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What kinds of developments do you foresee in personalized medicine over the next 5 years?

I think we will see a combination of different technologies, which are currently used to provide information on the status of individual patients. More specifically, I think that genomics will be combined with information derived from functional imaging technologies like PET-CT or PET-MR to allow doctors to obtain anatomic, biochemical, and genetic information at the same time. In addition to these technologies, we will see the introduction of artificial intelligence applications in personalized medicine. Our database at the Tübingen University Hospital contains information on more than 800,000 patients and we are currently exploring how to use this information to train machine learning algorithms, for example, to improve image analysis.

How does the Center for Personalised Medicine try to overcome the challenge of introducing cutting-edge technologies into clinical trials?

One of our most important projects was to set up an integrative database, which collects all clinical information from all patients treated at our medical center. This database is also used to manage all of our clinical trials and allows us to automatically scan all patients in order to potentially include them into the more than 1,500 clinical trials that are currently running at the medical school. The center also created the organizational framework to conduct complex clinical trials, which combine several technologies used in personalized medicine. An example is our current trial in patients with advanced liver cancer, which combines omics technologies with different types of functional imaging and concurrent studies in genetically modified mouse models. Even in the early stages of this trial, we are obtaining very interesting information on drug resistance from this study.

Which areas of personalized medicine do you consider the most developed, and which are the most promising?

Oncology is certainly the most developed field, and we know that many tumors are amenable to individualized treatments. We are regularly sequencing patient-derived tumor tissues at our center and are discussing the results of these studies in interdisciplinary boards to find the best treatment for a particular patient. The combination of individualized treatments with the newly developed immune treatments, tumor vaccination strategies, and functional imaging will lead to major breakthroughs in cancer treatments in the next few years. In addition, I think that the discovery of the importance of the microbiota, i.e. the collection of microorganisms living in our gut and other surfaces, will have a transformative impact on personalized medicine. Identifying treatments that change the composition of the microbiota will need to be highly individualized and will allow new breakthroughs in various fields of medicine.

Big data is a term that is often associated with personalized medicine. Are computing and data analysis necessary to make personalized medicine a success? If yes, why?

Big data collections are allowing us to derive new ideas about what causes disease as well as preventive measures. In addition to this large scale approach, big data will also improve the treatment of each individual patient specifically through databases that combine genetics-based individualized treatments with outcomes. Machine learning, which is currently entering various areas of our daily life, will also be a disruptive technology for medicine. Machines can already diagnose certain diseases like skin cancer better than human doctors. With the correct "training," machines will also be able to help us devise the right treatment and especially combinations of treatments for more complex diseases like Alzheimer's, solid cancers, or aging-related disorders.

Could you please describe one of your current research projects at the Center for Personalised Medicine?

One of our most important studies is the aforementioned trial on patients with advanced liver cancer. In this trial, we are combining extensive genomic, metabolomics and expression profiling with functional imaging. Through systems biology approaches, we will derive mathematical models that will hopefully allow us to "foresee" the course of a disease for individual patients, enabling us to tailor our treatments to their individual requirements. In addition, we are conducting research in a variety of medical fields, including eye disease, heart failure treatments, individualized treatments of brain metastasis, and imaging guided radiation treatments.