Converting Data Cemeteries into Sources of Knowledge: **Is Dentistry a Computable Industry?**

Muhammad Walji describes the many opportunities that the EHR of the future will bring to dental education. He defines the EHR as a critical tool for managing the care of patients and the clinical education of students and judiciously assesses the potential benefits of the dental EHR for patient safety and clinical decision support. The use of standardized terminologies is the *sine qua non* for reaping the benefits of institutionally supported data repositories, such as the Consortium of Oral Health Research and Informatics' BigMouth Dental Data Repository. Walji's vision of connecting dental EHRs to the continuous learning health system's infrastructure is another example of his forward-looking approach to the current state of dental EHRs that will benefit dental education in the years to come.

I argue, however, that despite our arrival in the age of computation, we are currently experiencing only a slow and gradual increase in our ability to improve the care of our patients and the education of our students. As I have

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recently outlined with some of my colleagues in an article describing the cost of health information technology in dental education (1), these gradual improvements come at a high price. Many educators assert, quite understandably, that investing in hiring more clinical educators to improve the faculty-student ratio would be more advantageous to patients as well as to students. Despite spending precious clinical encounter time to enter data into "poorly designed records [that] act more as loosely woven historical archives than as a clinically useful database," we still find that most EHRs are "described as WORN—write once read never."(2) Dental educators are only beginning to use EHR data and virtual cases to transition students from the basic sciences to the clinical sciences. To be honest, it appears that at times we still argue about whether or not we should use laptops.(3) And while society is mostly enthralled by the implications of social media radically changing how we interact with our surroundings and each other, dental educators have just started the discussion of its effects on provider-patient interactions.(4,5,6)

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During the American Dental Education Association (ADEA) fall 2015 meeting in Chicago, Tom Wujec introduced dental educators to the concept of "computable industries" in his keynote address. Wujec, who carries the title of Chief Disruptor at Autodesk, one of the world's largest software companies and leaders in 3D design, shared his proven approaches to encourage exploration, engagement, prototyping, and innovation. He argued that industries that become computable quickly enter an exponential growth phase

inspired by human innovation and digitization of business processes.

Where are we heading in dental education and what will the "exponential growth phase of computable industries" that Wujec describes look like in dentistry? A few examples might give us a glimpse into the future.

The fast growth of the tech industry will inevitably affect dental EHRs. Companies like Amazon, Google, and Microsoft build huge server farms for the Cloud, removing considerable hardware equipment costs.[7] Would it not make sense for dental EHR users and vendors to explore reducing costs by exploiting the power of the Cloud, now that we can purchase computing power on an as-needed basis? One company, ICE Health Systems, is trying to do this in collaboration with the universities of Michigan, Pittsburgh, North Carolina Chapel Hill, and Buffalo.[8]

After the IBM supercomputer Deep Blue won a chess game in a 1996 match against Garry Kasparov and after IBM's Watson won *Jeopardy* in 2011, we saw the first "Watson-enabled" hospitals.[9] Watson, originally designed as a question-answering computer system capable of answering questions posed in human-computer interaction, acts as Oncology Expert Advisor at MD Anderson's leukemia
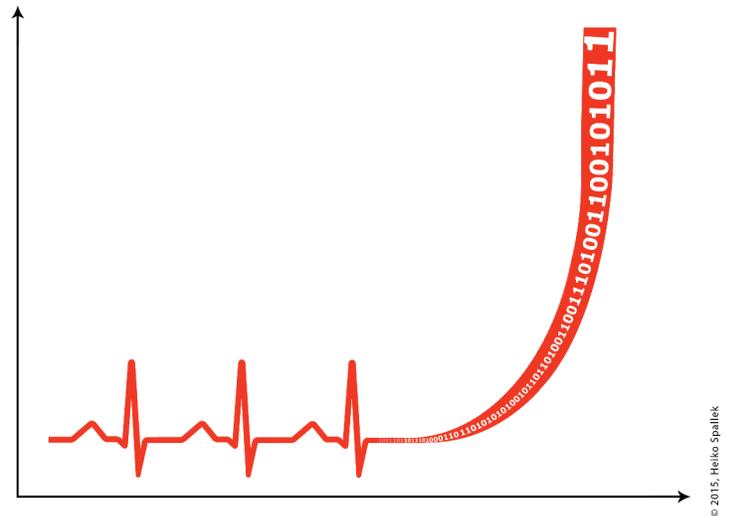
Once health care becomes fully computable, says Dr. Spallek, it is predictable that healthcare use will rise exponentially.

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treatment center in Houston.[10] The IBM program can synthesize patient data, offer a set of possible treatments, and rate the confidence of its recommendations. Watson's performance is not magic, but rather it is the result of what is known as machine learning—a laborious process guided by computer scientists and clinicians facilitated by huge reference databases. When Watson makes mistakes, it self-adjusts and thus continuously improves the underlying algorithms to generate better output.[11]

Given these advances in the "intelligence" of computer systems, will we finally start to overcome the culture in medicine of heroic individualism [12,13], autocracy, and meritocracy [14], and embrace clinical decision support tools? Nobel-prize winner Daniel

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Kahneman writes that "proponents of algorithms have argued strongly that it is unethical to rely on intuitive judgments for important decisions if an algorithm is available that will make fewer mistakes."(15) As the Institute of Medicine (IOM) stated in 2013, "Today in health care, there is more to know, more to manage, and more to do than ever before. The rate at which new scientific knowledge is being produced outstrips the cognitive capacity of even the most adroit clinician to monitor and evaluate effectively."(16) Clinicians need to understand that using computers to make better decisions for patients does not pit the computer against the clinician as demonstrated in chess or jeopardy, but enables the clinician to focus on higher-level questions. As Steve Lubow, cited by Wenz (17), says, "People who were using a lot of time reducing data can now spend more time thinking about it and trying different things."

Medicine needs a transformation like the one astronomy experienced after the printing press. In *The Printing Press as an Agent of Change,* Elizabeth L. Eisenstein writes that "Copernicus...was freed from the task of copying tables and charts, and thus had time for reading and reflecting."(18) When will we be freed from measuring undercuts on plaster models and have sufficient time to think about the individual risk factors regarding the oral health of our patients? A first step in dentistry is the trigger tool—which identifies EHRs with characteristics ("triggers") that are associated with adverse events in dentistry—that Walji helped develop for improving patient safety.(19)

Should we as dental educators be empowered by these developments or see them as an existential threat? The entrepreneur Elon Musk tweeted: "Hope we're not just the biological boot loader for digital super intelligence. Unfortunately, that is increasingly probable."(20) I do not share this bleak vision as I am convinced and energized by the notion that we can improve oral health and dental education by creatively using information technology and combining it with human intuition and creativity. These technologies, as Tom Wujec shared with dental educators, are first impossible, then impractical, next possible, and, finally, they are expected.

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