Independent Lung Ventilation is an intensive-care strategy to ventilate a patient's lungs separately. It is commonly applied in patients with respiratory failure in unilateral lungs pathology or patients undergoing thoracic surgery. Classically it exploits two ventilators for one patient, a first for the left lung and the second for the right lung. The ventilators must work synchronously, which is hard to retain in the long term. In the Nalecz Institute of Biocybernetics and Biomedical Engineering Polish Academy of Sciences (IBBE PAS), a divider (called Ventil) splitting the gas mixture was developed. With the Ventil, synchronous independent lung ventilation is possible only by one ventilator. Ventil was designed to cooperate with a ventilator working on the volume-controlled modes. However, ventilatory pressure-controlled modes now are generally preferable in intensive care mechanical ventilation.

A Shared/Splitted Ventilation is a procedure for simultaneous support of multiple patients connected in parallel to a single mechanical ventilator, widely discussed last year during the first phase of the SARS-Cov-2 virus pandemic and the shortage of ventilators. From a technical point of view, the Ventil can ventilate two patients by one ventilator. One of the problems in applying shared ventilation in clinical practice is the respiratory action of ventilated patients. The cough of one patient could cause unexpected pressure disturbances in the airways of the second patient. An endotracheal closed-loop suction maneuver used in one patient can also cause unexpected pressure changes for the second patient.

The project aims to assess the effectiveness of Ventil device to cooperate with a ventilator set up in pressure-controlled modes in the independent lung ventilation and to study the pressure disturbances in the system, consisting of the ventilator, Ventil, and two artificial patients, caused by phenomena like cough or respiratory suction event

To reach the project goals, we can employ modeling and simulation. Virtual patients and digital avatars connect computer modeling and simulation methods to personalized medicine. They could support a clinical decision improving the patient's outcomes and optimizing the treatment. "In silico" experiments or clinical trials is a term following the "in vivo" and "in vitro" ones and, according to the Avicenna Alliance, is the next step evolution in healthcare. The United States Food & Drug Administration agency also encourages the in silico market of simulators to design, develop, and evaluate critical care medical devices.

In this project, I will use the Ventil and real intensive-care ventilator. The role of patient's lungs or two patients will play artificial lungs (simple physical, respiratory system simulators). In addition to these artificial lungs, I will also use the previously developed in IBBE PAS, a hybrid respiratory simulator. Hybrid simulators combine the benefits of in-silico modeling and simulation and can be operated with physical devices like ventilators or Ventil. A mentioned hybrid respiratory simulator is equipped with a numerical respiratory system model, simulating the respiratory physiology in real-time and a compatible numerical model of the cardiovascular system.

The project will answer the following questions: what are the Ventil device limitations and clinical usefulness in controlling the pressure delivered to the lungs? How is the pressure disturbance transmitted across the system ventilator-Ventil-patients? The project outcomes will be the knowledge in the form of simulations. It could be valuable for physicians planning to use Ventil in critical care treatment and helpful for them when shared ventilation is considered in the future.