Project goals: The main aim of the proposed research project is to develop a personalized controller that can be used in the total intravenous anesthesia (TIVA) process. The research concept proposed by the *Personal_TIVA* project has a broad objective that combines the technical and medical science areas. The proposed research requires a multidisciplinary approach as it draws from scientific knowledge pertaining to the technological and medical areas as well as from the expert knowledge necessary to provide the clinical perspective. These goals fit into the scope of Personalized, Preventive and Precise Medicine (also known as 3P-Medicine or Medicine 4.0). Within this context, the work will focus on developing a patient-oriented personalized automatic control system for the anesthesia process, the objective being to provide precise and optimal drug dosage. Consequently, the automated system will prioritize patient safety, providing preventive measures to avoid the adverse effects of under or overdosage of the drugs. Simultaneously, the system will decrease the anesthesiologist's workload while limiting the impact of human factors related to stressful working condition and fatigue, which are especially relevant in lengthy surgical interventions.

Description of the research: The research activity's principal objective is to develop an optimized framework for applying an individualized control-system methodology employing an innovative and interdisciplinary approach; this will focus on a personalized drug-dosing approach that fulfils the anesthesia requirements in an efficient way, while prioritizing patient safety by reducing post-operative complications. All these tasks need an advanced control framework to be developed, which can be applied in real time under rigorous clinical conditions (exploring cutting-edge techniques and using them in a totally new way). In recent years, we have witnessed an unprecedented international effort to improve the quality and availability of medical care. Researchers in clinical automation have focused on novel solutions in the field of physiological closed-loop control systems. This scientific area requires a multidisciplinary approach that brings together specialist knowledge to tackle the problem in a holistic manner. Automated control applied to personalized therapies is one of the most promising research areas, where the application of new research techniques and cutting-edge technologies, such as AI, can expand the frontiers of this challenging field.

Reason for attempting research topic: Automatic control engineering has become an important enabling technology in many areas of medicine and biomedical technology. Prominent examples include the artificial pancreas, closed-loop anesthesia, and personalized drug-dosing strategies in neurology, oncology, endocrinology, and psychiatry. It is a testament to the power of control systems, which enable treatment to be individualized by providing mechanisms for linking treatment goals to treatment regimens, thus achieving the desired therapeutic effect. Additionally, the continuous advances in medical sensors, medical equipment, and artificial intelligence have created propitious conditions for incorporating closed-loop systems. Patient-dynamic models can be used to predict the patient's pharmacological/biological response to the drug/substance administered, and be incorporated into the AI-based individualized control system's design and tuning to calculate the right drug dosage and the right time to apply it, resulting in the desired optimal effect. This issue is one of the open research questions that will be explored in the *Personal_TIVA* project in the context of model-based control system individualization and the exploitation of surgery-specific data supported by AI-tools. To evaluate this work, a cardioneuroablation (cardiac surgery) protocol will act as the testbed since it is a challenging process from the anesthesiologist's standpoint. Based on this protocol, all the clinical requirements and restrictions will be mapped and incorporated into the advanced control system to obtain a-priori information that can be used in the developed methodology. The already established scientific collaboration with the 4th Military Hospital (Wroclaw, Poland) will provide the surgical input for the study. Using this clinical data, the developed control system will be tested and validated using a patient simulator to explore the realistic nonlinear model and the available clinical datasets. In this way, the personalized controllers that we develop will be evaluated against the most rigorous clinical protocols and standards by means of in-silico research.

Results expected: The successful completion of the research project's goals will allow us to design a personalized control system for total intravenous anesthesia that, on the one hand, increases patient safety through the adapted control scheme and optimal drug dosage, and on the other, helps tackle the severe problems facing the public health sector by reducing the number of possible post-operative complications and, in turn, the period of hospitalization.