Publishable Summary for 18RPT02 adOSSIG
Developing an infrastructure for improved and harmonised metrological checks of blood-pressure measurements in Europe

Overview

This project aims to improve the reliability and accuracy of blood pressure (BP) measurements by developing an advanced oscillometric signal generator (aOSG) and by establishing new calibration procedures and services for blood pressure metrology. Furthermore, the project will establish a competence centre for blood pressure metrology and create a network for blood pressure metrology consisting of NMIs, DIs, surveillance bodies and medical professionals.

Need

Hypertension affects almost half of the European population and is responsible for 13 % of all non-accidental deaths. Hypertension increases the probability of stroke, heart attack and kidney diseases, causing over 22 % of all heart attacks. Reliable and accurate BP measurements taken by sphygmomanometers (SMs) are indispensable in the diagnostics of hypertension.

The European legislation requires lengthy and costly clinical trials before a new sphygmomanometer enters the market. These clinical trials are performed on human subjects to demonstrate adequate accuracy in different BP ranges. Clinical trials are not performed on every manufactured device, but rather on single, well maintained specimens. Production devices enter the market without in-depth testing and end-users must rely on the manufacturer's quality assurance. After entering the market, the devices are subject to mandatory calibrations and verifications in several European countries, but nowadays these procedures only check that the internal pressure sensor works within tolerance, they do not address other components (e.g. software).

A sphygmomanometer entering the market can over- or underestimate the true blood pressure value by 5 mmHg and still meet the legal requirements. According to recent studies, if all BP measurements deviated to such a degree, then over 65 million Europeans would be affected either by non-treated hypertension or side effects of unnecessary treatment.

An advanced oscillometric signal generator can generate oscillometric blood pressure signals indistinguishable from real-life human signals. However, as there are currently no procedures for testing sphygmomanometers with advanced oscillometric signal generators, the development of such a reference device must be accompanied by the development of the corresponding procedures for its use in SM testing.

Existing challenges of blood pressure measurements are exacerbated by an insufficient metrology infrastructure at NMI level, demonstrated by the lack of traceability. This is insufficient for medical purposes. Most European NMIs lack the resources and/or know-how to address this issue because there is no harmonised approach. In particular, emerging NMIs suffer from not having a clear goal for their further development while synergetic sharing of resources is prevented by limited cooperation and missing strategies for further development.

Objectives

The overall aim of the project is to develop sustainable metrological research capabilities to provide traceability for blood pressure measurement in Europe. This will include the development of a new advanced blood pressure oscillometric signal generator and investigation of its possible role as an absolute blood pressure standard to carry out checks of the performance of sphygmomanometers.

The specific objectives are

1. **To develop an advanced oscillometric signal generator device** with the capability of accurately reproducing pre-recorded real-life oscillometric blood pressure pulses.

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2. **To define the necessary requirements and test procedures** for the newly developed advanced oscillometric signal generator to become a reference standard to establish traceability for automated sphygmomanometers.
3. **To develop a procedure for the periodic recalibration of the newly developed advanced oscillometric signal generator** at the NMI level, including defining acceptable uncertainty limits of ±1.5 mmHg or better.
4. **To engage closely with regional and European stakeholders**, including regulatory and governmental bodies, medical experts, professional medical societies, standards developing organisations, metrological committees and device manufacturers to ensure that all medical, legal and metrological requirements regarding blood pressure measuring devices are met.
5. **To develop and implement a concept for smart specialisation in the field of traceable blood pressure measurements** and to integrate this concept with similar ones for other medical devices. To establish a single joint research capacity and to develop a strategy for the perpetuation and sustainability of this new capability and a strategy for offering calibration and research services to national or international customers including NMIs/DIs. Additionally, for each internal partner, to develop an individual strategy for the long-term operation and transnational use of this joint research capacity, and for the access to its calibration and testing services from their respective countries. The individual strategies will be discussed within the consortium, to ensure that a coordinated and optimised approach to the development of traceability in this field is developed which is suitable for Europe as a whole.

Progress beyond the state of the art and results

The first three objectives of the project aim to progress metrological testing of sphygmomanometers beyond the state of the art by creating an advanced test device, procedures and calibration methods. To this end, an advanced oscillometric signal generator will be developed which will be able to generate real life signals as opposed to the strictly periodic oscillometric signals generated by the current commercial blood pressure simulators. The aOSG will be tested as a possible standard for the calibration and in-depth performance checks of sphygmomanometers. The project will develop a procedure for dynamic testing of sphygmomanometers with an aOSG as opposed to the static procedures representing the present state of the art.

The final two objectives aim at the establishment of joint research capacity, which will persist beyond the project lifetime and will support, promote and further develop advanced blood pressure metrology. Currently, a number of EU countries have regulations in effect requiring periodic metrological checks for professionally used SMs to ensure consistent performance in the field. This project aims to create harmonised metrological checks for blood pressure measurements to ensure a homogeneous European market.

Advanced oscillometric signal generator device

The aOSG will be able to generate signals undistinguishable from real-life human signals. Technically it will be suited, therefore, to assist in clinical trials for conformity assessments of new SMs (e.g. by replacing human subjects in critical or rare health conditions).

Necessary requirements and test procedures

For the aOSG to be used in the in-depth performance check of oscillometric sphygmomanometers, test procedures for such an in-depth, dynamic testing of sphygmomanometers and technical and metrological requirements will be defined. These requirements and test procedures will amend insufficient state-of-the-art static pressure testing and will allow the evaluation of performance of the whole sphygmomanometer rather than the pressure sensor.

