

Impact of exponential technology on health care. Change of mindset is needed?

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Economic realities are driving significant changes in Healthcare

volume

value

Clinical and economic outcomes are driving the 'consumerization' of healthcare

response

prevention

Move from treating illness to *maintaining wellness* shifts focus to avoidance of injuries, complications and readmissions

episodic

continuous

Connecting everyone unlocks value in the rich, but highly disconnected islands of information

fast

instantly

Readily available comprehensive data, largely collected by the patient, creates a viable source for prediction, risk stratification and diagnosis

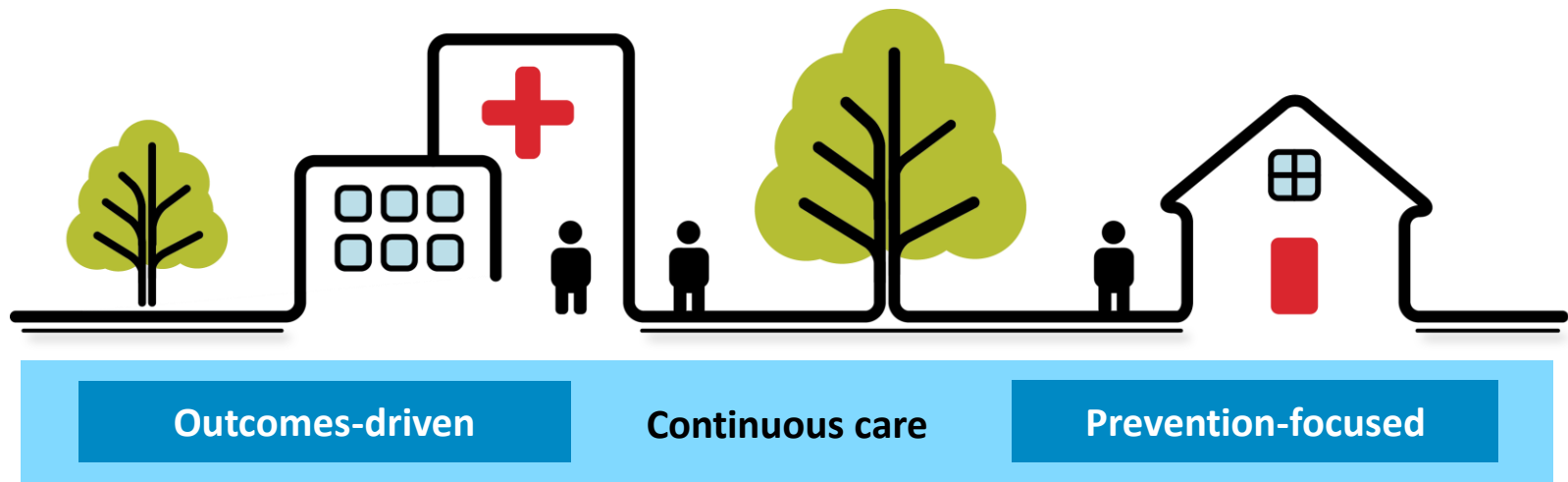
Let's start with the conclusions

- Hospitals will be smaller
 - Diagnostic and treatment 'satellites' connected electronically to hospitals
 - Self-diagnosis with more precision (sensors, artificial intelligence)
 - Physician will focus on severe cases and surgery
 - Ubiquitous IT will be the driver for change(s)
- Social networks, IoT and big data analytics are the foundation for deriving health patterns
- Patients want be in the driver seat
- Technological advances are essential to keep healthcare affordable
- Shift from disease care to health care

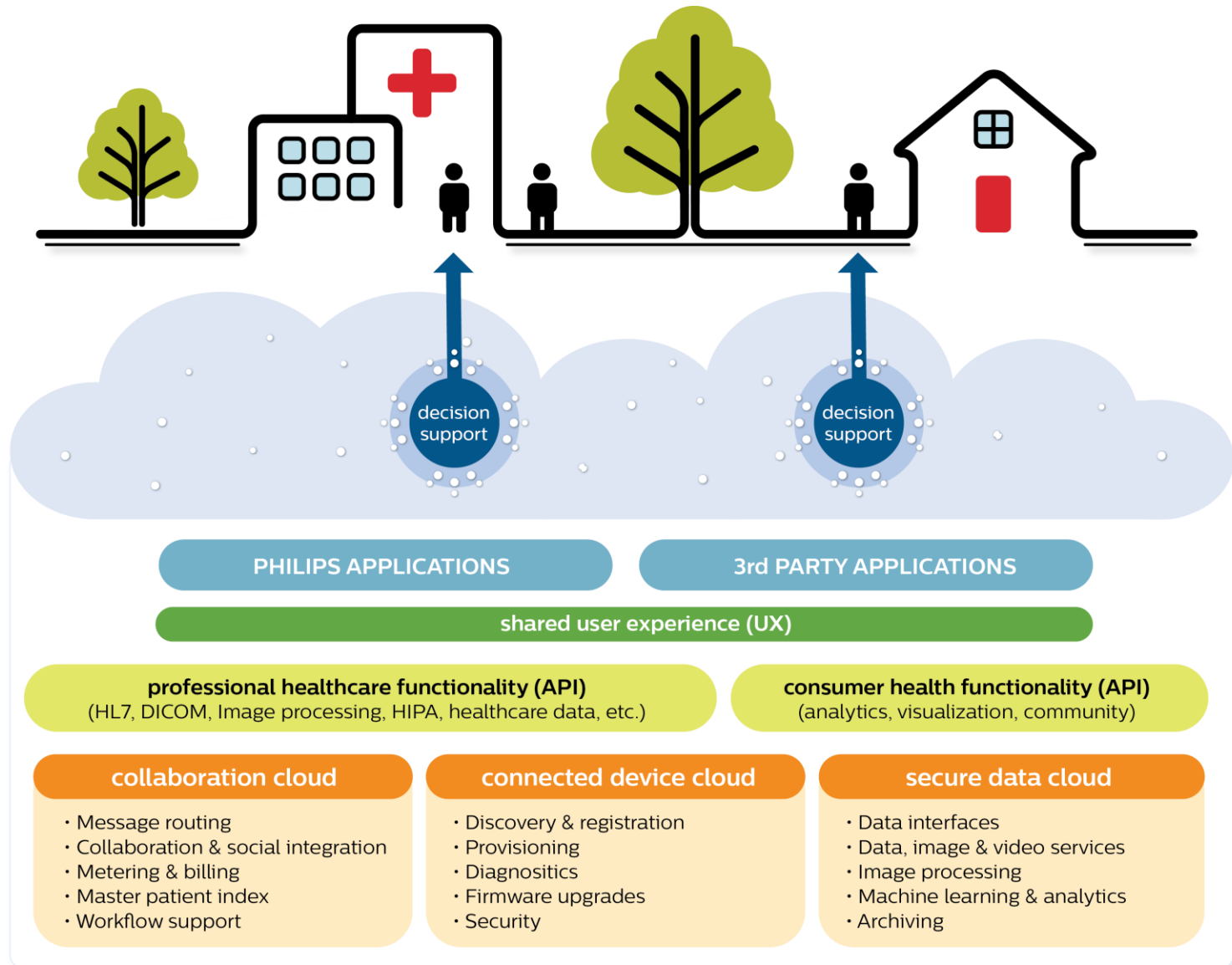
Transformation of healthcare

Professional healthcare delivery

Continuous personal health



Flexible, scalable and cost effective



Current directions

Exponential technology will (dramatically) impact the organization of healthcare

What does Exponential Technology mean?

Rapidly growing technological features which at the same time are becoming cheaper. Moore's law applies and when information is added to technique => law of acceleration returns applies

Are there examples?

