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The Intensifying Marriage of Medicine and Machine

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Steven A. Wartman, MD, PhD, MACP
President/CEO
Association of Academic Health Centers

Some definitions

- Marriage
 - Any close or intimate association or union
 - A formal agreement between two enterprises to combine resources for mutual benefit
- Medicine
 - The art or science of restoring or preserving health

Some more definitions

- Robot
 - Term coined by Czech writer Karel Čapek in his 1920 play, *R.U.R*
- Machine
 - A system or device, such as a computer, that performs or assists in the performance of a human task

The rise of the machines

- The market for the mixture of intelligent algorithms and robots is growing seven times faster than traditional manufacturing robots¹

1. Business Insider, February 2015

Robots trending in healthcare, e.g.:

- Dispensing meds: robot pharmacists
- Administering cancer treatments: Nano robots
- Diagnosing diseases: pap smear screening
- Caring for the elderly: 24 hour live-in robots
- Surgical robots are now a billion dollar industry in a growing range of medical specialties

Question:

- “Will smart machines replace humans like the internal combustion engine replaced horses?”¹

1. <http://www.esquire.com/lifestyle/a34630/viv-artificial-intelligence-0515/>

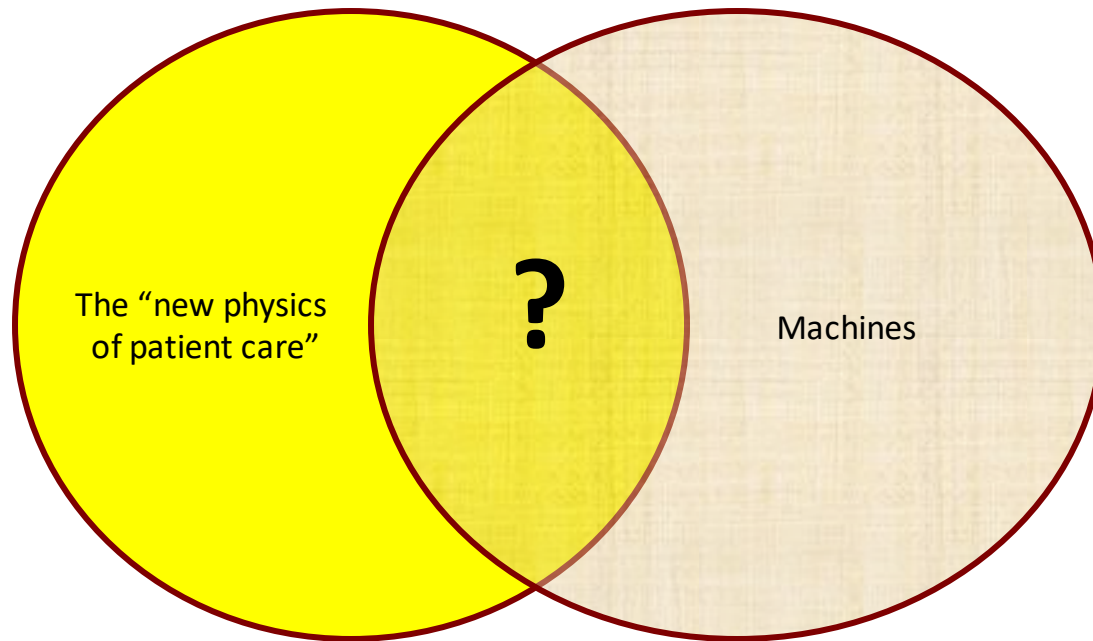
A deep perspective regarding all aspects of healthcare must include the intersection of:

The “new physics of patient care”

A diagram consisting of two large circles. The left circle is yellow and contains the text 'The “new physics of patient care”'. The right circle is light gray and contains the text 'Machines'. A red double-headed arrow connects the two circles, indicating a relationship or intersection between the two concepts.

Machines

The extent and nature of the overlap is unknown



Machines are busy disrupting our conventional thinking, for example:

- Healthcare workforce projections
- Education of healthcare professionals
- Biomedical and clinical research
- Patient care delivery

What will the future healthcare workforce look like?

“Simply adding more doctors to the current mix is not a thoughtful solution to workforce challenges.”¹

“It is not possible to determine the future shape of health care delivery and to project the workforce needed”²

1. From Pizzo et al. The Future of Graduate Medical Education: Is There a Path Forward? Chapter 11 in *The Transformation of Academic Health Centers*, Elsevier, May 2015
2. Nasca and Thomas. Medicine in 2015: Selected insights form ACGME’s scenario planning. *J Grad Med Ed*, March 2015: 139-142

Health professions education disruption

- Electronic/digitized education platforms
- Designing and implementing interprofessional teaching
- Contrast the electronic skills of students with that of the faculty

Biomedical research disruption

- Rise of “Team Science”
- Management of huge data sets
- Democratization of information
 - Crowd-sourcing
 - What constitutes a clinical trial?
 - Ultimately, who “controls” research?

