Development of a comprehensive bacteria detection procedure: the creation of a sensor and development of new protocols for sample preparation and deposition

Bacterial infections cause a severe socio-economic burden. In 2005 1.8 million people died due to consumption of infected food or water. Only in the USA number of infections and illnesses originating in food reaches 76 million. Among them, 325 000 are admitted to hospitals, and 5200 died. To make the situation even worse, hospitals are a natural place of occurrence of pathogenic bacteria. The European Centre for Disease Prevention and Control reports that only in Europe, 4.1 million patients are affected by healthcare-associated infection each year. In the USA, nosocomial infections cause around 100 000 deaths per year. The additional costs of treatment of hospital-related infections are enormous. It is estimated to be around 7.5 billion euros in the EU and around $5 billion in the USA. Moreover, targeted treatment of infections becomes a must as new bacteria strains, resistant to antibiotics, emerge. Modest estimates ($1.3 billion to $2.7 billion in the USA and $1.5 billion in the EU) have recently been reported.

In the majority of cases, serious repercussions can be avoided thanks to the fast and reliable detection of bacteria. The conventional detection method depends on culturing and isolation of the target bacteria, followed by biochemical confirmation. Classical methods, although cheap and straightforward, require up to 72 h to obtain a reliable output. In many cases, this is far too long, not only in the case of healthcare, but also in industry, e.g., food industry, especially of the short expiry date, or security (e.g., anthrax detection).

Thus the development of sensitive, specific, and rapid methods for bacteria detection is a must. We propose developing and testing bacteriophage-based biosensors for bacteria detection to improve the quality and time of analyses significantly. Bacteriophages (phages for short) are viruses whose host organisms are bacteria. Their natural affinity to host cells can be used to design precise tools for bacteria detection. Unlike antibodies, phages can be easily produced cheaply and in large quantities. In our recent works, we showed the possibility of utilizing ordered layers of model phages (T4) to prepare efficient sensing elements, allowing for the limit of detection of target bacteria (*Escherichia coli*) similar to the best reported for phage-based devices. Within the proposed project, we plan to develop sensory elements, combine them with a sensitive transducer, and develop sample preparation and analysis procedures to develop the entire process of bacteria detection with a detection limit below 1 CFU/ml within 1 hour. Such characteristics are required in many applications, i.e., to detect sepsis in the initial stages in children and infants.