AI and Healthcare

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The “good” algorithm?
Artificial Intelligence. Ethics, Law, Health

Roma, 27 February 2020
Are world health systems facing the perfect storm?

A "perfect storm" is an expression that describes an event where a rare combination of circumstances will aggravate a situation drastically.
The waves of demand and supply

Demographic and epidemiological transition
Technological innovation
Populations needs and demand
Professional differentiation

Health Systems
Chronic diseases

Source: Projections of global health outcomes from 2005 to 2060 using the International Futures integrated forecasting model. WHO bulletin 2011.
It has been estimated that the commonest chronic conditions are costing the EU countries more than 1 trillion Euros per year, which is expected to increase to 6 trillion Euros by the middle of the century.

In UK the cost of chronic conditions such as stroke, heart diseases, diabetes, cancer and dementia pile up to over 50% of total healthcare expenditure.

Chronic conditions and economic burden

<table>
<thead>
<tr>
<th>Condition</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stroke</td>
<td>4%</td>
</tr>
<tr>
<td>CVD</td>
<td>16%</td>
</tr>
<tr>
<td>Cancer</td>
<td>9.4%</td>
</tr>
<tr>
<td>Diabetes</td>
<td>9%</td>
</tr>
<tr>
<td>Dementia</td>
<td>17%</td>
</tr>
</tbody>
</table>

No country can afford this

1 trillion = 1.000.000.000.000.000.000.000.000
Financial constraints

Need & Demand

2012

€
Health spending

Average annual growth in health spending in real terms

Source: OECD Health Data 2013
What can we do for our health systems?
Healthcare Sustainability

Healthcare systems need to be reorganized, and sustainability framework represents a prominent option to guide new policies, plans and programs.

**Aim**

Policy Maker = Investment

Citizen = Gaining health

- Prevention and Early Intervention
- Empowered and responsible citizens
- Reorganisation of care
What makes health services ineffective and inefficient

- Delay in treatment
- Same treatment for all
- Undue variability in health conditions
- Waiting for patients to arrive in our silo structures
- Uncertainty on what really works
- Frequent medical errors (not notified)
- Irrational workflow
- Patients ignore doctor’s instructions

from Elias Mossialos, modified
As seen, health care providers are currently faced with an extremely complex challenge characterised by rising demand, increasing cost and insufficient funding.

Never as much as today have health care systems been interested and involved with the potential benefits deriving from innovations.

Innovation is a key feature that organisations have to incorporate as a condition to offer sustainable and efficient solutions.
Innovation

The process of translating an idea or invention into a product/service that creates value or for which customers or society or insurance will pay

The application of better solutions that meet new requirements, unarticulated needs, or existing population needs

Something original and more effective and - as a consequence- new, which "breaks into" the market or society
Innovation refers to the use of a better and, as a result, novel idea or method.

Invention refers more directly to the creation of the idea or method itself.

Whereas innovation refers to the notion of doing something different, rather than doing the same thing better.
# Types of innovation

<table>
<thead>
<tr>
<th>SUSTAINING</th>
<th>An innovation that does not affect existing markets</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous</td>
<td>An innovation that improves a product in an existing market in ways that customers are expecting.</td>
</tr>
<tr>
<td>Discontinuous</td>
<td>An innovation that is unexpected, but nevertheless does not affect existing markets.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DISRUPTIVE</th>
<th>An innovation that creates a new market or expands an existing market by applying a different set of values, which ultimately (and unexpectedly) overtakes an existing market</th>
</tr>
</thead>
</table>
| Main features are: | a) improved health outcomes  
| | b) create new professional culture  
| | c) serve new groups or have new products/services  
| | ("create new markets")  
| | d) create new players  
| | e) disorders old systems |
The EXPH understands disruptive innovation in health care as:

“a type of innovation that creates new networks and new organisations based on a new set of values, involving new players, which makes it possible to health improve outcomes and other valuable goals, such as equity and efficiency. This innovation displaces older systems and ways of doing things”.
Disruptive innovation in health care

The concept of disruption implies that not only does an innovation take place, but that the previous “market”, companies, employers or employees might change considerably.
Main characteristics of disruptive innovations

A disruptive innovation can often be characterised by some (or all) of the following elements:

- Provide improved health outcomes
- Empower the patient/person
- Create new services and overcomes challenges regarding accessibility to existing or new services
- Create new professional roles and capacities
- Lead to cost-effective methodologies that improve access
- Create new sets of values for the health workforce, patients, citizens and community
- Promote person-centred health delivery
- Introduce transformative cultural change
- Disorder old systems
In health care, high value can be defined as meeting patient expectations at the level of the individual or providing the better outcomes in the most cost-effective way in the short or long-term at the population level.

