibration continues to be an object of research interest, and different approaches have been proposed to solve these issues, for example by the application of artificial intelligence [14], [16], by focusing on the cuff related effects [17] or on the oscillometric blood pressure waveform [15], by analyzing the problems related to the NIPB instrument calibration [18]–[21]. The TC-25 SCOBPM, aware of the current BP measurement metrological problems and challenges, works to provide an objective reference for measuring systemic arterial BP in humans, in the form of definitions and descriptions of objective techniques and traceable calibration procedures that are independent of the specific devices, apparatus, instruments, or computing devices that may be used in BP measurements. The absence of an objective reference, in fact, makes it hard, if not impossible, to ensure measurement data quality assurance. A standardized objective reference for BP measurement that meets the level of data quality demanded by the rapid industrialization of health care, represents an indispensable and essential tool that is gathering a large audience of interested parties, including instrument manufacturers, doctors and medical personnel, health care government institutions, and people with pressure-related diseases who need to be monitored at home.

MeMeA

In its efforts to promote awareness of the role of measurement in the medicine, biology and the biomedical engineering fields, and to solicit involvement of interested people, the Committee has been promoting and organizing the International Symposium on Medical Measurements and Applications (MeMeA) over the last 15 years.

MeMeA started in 2006 in Benevento, Italy with a workshop dedicated to all aspects of the interaction between the measurement and the medical fields. Over the years, it has developed into an important Symposium which convenes the international community of researchers who are interested in medical measurements and instrumentation.

At the beginning, a successful series of international scientific workshops focused on novel solutions to instrumentation and measurement problems encountered in modern health care, from both the technological and the medical points of view, was organized worldwide: MeMeA 2007 Warsaw, Poland, MeMeA 2008 Ottawa, Canada, MeMeA 2009 Cetraro (CS), Italy, and MeMeA 2010 Ottawa, Canada. Eventually, in 2011, thanks to the notable increase in the number of attendees and presented papers (Fig. 4), MeMeA became a symposium held in Bari, Italy and was followed by MeMeA 2012 Budapest, Hungary, MeMeA 2013 Gatineau, Quebec, Canada and MeMeA2014 Lisbon, Portugal.

Edition after edition, until its 10th anniversary, MeMeA2015 in Torino, Italy, the symposium has highlighted more and more how medical measurements represent a need and a challenge to collect correct and trustworthy data for patient healthcare, giving space also to new discussion topics such as sensors design, bioengineering, rehabilitation, and automation for disability and old age.

In the last five years, MeMeA went back to Benevento, Italy in 2016 (MeMeA2016). The idea of a conference merging

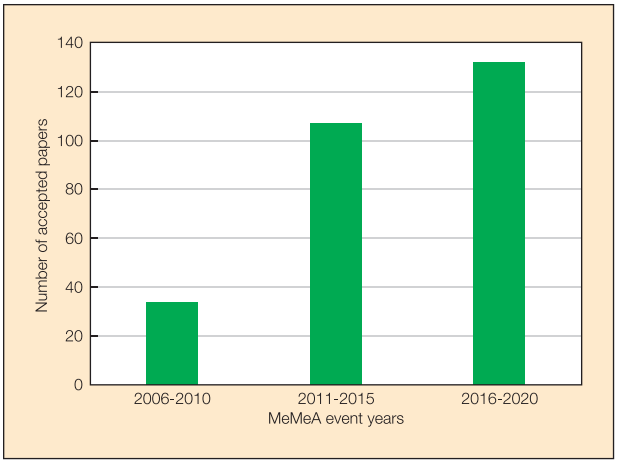

Fig. 4. Average number of accepted papers at MeMeA events.

the experience of scientists and researchers from Europe, Canada, USA, Asia and Middle East, and Australia still increased its success, and MeMeA became a state-of-the-art conference in the field measurements for medicine and healthcare.