Procedure for the periodic recalibrations of aOSGs

Currently, the calibration of almost every pressure instrument is carried out by static pressure. The aOSG will generate oscillometric blood pressure signals, i.e. short rapid dynamic pressure pulses superimposed on slowly decreasing pressure. As a valid calibration of such a device is currently not possible at NMI level, the development of advanced dynamic calibration procedures is one of the necessary steps to allow the aOSG to work as intended.

Close engagement with regional and European stakeholders

This project will bring together the most relevant international metrological and medical institutions, producers of sphygmomanometers and market surveillance bodies, and make the project known and accessible to the wider community. In addition, the possibility of the future expansion of the competence centre scope will be investigated i) geographically beyond Central Europe and ii) thematically towards all quantities in medical device metrology.

Impact

Impact will stem from the two main goals of the project: the development of an advanced oscillometric signal generator and the establishment of the research and competence centre for blood pressure metrology. The outputs of this project will significantly progress blood pressure metrology beyond the current state of the art, improving reliability and accuracy of oscillometric blood pressure measurements achievable at all levels including NMIs, DIs, surveillance bodies, manufacturers of sphygmomanometers, medical professionals and patients.

Impact on industrial and other user communities

Development of an aOSG and advanced calibration procedures will allow easier and more affordable in-depth performance checks of new sphygmomanometers. This will ease the development process of SMs for new and small manufacturers, offering them a chance to access the market at lower costs and thus encouraging the innovation.

The research and competence centre will create a well-developed metrological infrastructure with advanced calibration services and will provide manufacturers with clear guidance, and hence legal certainty on how requirements can be met. Physicians and medical staff will be able to rely on the existing traceability chain, trust the measurement results are correct and methods are validated. Patients in clinics, practitioner offices, and home-care settings will have more confidence in the measured BP values, as the improved infrastructure will allow surveillance bodies and other legal entities to ensure adequate quality of the devices available on the market.

Impact on the metrology and scientific communities

The project will make metrology for advanced blood pressure measurements accessible to a broader range of countries. This will be achieved through the smart specialisation, by condensing expertise and knowledge at one site, while simultaneously making it accessible to others. A centre of excellence for blood pressure measurement (competence centre) will be established at CMI, which will be designed for the needs of Czech Republic and all European NMIs/DIs in this field who cannot or do not want to build and maintain this capacity for themselves. The project will create a network for blood pressure metrology consisting of NMIs, DIs, surveillance bodies and medical professionals, and a calibration laboratory providing dynamic pressure traceability will be established. Other European NMIs, particularly emerging NMIs and DIs, which are lacking the capabilities or the resources to provide the complete traceability chain for BP measurements, will be able to serve their national customers with less demanding metrological services, while relying on the competence centre for the higher-level ones.

Impact on relevant standards

The project will have an active participation in key sphygmomanometry and pressure related standardisation committees, international and European legal metrology organisations (e.g. ISO/TC 121/JWG7, OIML TC18 and IMEKO TC16). This participation builds on links already established by the consortium, which is highly influential in national and international metrology and standardisation committees, and will be used to facilitate greater awareness of the benefits of the project.

In the longer term, i.e. after the end of the project, the outcomes may contribute to the revision of different normative documents (e.g. IEC 80601-2-30 and OIML R 16-2). The partners are the principal editors of the German "Leitfaden für die messtechnische Kontrolle von Medizinprodukten mit Messfunktion" (Guidelines for Metrological Checks of Medical Devices with a Measuring Function), so the relevant project results will serve as input into this document.

Longer-term economic, social and environmental impacts

The European healthcare industry will primarily benefit from this project in the long term. The prevalence of hypertension is 44 % in Europe, which means more than 200 million adults are affected by this health problem. The required accuracy of automated sphygmomanometers in a clinical trial is ±5 mmHg but a consistent over- or underestimation of measured BP values by 5 mmHg would change the number of diagnosed patients by ~30 % in either direction. At the end of the project, an aOSG will exist with uncertainty of better than ±1.5 mmHg and a dynamic traceability chain will be established. It can thus be ascertained that the initial ±5 mmHg uncertainty of a sphygmomanometer can be maintained without deterioration over the whole production and lifetime cycle of the device; a guarantee which cannot possibly be given today. Cautiously, assuming that for only 1 % of the patient misdiagnoses can be avoided in the future, the direct benefits of the project can be quantified as:

- 2 million EU citizens who will be spared a false positive or false negative diagnosis,
- 370 M€ per year which will be saved for the EU healthcare systems by avoiding the costs for unnecessary medication of healthy subjects and the even higher costs for undetected and untreated hypertension (estimated from 196 B€/a total costs for cardiovascular diseases in the EU in 2009, 53 % of which are treatment costs, and a ~36 % share for hypertension treatment).

<table>
<tr><td colspan="2">Project start date and duration:</td><td>01 June 2019, 36 months</td></tr>
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2. BEV-PTP, Austria
3. GUM, Poland
4. IMBiH, Bosnia and Herzegovina
5. IPQ, Portugal
6. NSAI, Ireland
7. PTB, Germany
8. SMU, Slovakia</td><td>External Funded Partners:
9. UL, Slovenia</td><td>Unfunded Partners:</td></tr>
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