In an era in which resources often do not increase in step with increasing need and demand, when they increase at all, it is essential to promote disruptive innovations that present high value.
Examples illustrating the taxonomy

<table>
<thead>
<tr>
<th>TECHNOLOGICAL</th>
<th>ORGANISATIONAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Antibiotic development</td>
<td>• Community-based mental health</td>
</tr>
<tr>
<td>• Anti-ulcer drugs</td>
<td>• Population based accountable organisations</td>
</tr>
<tr>
<td>• Minimal invasive surgery</td>
<td>• Integrated care</td>
</tr>
<tr>
<td>• New and more effective treatment for HCV</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PRODUCT AND SERVICES</th>
<th>HUMAN RESOURCES</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Development of palliative care</td>
<td>• Diabetic patient self-management</td>
</tr>
<tr>
<td>• Patient-centred care</td>
<td></td>
</tr>
</tbody>
</table>
5 strategic areas for disruptive innovations

- Translational research
- Health promotion
- Technology
- Professional education
- Precision medicine
AI refers to systems that display intelligent behaviour by analysing their environment and taking actions with some degree of autonomy to achieve specific goals.
Artificial Intelligence in Healthcare

Studies by Accenture predict that growth in the AI healthcare space is expected to touch $6.8 billion by 2021 with a CAGR of 40%.

"The new technology aims to enhance interactions between patients and caregivers to both improve the consumer experience and reduce physician burnout."

AI also holds promise for helping the healthcare industry manage costly back-office problems and inefficiencies. Activities that have nothing to do with patient care consume over 51% of a nurse’s workload and nearly 16% of physician activities.

AI-based technologies, such as voice-to-text transcription, can improve administrative workflows and eliminate time-consuming non-patient-care activities, such as writing chart notes, filling prescriptions, and ordering tests. It is estimated that these applications could save the industry $18 billion annually.
Artificial Intelligence in Healthcare can be deployed across these use cases:

- Virtual Assistants for Staff
- Robot-Assisted Surgery
- Automated Image Diagnosis with AI/ML
- AI in Pathology
- Personal Health Companions Powered by AI
- Rare Diseases Detection with AI
- Oncology – Detecting Cancer with AI
- Cybersecurity Applications of AI in Healthcare
- AI-Powered Chatbots
- Medication Management with AI and ML
- Robots for Explaining Lab Results
- Health Monitoring with AI and Wearables

"AI chatbots in healthcare will be a crawl-walk-run endeavor, where the easier tasks will move to chatbots while awaiting the technology to evolve enough to handle more complex tasks."
Artificial Intelligence in healthcare: promising future, but barriers remain

The future looks promising for AI-based automation ...

- New job creation
- Opportunity to build advanced AI capabilities
- Emergence of general AI to create a synthetic system as sophisticated as the human
- Formulation of an AI regulatory framework

... but barriers that restrict its universal acceptance remain

- Absence of interoperability
- Regulatory implications
- Moral/ethical implications
- Concerns about data privacy
- Shortage of relevant and sufficient talent
The market will be **accelerating** growing at a **CAGR** over **28%**.

**Incremental Growth**: $5.16 bn

The year-over-year growth rate for 2019 is estimated at **25.19%**.

The market is **moderately concentrated** with a few players occupying the market share.

**49%** of the growth will come from **North America**.

One of the **key drivers** for this market will be the **push for digitalization in healthcare**.