Healthcare delivery “disruptors”

- Changing market forces
- Consumer empowerment
- Disease patterns
- Entrepreneurism
- Globalization
- Politics and policy
- Population demographics
- Science
- Societal needs and values
- Technology

These challenges are beyond the ability of a single clinician or health care team to manage

Patient care disruption

The new “physics” of patient care

$$E = mc^4$$



$$E = mc^4$$

The Emerging model of healthcare^a, where:

- m = the population, both individually and collectively
- c³ =
 - c¹ = care anywhere
 - c² = care in teams
 - c³ = care by large data sets
 - c⁴ = care by machines

a. Inspired by Eric Dishman's Ted Talk at http://www.ted.com/talks/eric_dishman_health_care_should_be_a_team_sport.htm.

Care anywhere (c¹)

- Technology is moving with and inside the patient's body, wherever the patient may be
- Large, fixed infrastructures are necessary, but could be configured differently
- Consumers want convenience and one-stop shopping

Care in teams (c²)

- The sacrosanct one-to-one doctor patient relationship is being replaced by relationships with multiple health professionals
- Figuring out how to gain the most value from team care is key
- Reimbursement must be supportive
- Scope of practice needs careful re-design

Care in large data sets (c³)

- Collections of huge meta-data sets are becoming standard for patients, eventually leading to continuous monitoring
- A new interpretive and functional infrastructure to is required to manage this data
- Locus of decision-making is shifting

Care by machines (c⁴)

- Machines can out-perform humans in many tasks (surgery, data storage and recall)
 - They don't have to be perfect, but just make less mistakes than humans
- Machines' abilities don't decline with age
 - They can be updated
- Machines don't get tired

The reality

- No human can effectively process the exploding volume of medical knowledge and data
- Machines will know more and be able to perform more tasks than care givers
- Devices out-perform human capacity in both the cognitive and physical senses

Levels of mastery

- Skill: the ability to perform a concrete act
- Competence: level at which the skill is performed
- Expertise: the ability to see the big picture, understand all the unique elements involved, and draw appropriate conclusions
- Professional intelligence: *the confluence of professional values and expertise*

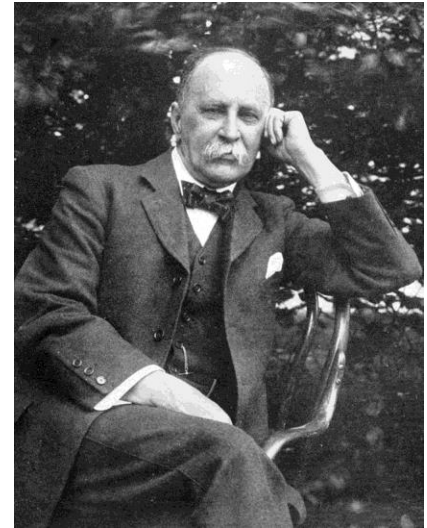
Humans vs Machines

Attribute	Humans	Machines
Skill	+/-	√
Competency	+/-	√
Expertise	+/-	?
Strong work ethic	+/-	√
Emotional intelligence	+/-	?
Professional intelligence	Maybe	?

We need to develop a working definition of “professional intelligence”

- In healthcare (and other fields), what is the role that humans will play?
- Who ultimately manages the machines?
- What is the reality of the “human touch?”
- How do we need to change our curricula and care practices?
- What kind of future planning is essential now?

Aequanimitas



- “Imperturbability”
 - Calmness, patience
 - Very hard to disturb or upset
- Osler regarded it as the premier quality of a good physician
- Is it not a feature of the machine?
- What is it that remains solely within the human capacity?

Is this [still] true?

“Healing, whether physical or emotional, is an experience of life, one that technology can never replace.”¹

1. Polacco MA. The \$6 million physician. *The Pharos* 2015; 78(2): 11-15.

“Not every patient can be saved, but his illness may be eased by the way the doctor responds to him – and in responding to him, the doctor may save himself...”

...In learning to talk to his patients, the doctor may talk himself back into loving his work.”

- Intoxicated By My Illness, Anatole Broyard

A little levity to conclude: from “Ex Machina” 2015

- Clip from “Ex Machina”

Thank you



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