Medical revolution driven by Artificial Intelligence (AI)
Sensors
3D-printing
Big data
Internet of Things (IoT)
Quantified Self
Genomics
Synthetic biology
Robotics
Stem cells

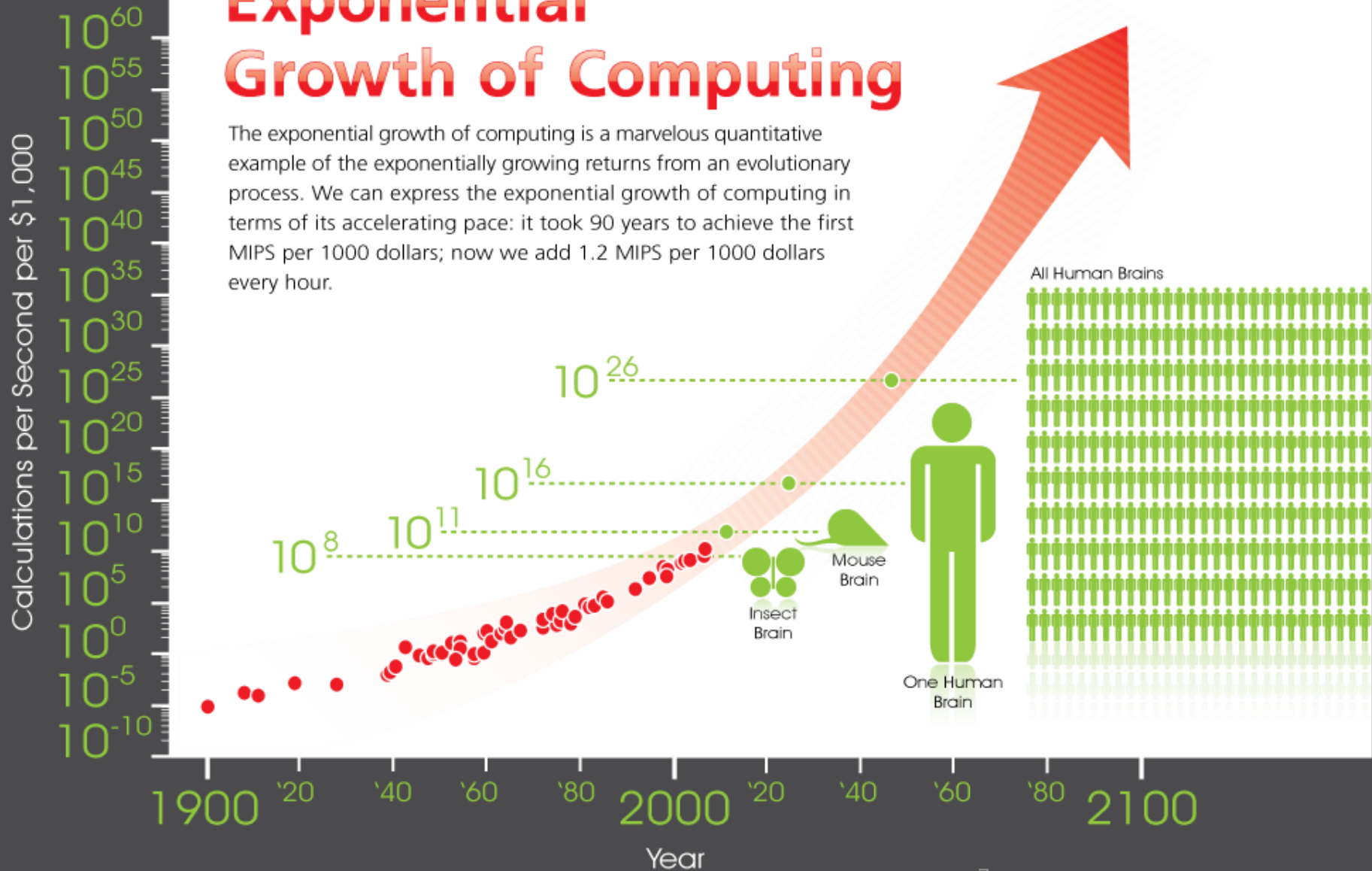
Who will be affected?

Healthcare providers
Healthcare consumers
Policy makers
Legal bodies
... everyone

Disruptive

Exponential Growth of Computing

The exponential growth of computing is a marvelous quantitative example of the exponentially growing returns from an evolutionary process. We can express the exponential growth of computing in terms of its accelerating pace: it took 90 years to achieve the first MIPS per 1000 dollars; now we add 1.2 MIPS per 1000 dollars every hour.



What does that mean: disruptive

The 6 D's according to P. Diamandis

Effect that we see, experience

1

Digitize

All technology that will digitize, add information to it

2

Deceptive

In the early stage small doublings => once it hits the knee you're 10 doublings away from a thousand, twenty doublings to reach a million; thirty doublings to get a billion

3

Disruptive

When this steep growth path is entered. Once disruptive it ...

4

Dematerialization

You don't have separated solutions (flashlight, GPS or camera,...)
Instead => apps on your smartphone

5

Demonetization

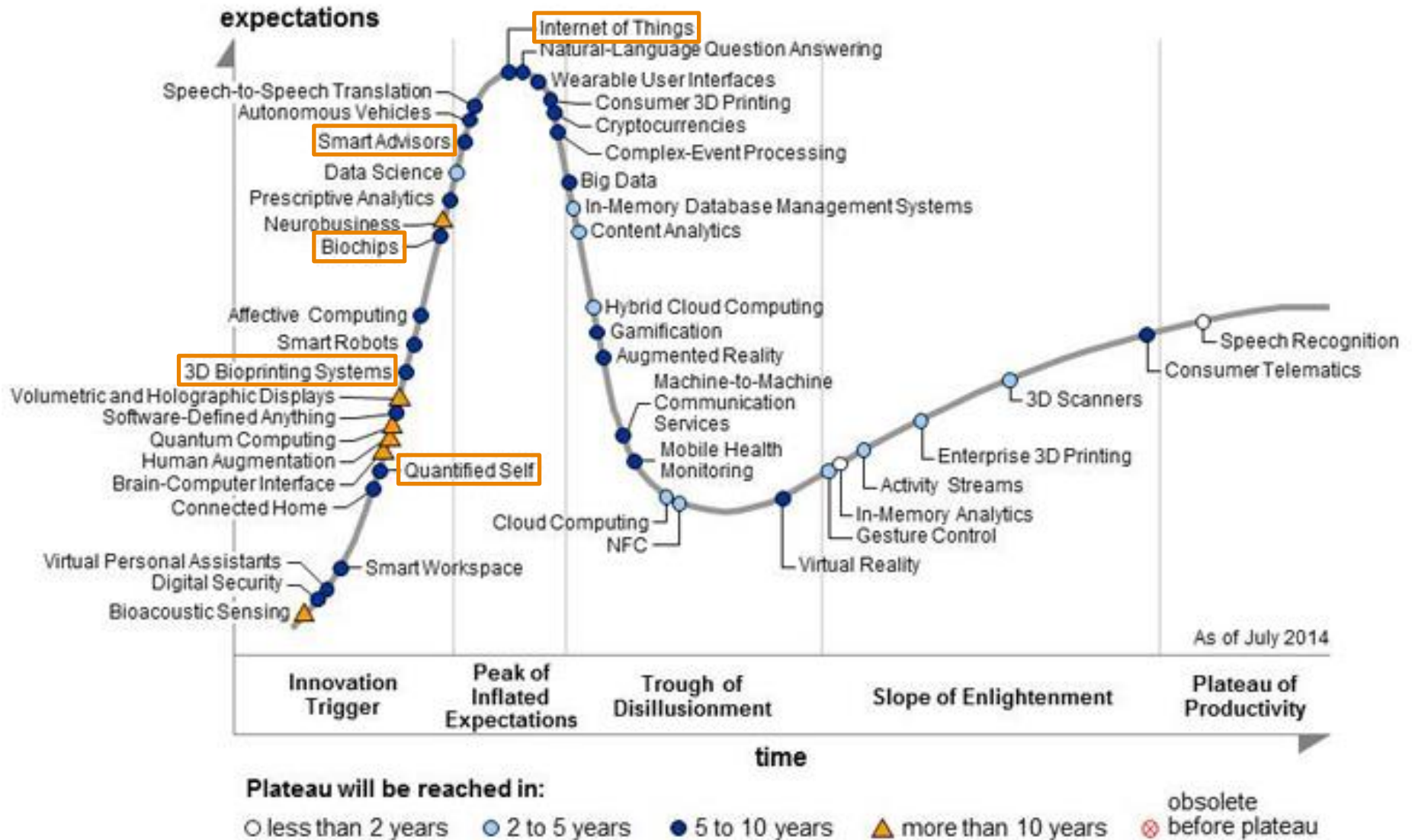
An existing product or service (Uber, Airbnb, Craigslist, etc)