MeMeA 2017 was another important conference; as a matter of fact, for the first time, the event was held in Rochester, Minnesota, USA and was hosted by the Mayo Clinic, one of the main research institutions in the USA. Mayo's mission fits perfectly with the MeMeA vision of blending measurements and medicine, creating synergies for developing new methods and devices that provide medical data, and leading to the birth of a joint multidisciplinary and international research group. Moreover, thanks to the collaboration of the Mayo Division of Engineering and the IEEE Southern Minnesota Section, a tutorial day was organized for the first time at MeMeA.

The 13th edition of the symposium, MeMeA2018 Rome, Italy, continued to promote concrete discussions on electrical, chemical, and physiological sensors and measurement systems for prevention, diagnosis, or treatment of different diseases, while also presenting other aspects related to the measurement sciences such quality control of medical devices, medical instrumentation uncertainty/calibration, e-health technologies, wearable devices, and biomechanics/rehabilitation systems.

In 2019 the symposium was held for the first time in Asia, MeMeA2019 Istanbul, Turkey, with an event mainly focused on the metrological point of view in medical measurements. The importance for physicians and clinical scientists to know such aspects and to have confidence in the quantitative measurement results and in the performance of medical devices to take correct decisions for the patients was one of the main themes of discussion during this event.

Eventually, in 2020 the MeMeA community (Fig. 5) was expected to meet again in Bari, Italy for the MeMeA2020. Due to the COVID-19 pandemic, the symposium was held virtually. The online event allowed reaching a wider audience in times of travel restrictions while maintaining the high-quality content MeMeA is known for. This way, the MeMeA community continued to stay together and grow, providing a common ground and establishing stronger relations and research collaborations. MeMeA2020 attendees had the possibility to access the virtual platform for the entire month of June to see the presentations of the more than 150 papers accepted after the rigorous review process which always characterized the symposium. Moreover, for the first time a Student Showcase devoted to Students and Young Professionals was organized. It offered an awesome opportunity for students to build strong professional and international networks and improve networking skills.

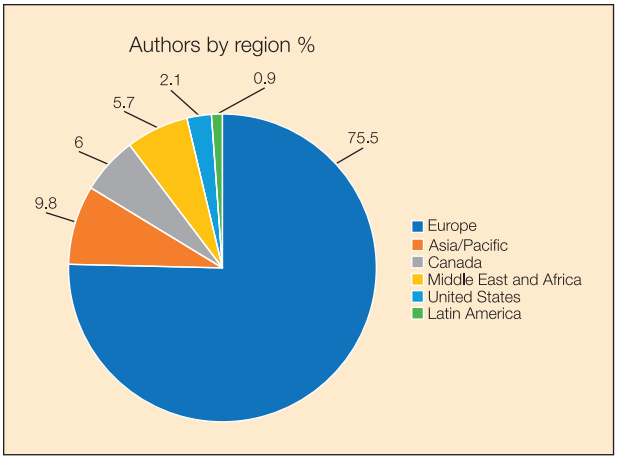

Fig. 5. The MeMeA2020 Community.

This year, MeMeA2021 was organized by the colleagues of the École Polytechnique Fédérale de Lausanne (EPFL), Switzerland and again took place virtually from June, 23–25, 2021.

Conclusions

TC-25's mission is to respond the metrological needs related to biological and medical measurements. The focus topics of the committee include biological sensors, instrument characterization, interoperability and interconnection, and data processing. Fresh ideas and new perspectives are continuously encouraged and the involvement from interested people is solicited by means of the organizations of special sessions during annual IEEE Instrumentation and Measurement Technical Conferences and the Symposia on Medical Measurements and Applications (MeMeA). This brief paper describes the main TC-25 activities, giving an example of the problems and the metrological challenges the committee is focused on. Anyone who is interested in the TC-25's work and would like to join the committee is encouraged to visit the Committee home page at http://tc25.ieee-ims.org/tc25-home for information. TC-25 welcomes your interest and participation.

Acknowledgment

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