

NOTA BENE

IDEAS FOR THOUGHT LEADERS

MEDICINE AND MACHINES: THE COMING TRANSFORMATION OF HEALTHCARE

DECEMBER 2016



Association of Academic Health Centers®
Leading institutions that serve society

www.aahcdc.org

MEDICINE AND MACHINES: THE COMING TRANSFORMATION OF HEALTHCARE

Medicine and Machines: The Coming Transformation of Healthcare

Steven A. Wartman, MD, PhD, MACP // President/CEO

“What is the compelling urgency of the machine that it can so intrude itself into the very stuff out of which [we build our] world?”¹

– Joseph Weizenbaum

THE LOOMING TSUNAMI: TECHNOLOGY, DATA, AND ARTIFICIAL INTELLIGENCE

The 21st century is on course to transform the practice of medicine, largely through the exponential convergence of science and technology. This “convergence” refers to the synergistic and inter-operative deployment of multiple digital-related technologies, such as large data analytics using dense data clouds, deep learning, DNA processing, and nanotechnology. And, the law of accelerating returns² suggests that the pace of change is faster than we often imagine or foresee. As a result, healthcare is ripe for upending transformation as we enter an era of rapidly evolving digital-based technologies that are fundamentally changing what it means to be part of a profession.³ Surpassing the impact of the printing press centuries ago, which

democratized a wide array of “news” and literature, digitization and the internet enables specialized knowledge to be readily available on an unfathomable scale. As a result, the health professional no longer occupies the role of sole guardian of a specialized body of knowledge as the lines between physician and patient blur dramatically. Among the emerging technologies that underscore this issue are:

- Portable and direct-to-consumer diagnostics and therapeutics;
- Artificial intelligence in medical decision making;
- Precision medicine enhanced by digital biology;
- Augmented reality; and
- Affective computing.

In an environment of accelerating returns, these are striking examples of the transformative power that results from the ongoing convergence of these and other technologic advances. It is not surprising in this regard that the market for the mixture of intelligent algorithms and robots is growing seven times faster than the market for traditional manufacturing robots.⁴ The overall impact on medical practice and healthcare is a

direct challenge to the health professions writ large, including the time-honored and sacrosanct doctor-patient relationship, which is already being augmented by other health professionals and a growing variety of machines and technology. As starkly depicted in a recent book:

*“...machines and systems will work alongside tomorrow’s professionals as partners. The challenge here is to allocate tasks, as between human beings and machines, according to their relative strengths...Human professionals will have to come to terms with the need to defer to the superior capabilities of machines.”*⁵

Collation and analysis of mega-sized health datasets will inevitably become the exclusive domain of machines that will continually monitor large amounts of individualized patient data, augmented by biobanks and published information from the medical literature and other sources. Because no human can effectively process the exploding volume of medical knowledge and data, machines eventually will come to “know” more and be able to perform more assignments than caregivers as they gradually out-perform human capacity in many cognitive and physical tasks. How this

information will be interpreted and acted upon remains unclear at this time, but no less than the future of medical practice and healthcare is at stake.

As we think about the future of healthcare, an essential and critical point becomes how the analytic interpretation of clinical information by artificial intelligence (AI) impacts the decision-making of human professionals (and human beings in general). Because AI will become the only realistic means by which caregivers can meet the demands of their jobs in the future, the practice of medicine will be increasingly augmented by machines, a hopefully symbiotic circumstance that has been described as making the “visible invisible and the invisible visible.”⁶ One author has gone so far as to suggest that physicians will “be paid in the future based on how well [they] work with robots.”⁷ Care will be far more consumer-centric and consumer-driven than it is today, utilizing virtual cognitive systems and large social media networks to form educational and supportive care communities for consumers. The healthcare workforce as we know it will undergo considerable redesign and automation, first focusing on routine tasks and then moving gradually into middle-level and,

to an unknown degree, upper-level skills. Some of the work of physicians not being replaced by machines will be transferred to alternative care practitioners, including new classes of practitioners yet to be identified.