6

Democratization

You can reach very quickly very large groups of people

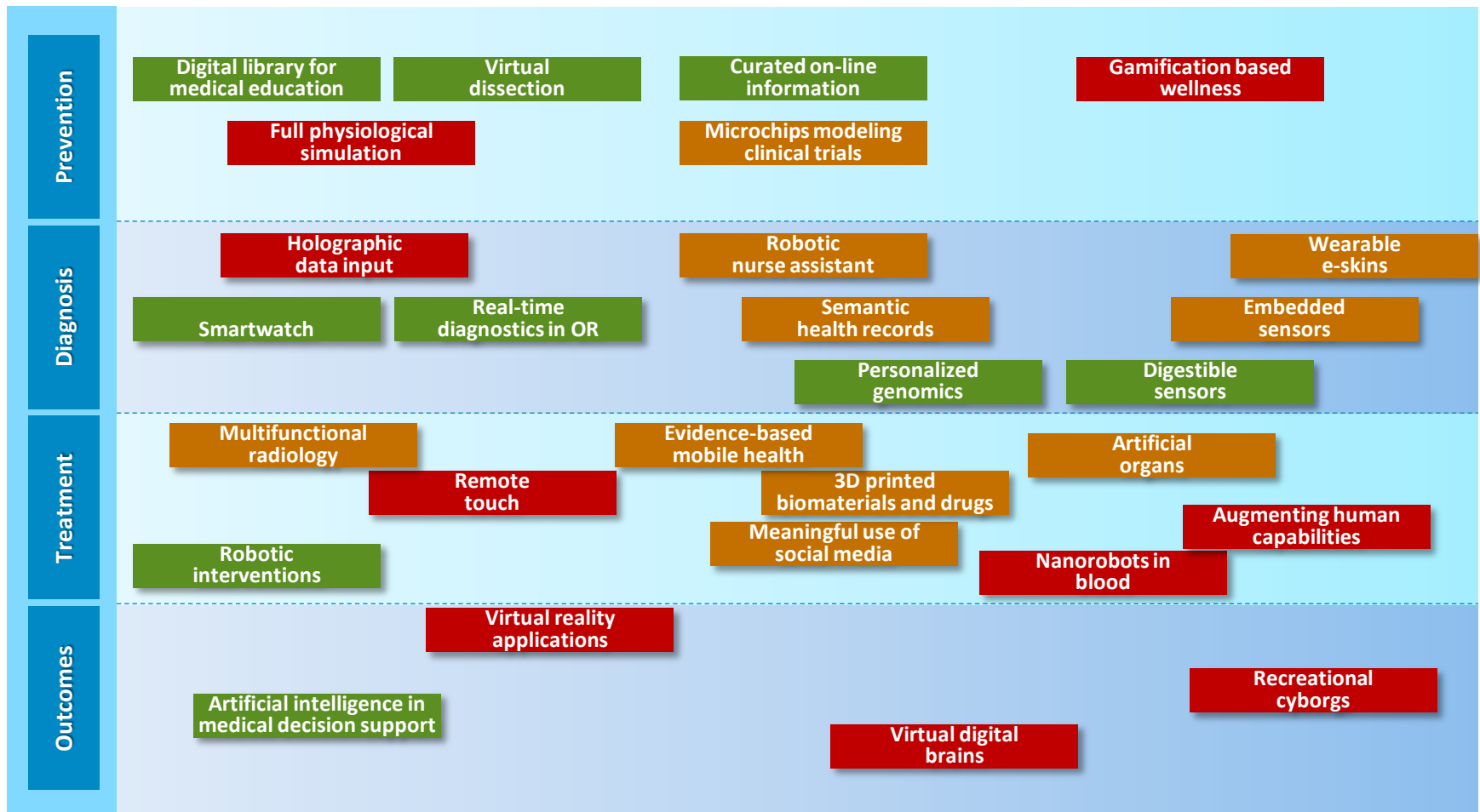
Hype cycle



Exponential growth

Professional healthcare delivery

Continuous personal health

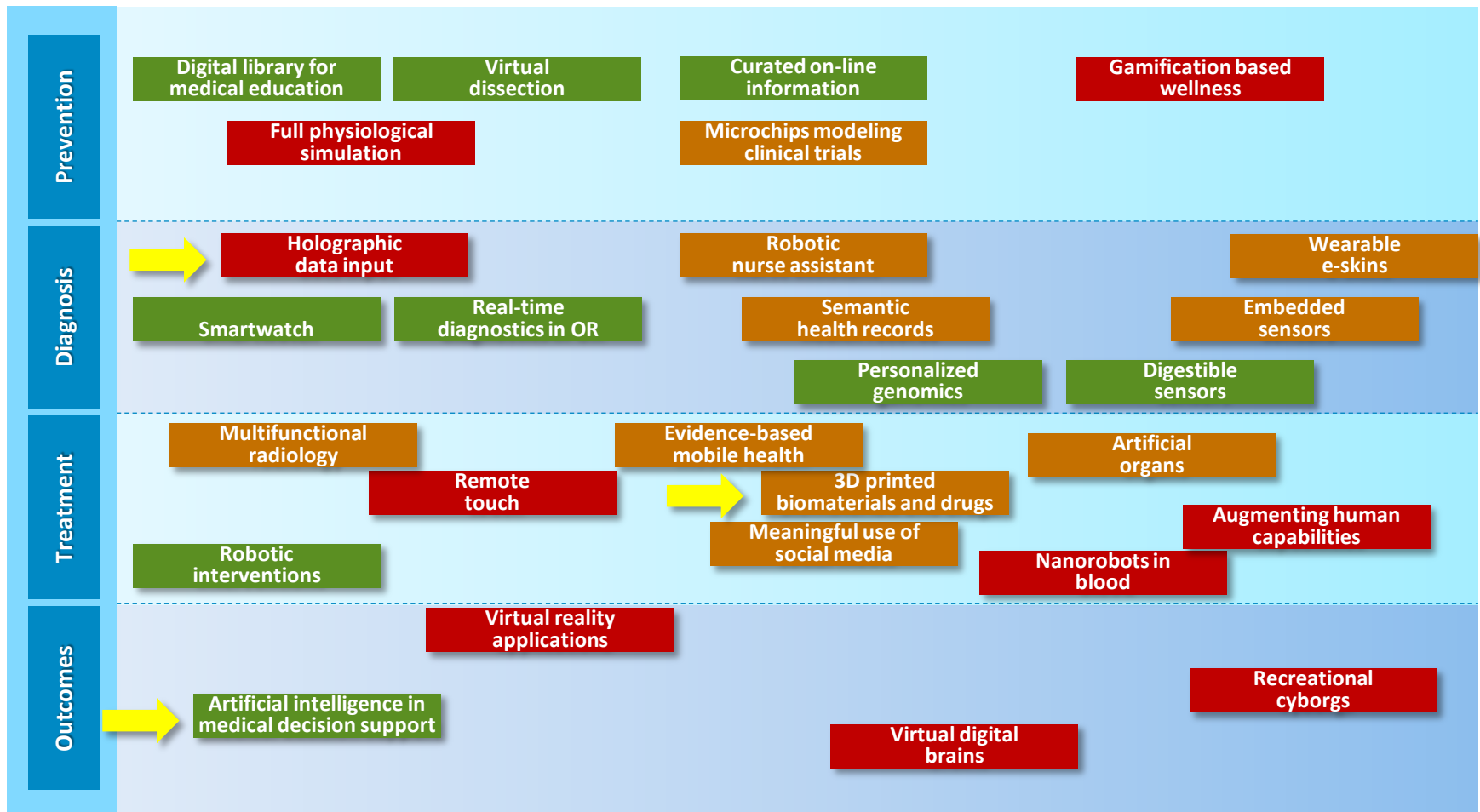


Already available
In progress
Still needs time

Exponential growth

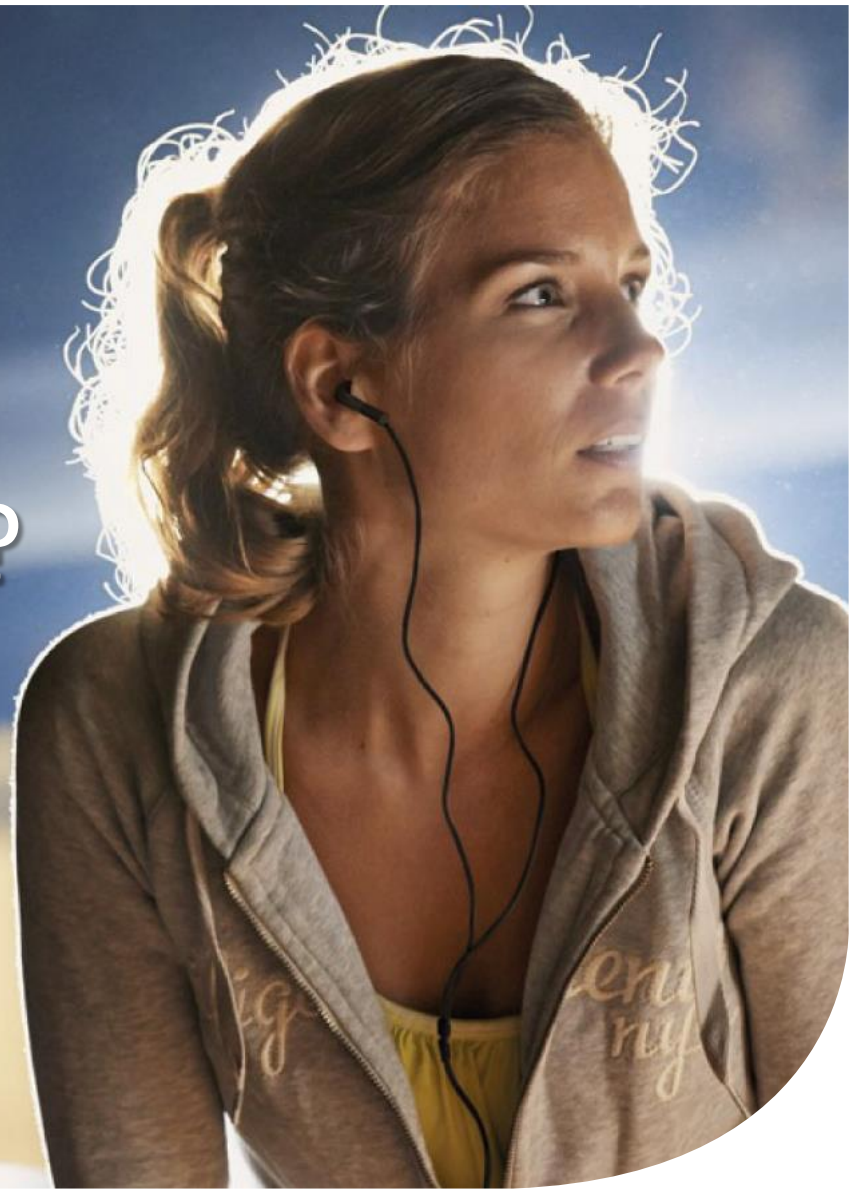
