Medical Knowledge in Data driven Environments

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Data intensive science has started to influence both medical knowledge and medical practice. Computational pathology based on computer vision and machine learning offers Big Data based approaches being as good as humans in analyzing biopsies. Moreover, Big Data-based predictive algorithms allow the focus to be shifted from reactive measures to proactive prevention. They are experimentally used in early warning systems providing a continuous assessment of the 'not yet'. They may be employed to monitor neural anomalies in intensive care e.g. in order to detect and predict epileptic seizures. In addition, drug discovery supported by deep learning demonstrates how data intensive science changes and accelerates explorative research processes by applying novel heuristics. In the “data-driven world” medical diagnostics and treatment as well as drug discovery will increasingly profit from Big Data analytics. In economic parlance, one might even say that well established forms of “knowing that” and “knowing how” will be disrupted by the current wave of AI technologies. Authors like Kenneth Cukier wholeheartedly embrace this development: “anything that requires highly specialized training, judgement and decision-making under conditions of uncertainty will the done better by an algorithm than a human” (2017).

Considerable similarities exist between data-intensive science and the engineering sciences as Wolfgang Pietsch points out (2016): both predominantly stay on the phenomenological level. They are strongly inductive relying on exploratory experimentation or related methods. Often, explanations are not available beyond establishing the causal relevance of certain conditions. The reliance on phenomena may explain the success of data driven approaches in medicine and pharmaceutics. The proximity to engineering sciences may change the *ars medicina*, the art of healing, in fundamental ways: clinical decision support systems challenge the balance between art and science in medical practice (Dan Sholler et al. 2016).

As the examples given above show “actionable data” intend to provide a link between “knowing that” and “knowing how”. In many sociotechnical systems, they result in micro-directives guiding both machines and humans. In so-called smart health systems, they potentially challenge the practitioners’ broadening of knowledge and skills and their autonomy in selecting a therapeutic approach. Moreover, the anticipatory governance embedded in these systems restricts the autonomy of all participants – doctors, caretakers and patients - and may impose an opaque guidance. This may result in steering the participants towards predefined goals regardless of their preferences. In these “learning healthcare systems” knowledge is generated by the AI tools. Operational and tactical decisions, e.g. the distribution of scarce resources, are mostly system-initiated. Such approaches may be used for social engineering based on (micro-)directives. However, such systems are autonomous only in so far as they are capable of operative and strategic control. The normative control remains in the hands of the human operators (Gransche et al. 2014).

Due to the promises of “the age of analytics”, i.e. „data and analytics can enable faster and more evidence based decision making“ (McKinsey Institute 2016) medical practice will continue to evolve. Moreover, these techniques have begun to influence the agenda setting promoting preventive health care and personalized medicine on the basis of behavioral, genetic and molecular data.

Predictive technologies will inform and change medical knowledge and understanding. Big Data analytics promises to provide not just insights but foresight. The anticipatory governance in medical early warning systems and learning healthcare systems allows medical decision processes to be supported or even automated. The focus is on providing knowledge under conditions of uncertainty in order “to know ahead and act before” trying to streamline medical processes towards enhanced efficiency and – last but not least – cost-efficiency.