Healthcare is a highly regulated enterprise with many requirements, including those promulgated by various accrediting, specialty, and licensing bodies. It is unclear at present how these mostly non-profit organizations will respond, adjust, or proactively lead these efforts, as it is often conceptually and practically difficult to change long-standing practices. At a minimum, a serious, ongoing, and probably facilitated dialogue needs to occur with all of the stakeholders involved.

IMPLICATIONS FOR ACADEMIC MEDICINE

It should be evident that the accelerating pace of change in medicine and healthcare directly impacts universities' health entities. This is especially true for academic health centers, whose missions are to educate health professionals, conduct biomedical and clinical research, and provide patient care. To adapt—and indeed thrive—these institutions need to develop a strong culture of innovation and experimentation, something that is, not

surprisingly, challenging given their strong culture of academic individualism and entrenched programs and policies. Creating a “frictionless environment” for experimentation in partnership with the tech sector is a tall but necessary order as the coming environment requires lowering the barriers to innovation. Implementation of original ideas often necessitate institutional structural, organizational, and cultural changes—a challenging goal for established institutions to achieve.

What might be some of the guideposts for university-based health components as they transition into 21st century medicine? A frequently repeated phrase that comes to mind is “software eats the world.” Although this comment is subject to various interpretations, for the purposes of this article it suggests that new software in all its manifestations (algorithms, tasks, communications, and so forth) can readily disrupt existing industries. If this is indeed the case, then the existing large and fixed infrastructures of health-related campuses, while necessary, may become liabilities as patient care increasingly moves to wherever the patient happens to be and the overwhelming

burden of disease becomes chronic. At a recent meeting, I heard healthcare being described as “an information industry that thinks of itself as a biological industry.”⁸ I would urge fresh thinking not only about the relationship between academe and the tech sector, but also how academic institutions can develop a culture of innovation by taking on more of the qualities of tech companies and increasingly becoming direct providers of healthcare solutions.

A strong emphasis on optimally integrating healthcare with technology to decrease healthcare costs and improve quality will help achieve the triple aim⁹ in the coming era of value-based healthcare. This provides academic institutions the ability to create, when aligned with the missions of education and research, a learning health system that captures meaningful synergies, such as real-time clinical research that directly informs patient care and health professions education. In order to support this integration, universities and academic health centers need to rethink the role of “informatics” as a support department to an entity that serves as the foundation of the entire organization’s programs and processes. In anatomic terms, this can be described as envisioning informatics as

the central and peripheral nervous system of the institution.

The time has come for academic health centers to take full advantage of their unique ability to optimally align education, research, and patient care into a learning healthcare system. It is especially important to cultivate and secure leaders capable of changing institutional culture and behavior, which, on many of my visits to academic health centers, has been described as the toughest challenge of all. Indeed, the medical profession is no different from other professions in sharing “the bias of finding difficulty in imagining any thoroughgoing re-engineering of their own discipline.”¹⁰ Failure to do so raises the question as to how these institutions can truly distinguish themselves in the new healthcare era.

WHAT DOES THIS MEAN FOR THE PROVISION OF PATIENT CARE?

In the context of what has been described above, a foundational re-design of the healthcare system is in store. A new era of competitive cooperation will arise between practitioners and the tech sector. Learning to harness, interpret, and use data and other digital tools effectively offers an opportunity for healthcare practitioners

to maintain control of the profession. But the fundamental changes in medical practice that will occur demand new skills in working with artificially intelligent machines and cross-disciplinary teams to integrate digital medicine into day-to-day clinical practice. Specifically, these new skills include:

- The management and oversight of delegated responsibilities within multiprofessional healthcare teams;
- Monitoring and interpreting ever larger amounts of patient data generated by ubiquitous wearable and/or “insideable” health technology as analyzed by artificially intelligent machines; and
- The mathematical and communications skills necessary to understand and communicate the meaning of probabilities to patients, including predictive data and analytics.