Professional healthcare delivery

Continuous personal health



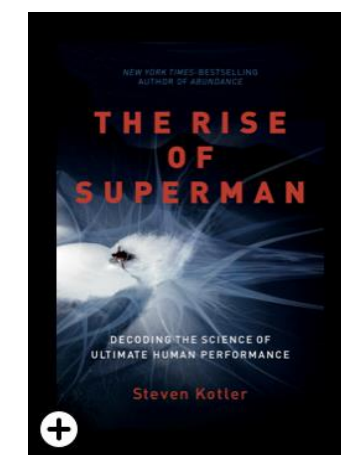
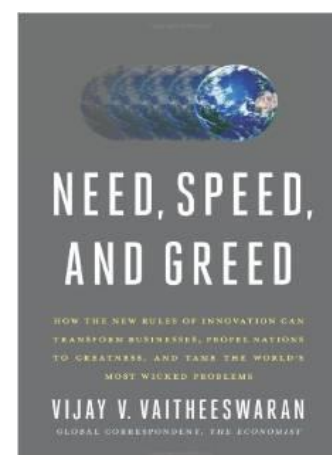
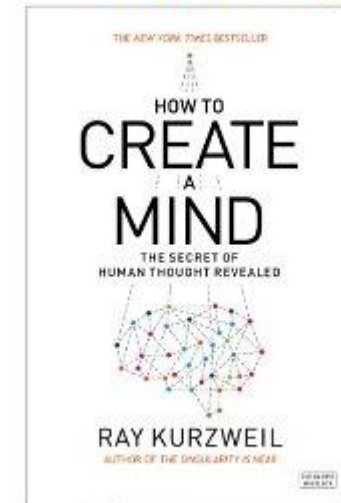
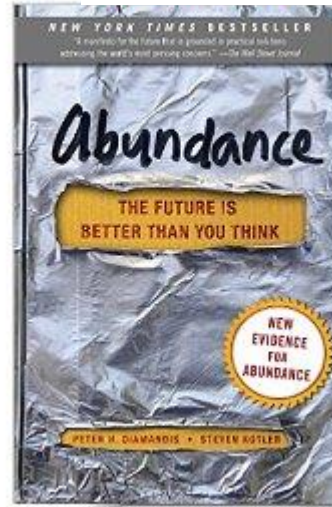
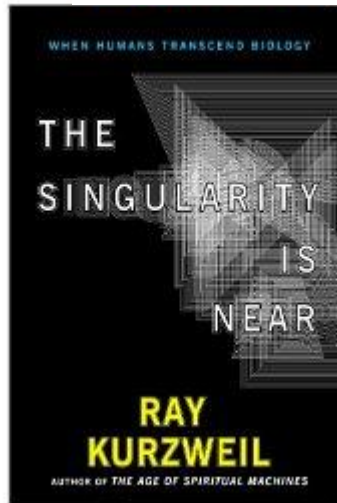
Already available
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Still needs time

What's behind this?
And why now?

