Extended Abstract | Cardiovascular Investigations: Open access | 2020 | Vol.4 No.3

Cardiologists 2018: Personalized and translational medicine as a model of the healthcare services and ar-mamentarium to get the model armed: Myth or the reality?

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A new systems approach to diseased states & wellness result in a new branch in the healthcare services, namely, personalized medicine. To achieve the implementation of personalized medicine concept into daily practice including clinical cardiology, it is necessary to create a fundamentally new strategy based upon the subclinical recognition of bio-indicators (bio-predictors & biomarkers) of hidden abnormalities long before the disease clinically mani-fests itself. Each decision-maker values the impact of their decision to use personalized medicine on their own budget & well-being, which may not necessarily be optimal for society. It would be very useful to integrate data harvesting from different databanks for applications such as prediction & personalization of further treatment to thus provide more tailored measures for the patients & persons-at-risk resulting in improved outcomes whilst securing the healthy state & wellness, reduced adverse events, & more cost effective use of health care resources. One of the most advanced areas in cardiology is atherosclerosis, cardiovascular & coronary disorders as well as in myocarditis. A lack of medical guidelines has been identified by most responders as the predominant barrier for adoption, indicating a need for the development of best practices & guidelines to support the implementation of personalized medicine into the daily practice of cardiologists! Implementation of personalized medicine requires a lot before the current model “physician-patient” could be gradually displaced by a new model “medical ad-visor-healthy person-at-risk”. This is the reason for developing global scientific, clinical, social & educational projects in personalized medicine to elicit the content of new branch.

At present, personalized medicine is only a promising reality. Molecular tumor boards at hospitals are probably furthest in realizing the promises of personalized medicine in clinical practice. At the same time, this example already demonstrates a strong dependency of personalized medicine on computational solutions. Herein, we first describe, how modern approaches from data science & specifically machine learning, are now beginning to impact personalized medicine. However, the way in which machine learning (often used interchangeably with the term Artificial Intelligence) is presented in the mainstream media often constitutes a hype, which must be contrasted with reality. We identify several challenges that currently constitute hurdles for realizing machine learning-based solutions more broadly in clinical practice. We discuss these challenges together with the existing potential of data science for personalized medicine. Finally, we highlight directions for future development.

In the era of growing data volumes & ever shrinking costs for data generation, storage & computation, personalized medicine comes with high promises, which can only be realized with the support of advanced algorithms from data science, particularly machine learning. Modern machine learning algorithms have the potential of integrating multi-scale, multi-modal, & longitudinal patient data to make relatively accurate predictions, which, in some examples, may even exceed human performance. Large commercial competitors that are now entering the field of medicine underline the potential that is widely seen for computational solutions.

However, the current hype around AI & machine learning must be contrasted with reality. While many prediction algorithms for patient stratification have been published over the last decade, only very few approaches have reached clinical practice so far. Major existing bottlenecks discussed in this paper include the lack of sufficient prediction performance due to a lack of signals in the employed data; challenges with model stability & interpretation; a lack of validation of stratification algorithm via prospective clinical trials, which demonstrate benefit compared to standard of care & general difficulties to implement a continuous maintenance & updating scheme for decision support systems.

In addition, general concerns around data privacy as well as ethical & legal aspects must not be overlooked. To overcome these hurdles, an interdisciplinary effort including computational scientists, physicians, patient advocates, regulatory agencies, & health insurance providers is required in the context of a ‘learning healthcare system’. There is a need to better manage the (partially unrealistic) expectations & concerns about data science & AI-based solutions.

In parallel, computational methods must advance to provide direct benefit to clinical practice. Current algorithms are far from being able to recommend the right treatment at the right time & dose for each patient. Steps that bring us closer to this goal could be innovative software tools that better link knowledge with machine learning-based predictions from multi-scale, multi-modal, & longitudinal data; innovative modeling approaches, such as causal inference techniques & hybrid modeling, which go beyond typical state-of-the-art machine learning; & new computational modeling approaches that allow us to identify critical transitions in a patient’s medical trajectory.

More speculatively, a broader understanding of human disease, incorporating findings from basic research & evolutionary studies, might help the creation of entirely new concepts for simulating human diseases & predicting optimal intervention points. Overall, the ambition of research towards personalized medicine should be to move from a system analysis perspective (such as in

This work is partly presented at 24th Annual Cardiologists Conference in June 11-13, 2018 held at Barcelona, Spain

molecular biology) to a system control view that allows for the planning of optimal medical interventions at the right time & dose on an individualized basis. Novel computational modeling approaches that go beyond the current machine learning methodology may play an increasing role for that purpose.

In this context, it must be emphasized that no algorithm is meant to replace a physician. Rather, the idea is to provide them a tool at h&, which supports their decisions based on objective, data-driven criteria & the wealth of available biomedical knowledge.

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