These are some—but clearly not all—of the array of new skills fundamentally necessary for 21st century healthcare, not to mention significant challenges in the areas of privacy and cybersecurity. How will practitioners get up to speed and how will health professions students learn these skills? A fresh perspective is urgently

needed, given all the technologically driven changes that are coming down the line. In my view, incremental changes will not be enough to address these issues: both medical practice and health professions education effectively need a “reboot.” But there are non-technologic components of healthcare that are uniquely human and necessary for 21st century practice and education.

A TIMELESS AND CRUCIAL SKILL

There are some things people come to know only as a consequence of having been treated as human beings by other human beings.¹¹

Perhaps the role of the human medical practitioner in the 21st century is to fulfill this statement written 40 years ago by the computer science pioneer, Joseph Weizenbaum. Indeed, there is a strong case to be made that, at least in the near and intermediate term, human clinicians will need to emphasize the “soft side” of medicine in their practices. The provision of empathy along with the uniquely human services that patients need will likely become the hallmark of professional practice, something that has existed for thousands of years, but is now perhaps in jeopardy in the coming era.

The health professions, in conjunction with multidisciplinary thinkers, need to take definitive and coordinated steps to answer such questions as: what is the meaning and value of the “human touch?” How does the human factor in medical decision-making go beyond probabilities to address uniquely human complexities? How does empathy and compassion remain an essential feature of healthcare? And, ultimately, who manages the machines—and how? Currently, this important discussion does not appear to be occurring in an organized way. To continue to “go with the flow” will result in missing critical opportunities and taking the risk of being left behind as the fundamental nature of healthcare delivery changes.

As “smart” technology advances, it is both an opportunity and an obligation for the profession of medicine to oversee the application of these technologies in patient care.¹² This is the basis of the first offering of the new AAHC Thought Leadership Institute (TLI) on the interface between medicine and machines.¹³ The TLI aims to combine futuristic thinking and differing perspectives to create a set of principles to meet these new professional responsibilities.

CONCLUDING COMMENTS

The ongoing transformation of so many aspects of healthcare mandates an in-depth assessment of many of the most fundamental tenets of medical practice. These transformations are not to be disregarded or debunked; rather, they need to be viewed as an opportunity for all the health professions—in a new juxtaposition with society—toward responsive reform. Healthcare is increasingly becoming democratized in the sense that much information, testing, and therapeutics will be conjoined in the accelerating technologic convergence described earlier. The role of the healthcare provider—no longer the exclusive owner of the body of knowledge—is changing dramatically, and it is critical that the health professions adapt through practice, education, and training to reflect the new skills that will complement and enhance all aspects of healthcare delivery. Underlying the need for change is perhaps this fundamental question: by whom and by what means are the evolving healthcare technologies to be managed? The answer surely lies in the intangible nature of the human spirit and the will to achieve health and well-being for all.

Endnotes

- ¹Weizenbaum, J. *Computer Power and Human Reason*. San Francisco: W.H. Freeman, 1976
- ²Kurzweil, R. *The Singularity is Near*. New York: Penguin, 2005
- ³Susskind, R and Susskind, D. *The Future of the Professions*. Oxford: Oxford University Press, 2015.
- ⁴Business Insider. February 2015. <http://www.businessinsider.com/growth-statistics-for-robots-market-2015-2>
- ⁵Susskind and Susskind, op.cit.
- ⁶Anthony Chang at the 2016 Exponential Medicine Program, Singularity University, San Diego CA
- ⁷Kevin Kelly, quoted in Brynjolfsson, E and McAfee, A. *The Second Machine Age*. New York: Norton, 2014.
- ⁸Laurence McMahon at the AAHC Thought Leadership Institute meeting, August 2016, Chicago IL
- ⁹Berwick, DM, Nolan, TW, Whittington, J. The Triple Aim: Care, health, and cost. *Health Affairs* 2008;27(3):759-769
- ¹⁰Susskind and Susskind, op.cit.
- ¹¹Weizenbaum, op.cit.
- ¹²Darcy AM, Louie AK, Roberts LW. *JAMA* 2016;315:551-2.
- ¹³<http://www.aahcdc.org/About/DevelopmentPartnerships/CurrentPartnerships.aspx>