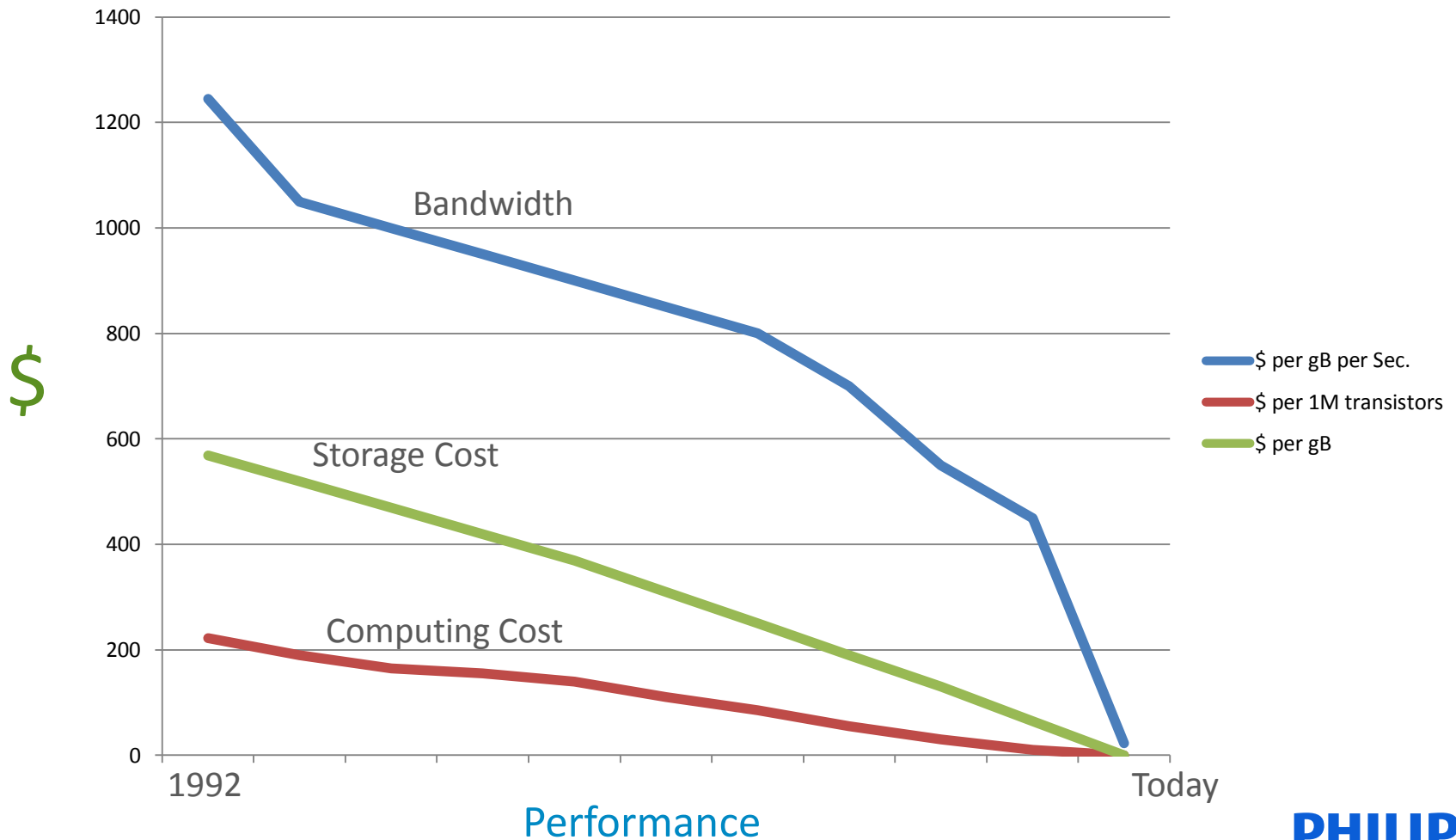


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Influential books

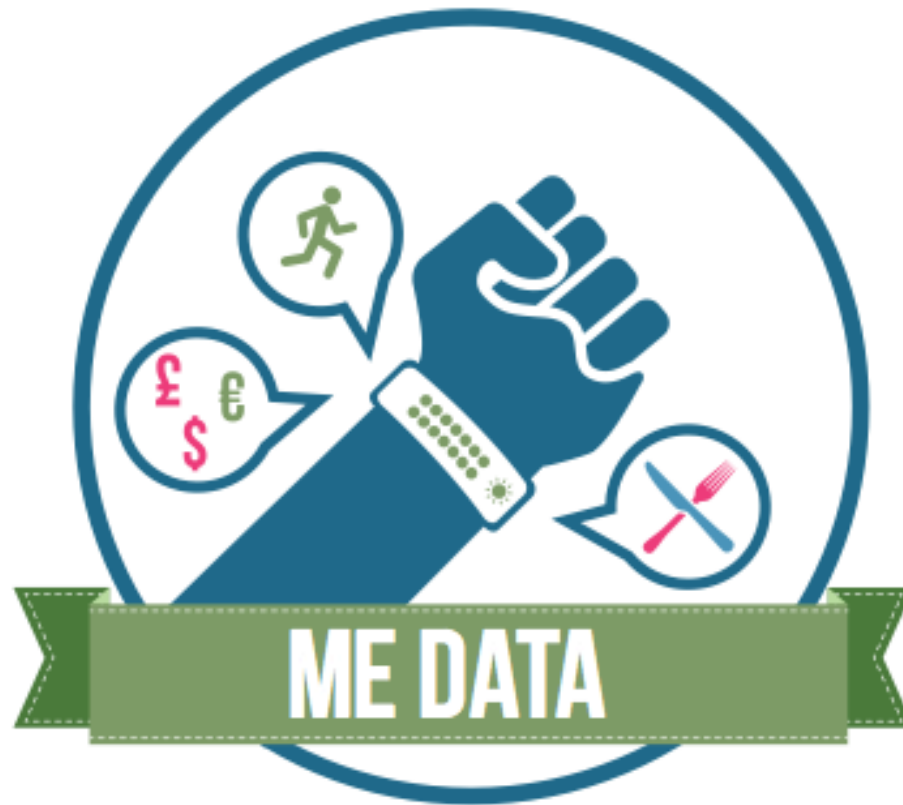


Exponential technological growth at reduced cost for performance



Quantified self.

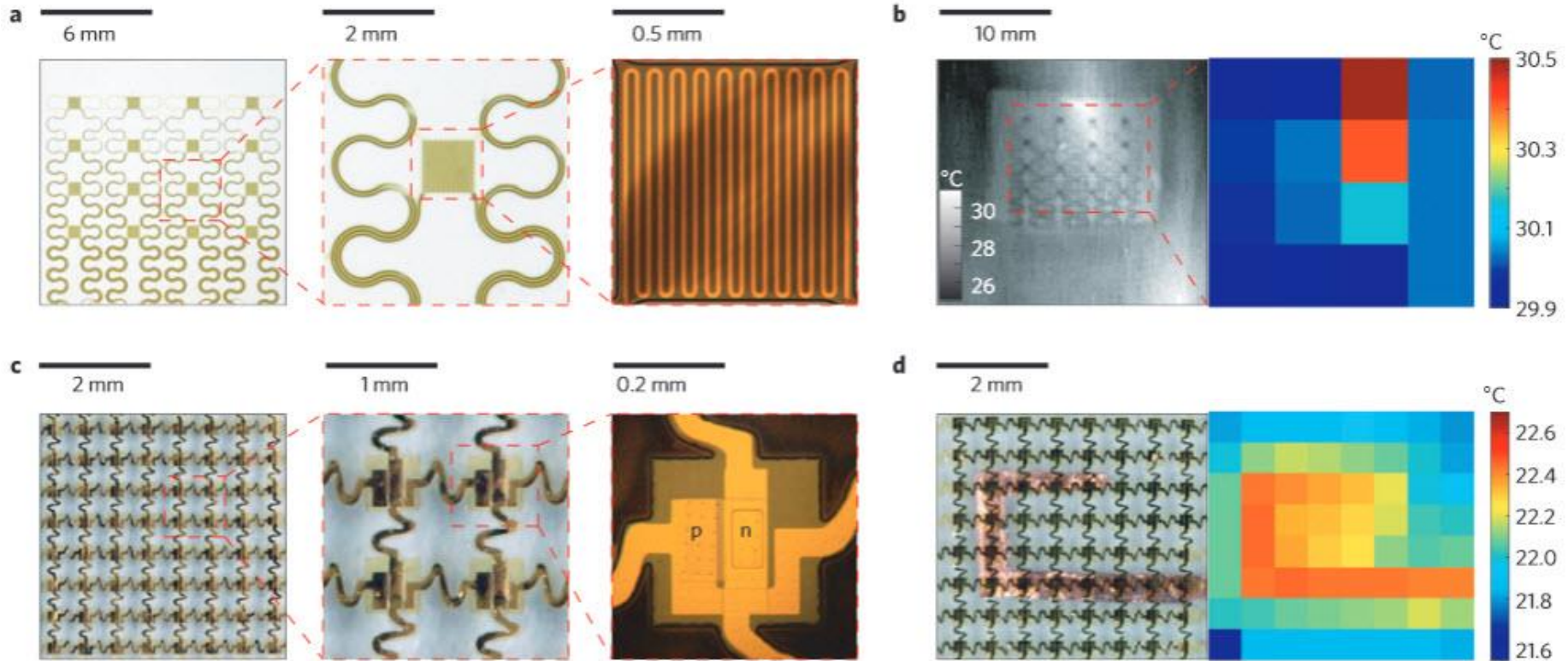
A powerful way to change behavior.