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**Read the report:**

**Global Artificial Intelligence (AI) Market in Healthcare Sector**

10,000+ reports covering niche topics in **Information Technology**

Read them at: [www.technavio.com](http://www.technavio.com)
The Kendall Square Technology and Innovation Cluster
90+ Healthcare AI Startups To Watch

**Imaging & Diagnostics**
- ablacon
- Aidance
- Aidoc
- Healthy.io
- PathAI
- RadiomicsAI
- Aillis
- enlitic
- BUTTERFLY Network, Inc.
- freemeanome
- IDx
- Sigtuple
- Lunit
- VIZ
- Ultromics
- PAIGE
- Vuno

**Drug Discovery**
- Accutar Biotech
- BenevolentAI
- FINCH THERAPEUTICS
- AMOTION
- BlackThorn Therapeutics
- Frontier Medicines
- insitro
- Atomwise
- Exscientia
- Engine
- Juvenescence
- Notable Labs
- Standigm
- XtalPi
- twoxAR
- SPRING DISCOVERY

**Predictive Analytics & Risk Scoring**
- BenchSci
- LU
- Medical EarlySign
- TEMPUS
- ikioo
- medopad
- Welltok

**Genomics**
- DECIPHER BIOSCIENCES
- SOPHIA GENETICS
- Syntekabio
- WuXiNextCODE

**Hospital Decision Support**
- binaryfountain
- Cardinal Analytics
- Qventus
- OM
telx
- Medical Information
- gauss
- KenSci
- Olive
- LeanTaaS

**Fitness**
- FINC
- Vi

**Remote Monitoring**
- biofourmis
- ContinUse Biometrics
- DENTAL MONITORING

**Virtual Assistant**
- babylon
- Curai
- mfine
- notable
- Suki

**Clinical Trials**
- deep
- HEALTHiS
- scaleI
- teckro

**Compliance**
- DATAVANT
- PROTENUS

**Mental Health**
- mindstrong

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TABLE 1-1 | Practical challenges to the advancement and application of AI tools in clinical settings identified during the November 30, 2017 Digital Health Learning Collaborative Meeting

<table>
<thead>
<tr>
<th>Challenge</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Workflow integration</td>
<td>Understand the technical, cognitive, social, and political factors in play and incentives impacting integration of AI into health care workflows.</td>
</tr>
<tr>
<td>Enhanced explainability and interpretability</td>
<td>To promote integration of AI into health care workflows, consider what needs to be explained and approaches for ensuring understanding by all members of the health care team.</td>
</tr>
<tr>
<td>Workforce education</td>
<td>Promote educational programs to inform clinicians about AI/machine learning approaches and to develop an adequate workforce.</td>
</tr>
<tr>
<td>Oversight and regulation</td>
<td>Consider the appropriate regulatory mechanism for AI/machine learning and approaches for evaluating algorithms and their impact.</td>
</tr>
<tr>
<td>Problem identification and prioritization</td>
<td>Catalog the different areas of health care and public health where AI/machine learning could make a difference, focusing on intervention-driven AI.</td>
</tr>
<tr>
<td>Clinician and patient engagement</td>
<td>Understand the appropriate approaches for involving consumers and clinicians in AI/machine learning prioritization, development, and integration, and the potential impact of AI/machine learning algorithms on the patient-provider relationship.</td>
</tr>
<tr>
<td>Data quality and access</td>
<td>Promoting data quality, access, and sharing, as well as the use of both structured and unstructured data and the integration of non-clinical data is critical to developing effective AI tools.</td>
</tr>
</tbody>
</table>
A road-map for transformation: The NYU Langone Story

<table>
<thead>
<tr>
<th>KPI</th>
<th>2007</th>
<th>2019</th>
</tr>
</thead>
<tbody>
<tr>
<td>QUALITY &amp; SAFETY RANKING ON 90 HOSPITALS</td>
<td># 60</td>
<td># 2</td>
</tr>
<tr>
<td>MEDICAL SCHOOL RANKING</td>
<td># 34</td>
<td>TOP 10</td>
</tr>
<tr>
<td>PROFIT PERFORMANCE</td>
<td>LOSS 150 Mio $</td>
<td>GAIN 240 Mio $</td>
</tr>
</tbody>
</table>
PROGETTO DIREZIONE
DIGITAL INNOVATION & CHANGING PROCESS
Conclusions

Artificial intelligence

- can be an important instrument
- can provide a new and different perspective that tends to reduce complexity in favour of the empowerment of the citizen/patient
- should be seen by policy makers as possible new methods of dealing with old issues

Health systems should be responsive to innovations and allow promising disruptive innovations to be tested, evaluated, and implemented. This requires the presence of responsive and open-minded systems.

There may not be a “one size fits all” solution for monitoring, managing and stimulating the adoption of disruptive innovations.
Thank you for your attention