ACKNOWLEDGEMENTS

I'm pleased to acknowledge the support of Elsevier for the ongoing "Professional Intelligence Program" of the AAHC Thought Leadership Institute and, in particular, thank Brad Fenwick, Elsevier's Senior VP for Global Strategic Alliances, for his leadership and support.

Some Suggested Reading

- Bostrom, Nick. *Superintelligence*. Oxford: Oxford University Press, 2014
- Brynjolfsson, Erik and McAfee, Andrew. *The Second Machine Age*. New York: Norton, 2014
- Combs, C. Donald, Sokolowski, John A., and Banks, Catherine M. *The Digital Patient*. Hoboken: John Wiley and Sons, 2016
- Ford, Martin. *Rise of the Robots*. New York: Basic Books, 2015
- Kurzweil, Ray. *The Singularity is Near*. New York: Penguin, 2005
- Susskind, Richard and Susskind, Daniel. *The Future of the Professions*. Oxford: Oxford University Press, 2015
- Wachter, Robert. *The Digital Doctor*. New York: McGraw Hill: 2015
- Weizenbaum, Joseph. *Computer Power and Human Reason*. San Francisco: W.H. Freeman, 1976

nō-tā- bē-nē \ [Latin. note well; take notice.] Nota Bene:
no ta be ne, nō-tā- bē-nē \ [Latin. note well; take notice.
Nota Bene: \no ta be ne, nō-tā- bē-nē \ [Latin. note wel
take notice.] Nota Bene: \no ta be ne, nō-tā- bē-nē \ [Latin
note well; take notice.] Nota Bene: \no ta be ne, nō-tā- bē-nē
\ [Latin. note well; take notice.] Nota Bene: \no ta be n
nō-tā- bē-nē \ [Latin. note well; take notice.] Nota Bene:
no ta be ne, nō-tā- bē-nē \ [Latin. note well; take notice.
Nota Bene: \no ta be ne, nō-tā- bē-nē \ [Latin. note wel
take notice.] Nota Bene: \no ta be ne, nō-tā- bē-nē \ [Latin
note well; take notice.] Nota Bene: \no ta be ne, nō-tā- bē-nē
\ [Latin. note well; take notice.] Nota Bene: \no ta be n
nō-tā- bē-nē \ [Latin. note well; take notice.] Nota Bene:
no ta be ne, nō-tā- bē-nē \ [Latin. note well; take notice.
Nota Bene: \no ta be ne, nō-tā- bē-nē \ [Latin. note wel
take notice.] Nota Bene: \no ta be ne, nō-tā- bē-nē \ [Latin
note well; take notice.] Nota Bene: \no ta be ne, nō-tā- bē-nē
\ [Latin. note well; take notice.] Nota Bene: \no ta be n
nō-tā- bē-nē \ [Latin. note well; take notice.] Nota Bene:
no ta be ne, nō-tā- bē-nē \ [Latin. note well; take notice.
Nota Bene: \no ta be ne, nō-tā- bē-nē \ [Latin. note wel
take notice.] Nota Bene: \no ta be ne, nō-tā- bē-nē \ [Latin
note well; take notice.] Nota Bene: \no ta be ne, nō-tā- bē-nē
\ [Latin. note well; take notice.] Nota Bene: \no ta be n



Association of Academic Health Centers®

Leading institutions that serve society

1400 Sixteenth Street, NW, Suite 720

Washington, DC 20036

202.265.9600 FAX 202.265.7514

www.aahcdc.org