You are just a number

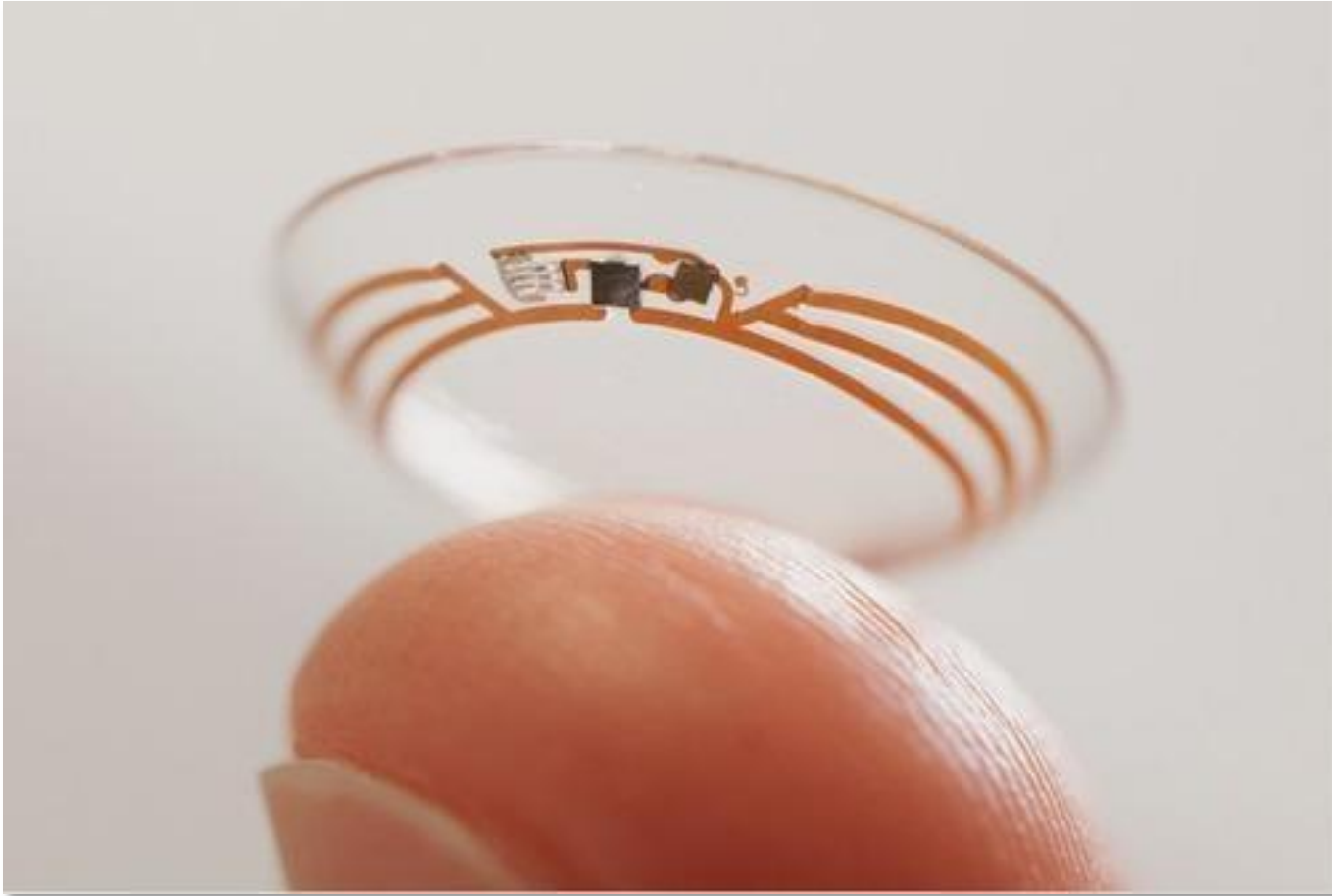


Ultrathin 'diagnostic skin' *allows continuous monitoring*



“Smart Contact Lens”

acquires all sorts of physiologic data

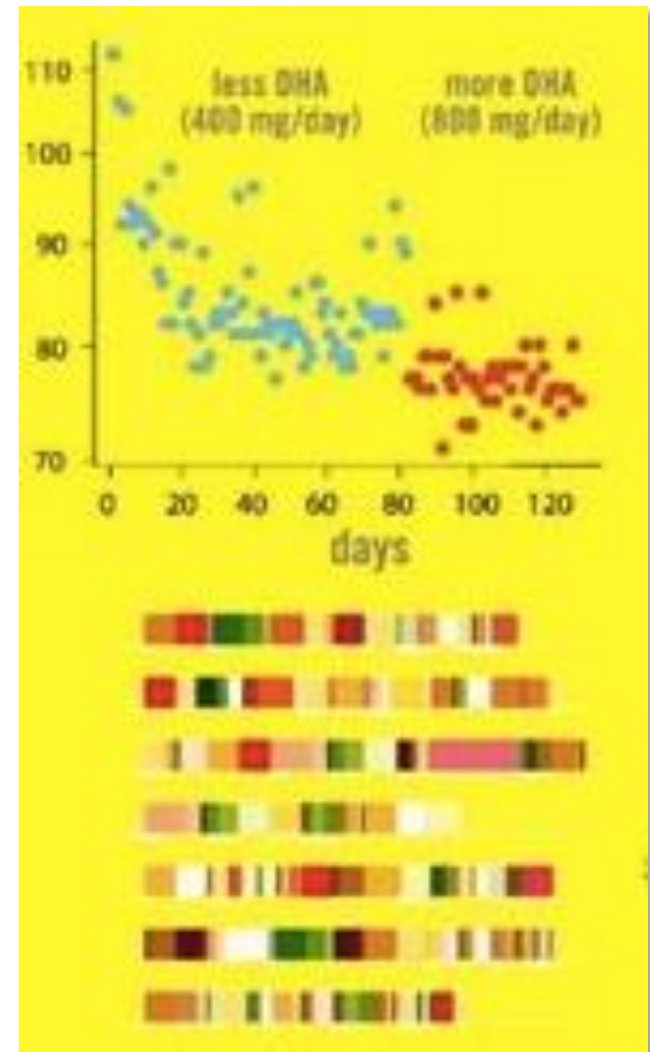


Data, data, data

- Collect data
- Share data
(*we are our social network*)
- Analyze data
- Find patterns
- Feed it to the “new” physician

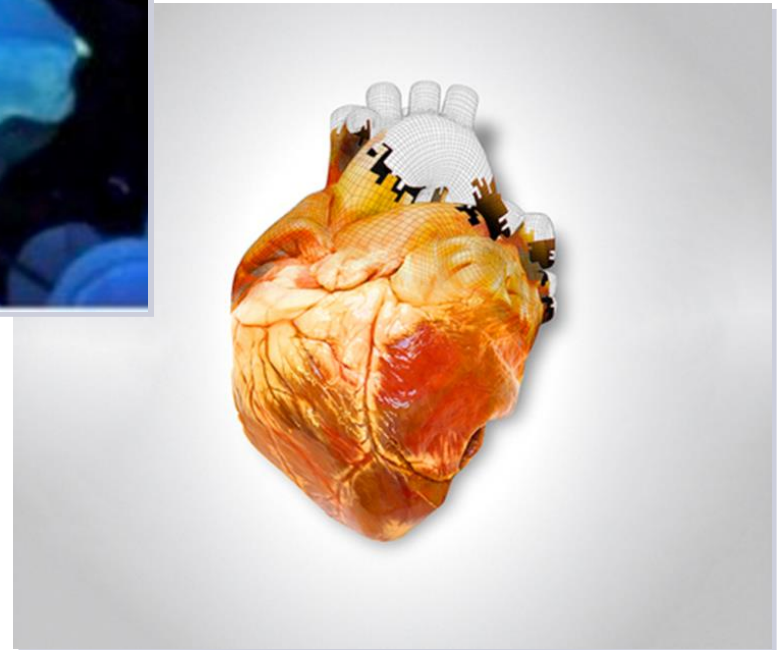
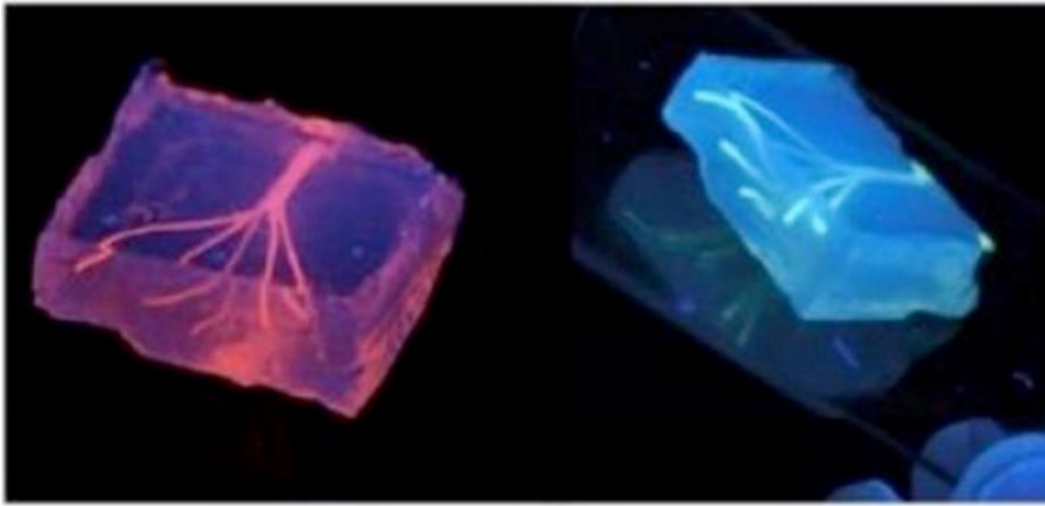
*People will contribute
their own private data*

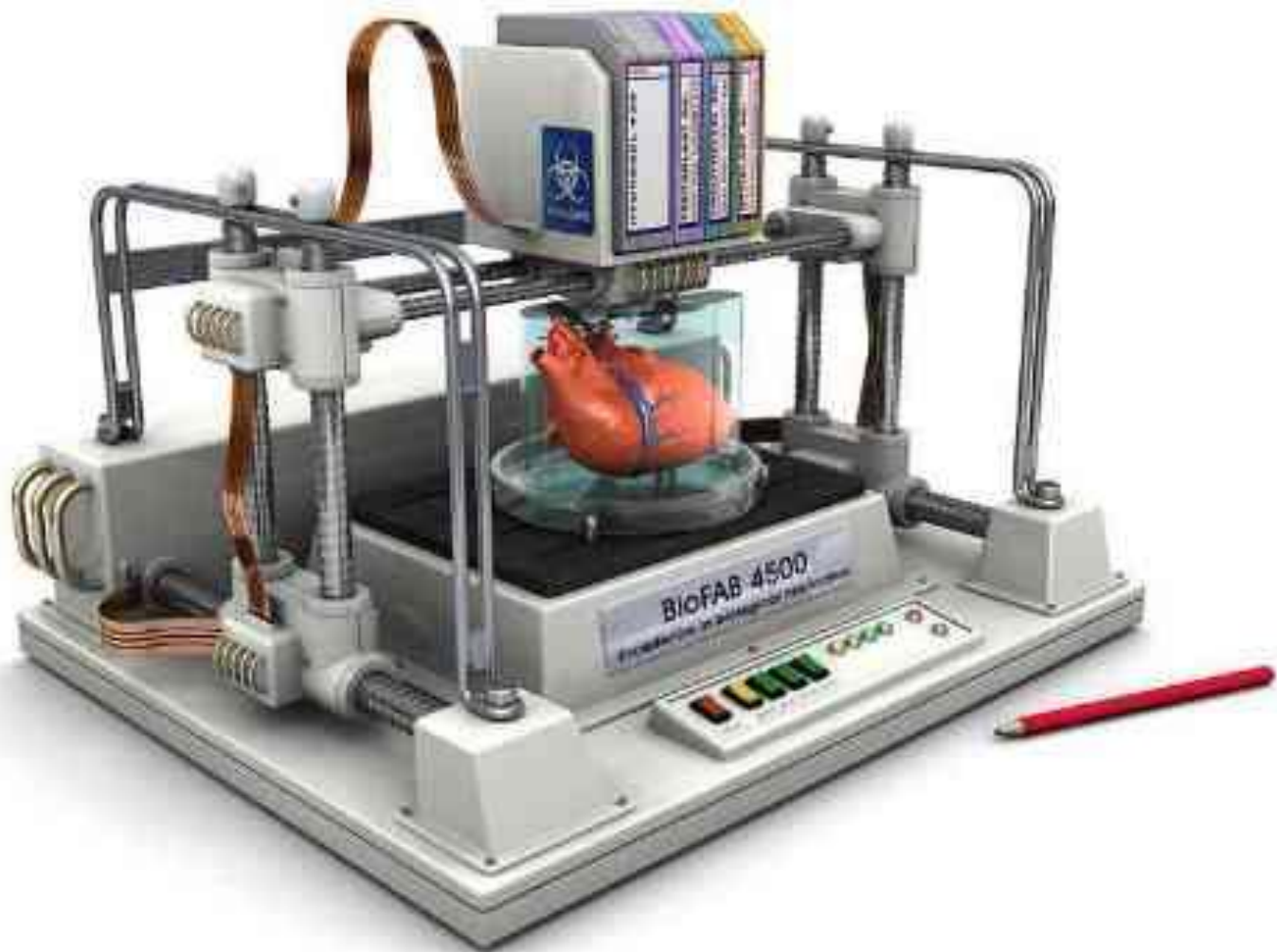
as long as they get value back

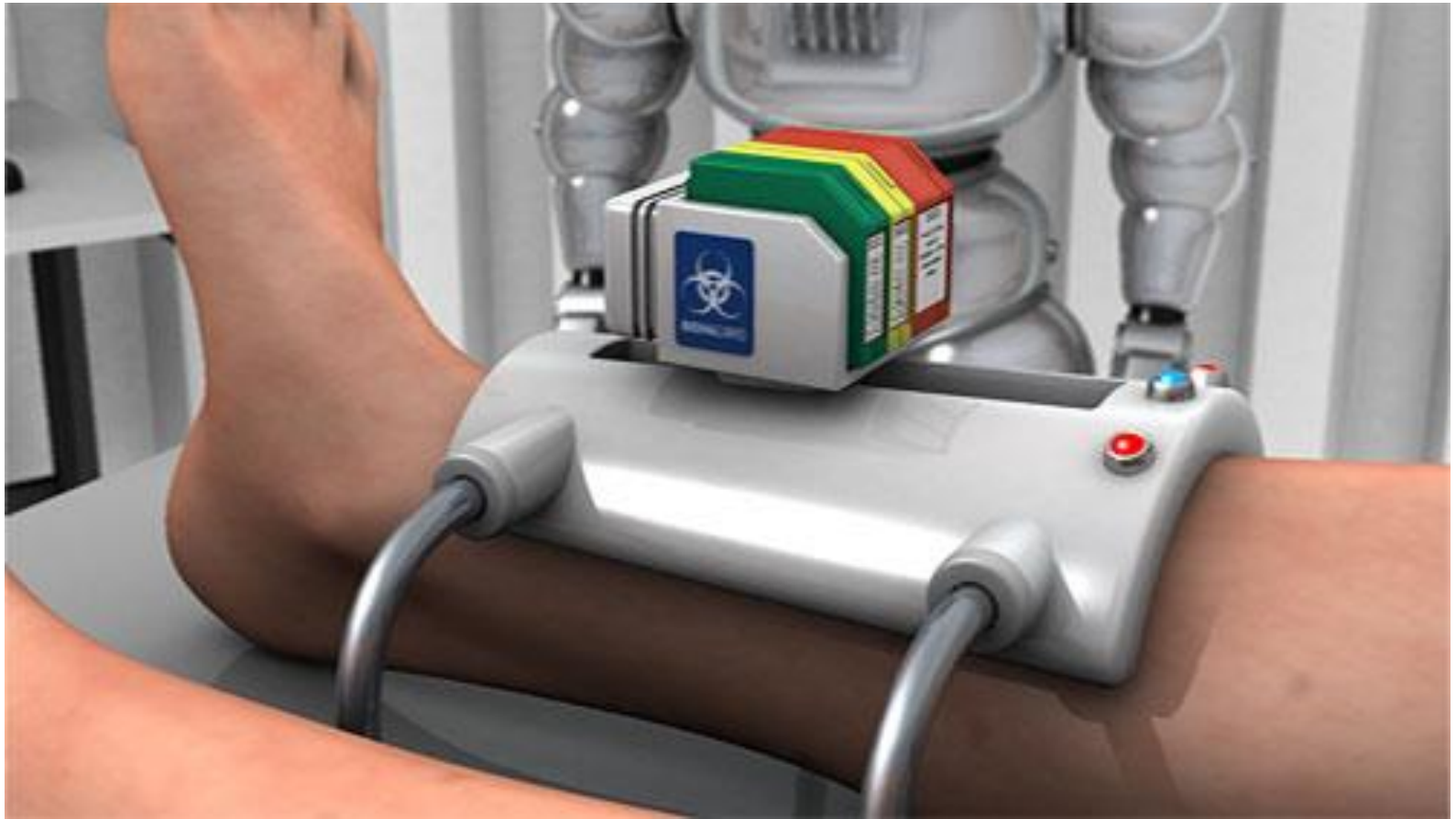


Waiting for a donor?

Let's (3-D) print it!











A visit with Dr. Watson....

With thanks to Dr. N. Hekster, IBM

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Dr. Watson supports healthcare with:

Education

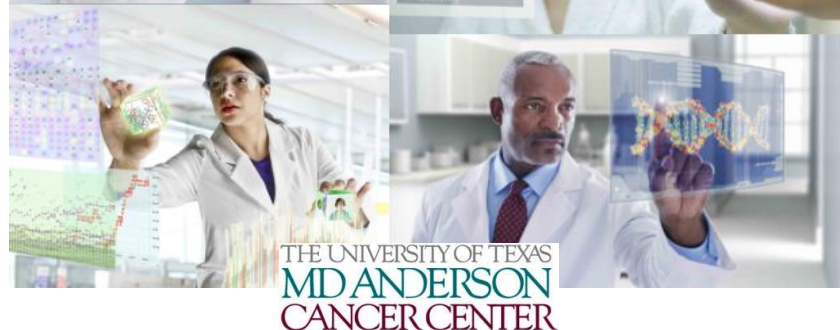


Payment

Clinical
Practice



Research



What is Dr. Watson doing?

Understands **natural language**
and human communication

Adapts and learns from choices
and answers of his users

Generates and evaluates
founded hypotheses



*Based on unstructured information management architecture (UIMA),
deep natural language processing (NLP),
deep Quality Assurance (QA) of the data,
hundreds of annotators, neural networks, and
massively parallel processing (MPP)*

Dr. Watson uses the *New England Journal of Medicine* for annotations of medical concepts

Disease

Symptoms

Entity Types / Roles

FAMILY-DISEASE
FAMILY-SUBSTANCE-ABUSE
FINDING-BLOODPRESSURE
FINDING-GENERIC
FINDING-HEARTRATE
FINDING-HEIGHT
FINDING-OXYGEN-SATURATIO
FINDING-RESPIRATORYRATE
FINDING-TEMPERATURE
FINDING-WEIGHT
MODIFIER-ANATOMY
MODIFIER-GENERIC
MODIFIER-NEGATION
MODIFIER-TIME
PATIENT-ACTIVITY-EVENT
PATIENT-AGE
PATIENT-ALLERGY
PATIENT-FEMALE
PATIENT-HAZARD-EXPOSURE
PATIENT-HEALTHSTATE
PATIENT-LOCATION
PATIENT-MALE
PATIENT-NAME
PATIENT-OCCUPATION

Relations
causeOf
modifierOf
negationOf
partOf
remedyOf
resultOf

1 Chamarthi, Bindu; Morris, Charles A.; Kaiser, Ursula B.; Katz, Joel T.; Loscalzo, Joseph
2 Stalking the Diagnosis
3 362/9/834
4 <http://content.nejm.org/cgi/content/full/362/9/834></citation_fulltext_html_url>

5 A 58-year-old woman presented to her primary care physician after several days of dizziness, anorexia, dry mouth, increased thirst, and frequent urination. She had also had a fever and reported that food would "get stuck" when she was swallowing. She reported no pain in her abdomen, back, or flank and no cough, shortness of breath, diarrhea, or dysuria. Her history was notable for cutaneous lupus, hyperlipidemia, osteoporosis, frequent urinary tract infections, three uncomplicated cesarean sections, a left oophorectomy for a benign cyst, and primary hypothyroidism, which had been diagnosed a year earlier. Her medications were levothyroxine, hydroxychloroquine, pravastatin, and alendronate. She lived with her husband and had three healthy adult children. She had a 20-pack year history of smoking but had quit 3 weeks before presentation. She reported no alcohol or drug abuse and no exposure to tuberculosis. Her family history included oral and bladder cancer in her mother, Graves' disease in two sisters, hemochromatosis in one sister, and idiopathic thrombocytopenic purpura in one sister.

Medication

Time

IBM's Oncology Diagnosis & Treatment Advisor

Shows how Watson assists an oncologist when:

- **Correlates scattered data**
EMR's, summaries, test results, pathology reports, etc.
- **Suggests additional diagnostics**
- **Provides evidence-based treatment options**



Treatment Plan	Confidence	Patient Preferences Match
Treatment plan 1 Systemic Chemo: Cisplatin, Pemetrexed, Bevacizumab	95%	Acceptable match with patient preferences
Treatment plan 2 Systemic Chemo: Carboplatin, Paclitaxel, Bevacizumab	45%	Unacceptable match with patient preferences
Treatment plan 3 Systemic Chemo: Erlotinib	8%	Preferred match with patient preferences

A photograph of two surgeons in an operating room, viewed from behind. They are wearing blue scrubs, surgical masks, and blue bouffant caps. They are looking at a large monitor in the background which displays a 3D medical scan of a patient's internal organs. The text "Augmented reality?" is overlaid in white on the left side of the image. In the foreground, there is a control panel with a small screen and several buttons.

Augmented reality?

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Google Glass in the Operating Room

Presents vital signs & EMR data to the surgeon directly



UMC-St. Radboud

Already a commodity?

Robotic healthcare provider

Technology closer to the patient

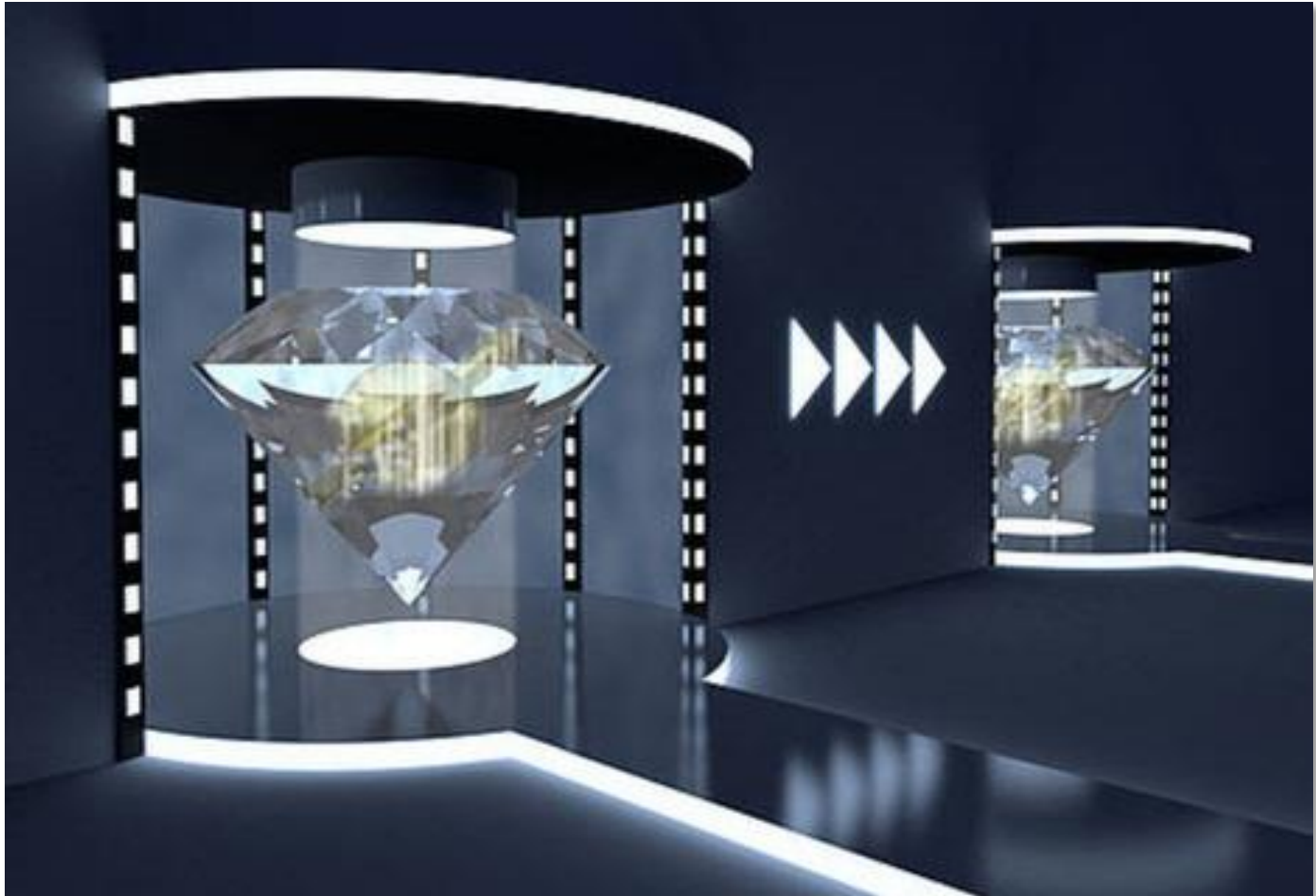


TU – Eindhoven

the new physician, nurse ...?

“Beam me up”

Experiments with teleporting of experts



TU - Delft

The new OR advisor?

Conclusions

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