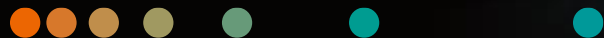


AI and Machine Learning in Diagnostics: A CMO's perspective

2021 AMDM Annual Virtual IVD Regulatory Meeting

April 23rd, 2021

Richard A. Frank, MD, PhD, FFPM (RCP)



Low digital maturity is a major challenge for healthcare providers worldwide

Low degree of process digitization¹

50% of patients report that information necessary to their care **was not available when needed**²



Missing systematic approach to leverage wealth of data¹

4 in 5 hospitals lack an effective data management strategy³



Fragmented information on siloed data pools

US\$342 bn in lost benefits each year due to poor data integration⁴



Low digital maturity is wasting resources and hinders progress in improving health

¹Boston Consulting Group, Digital Maturity Is Paying Off, Grebe, Rüßmann, Leyh, Franke, June 2019; ²Best care at lower cost: The path to continuously learning healthcare in America, Institute of medicine; ³Stanford Medicine, 2017: Health Trends Report – Harnessing the Power of Data in Health; ⁴Andrew, John (2016), “Unsexy Plumbing” – Integrated Data And The Future Of The Healthcare System. techcrunch.com <http://tcn.ch/1lxRe5B>

We enable healthcare providers to increase value by...

Expanding
**precision
medicine**

Transforming
**care
delivery**

Improving
**patient
experience**

Digitalizing
healthcare



Digitalizing healthcare is the most important enabler for expanding precision medicine, transforming care delivery, and improving patient experience.

Expanding
precision
medicine

Transforming
care
delivery

Improving
patient
experience

Digitalizing
healthcare

Who we are

Market leader

in majority
of businesses

€14.6bn

revenue¹

>70

countries with
direct presence

~54,300

highly skilled
employees

+18,500

IPR, thereof +13.500 granted
patents



~240,000

patient touch points
every hour

Access to care for

~1.3bn people

in developing countries

>70%

of critical clinical decisions are
influenced by the type of
technology we provide²

>90%

of global top 100 providers
partner with us

~600,000

installed base

¹ Revenue FY 2020.

² AdvaMedDX, "A Policy Primer on Diagnostics", June 2011, p. 3.

Siemens Healthineers: We have what it takes in AI



= 1.1 billion

curated images, reports,
operational data



~ 600,000
installed base



AI
competence
center with
awarded Data
Scientists



Dedicated
annotation
team



Close clinical
collaborations



More than 65
AI-enriched
offerings on
the market

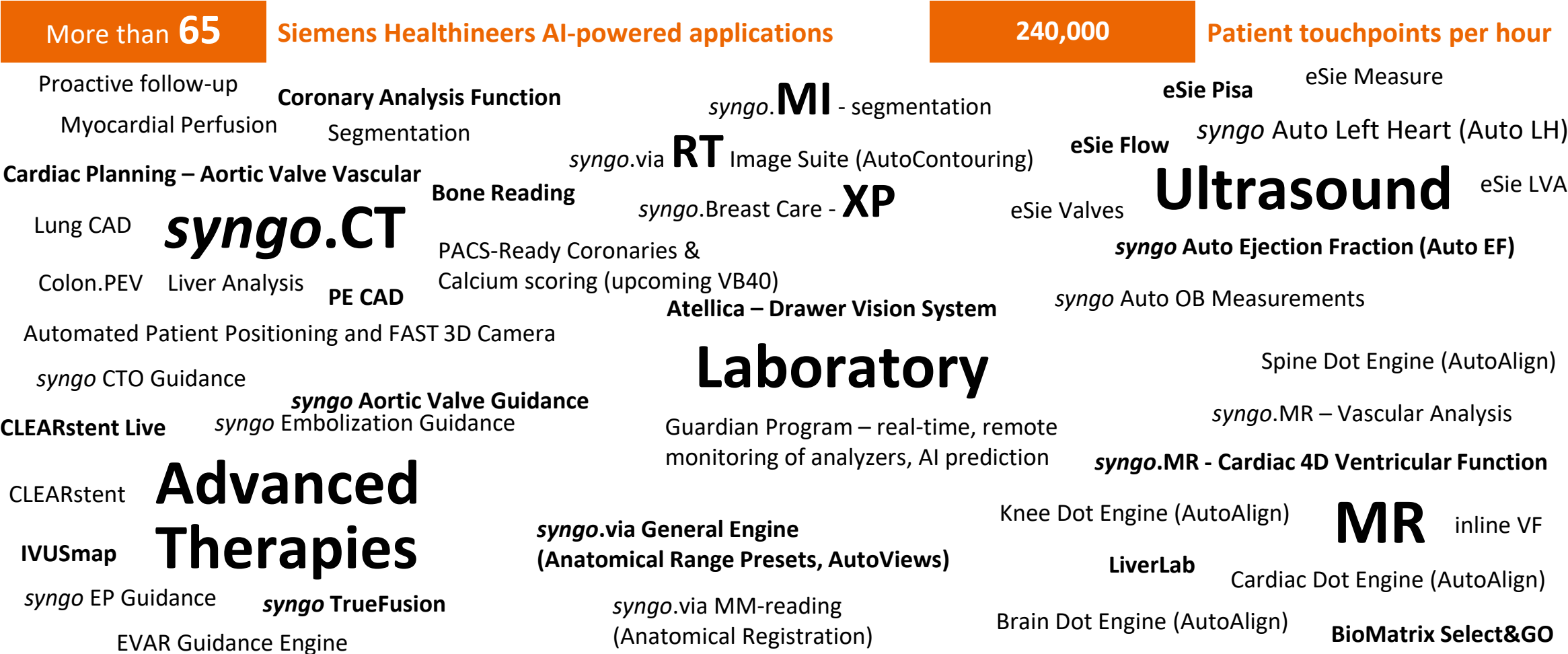


More than 700 patent
families related to
machine learning, of
which 275 patent families
are related to deep
learning

4

Regional
supercomputing
data centers

AI-powered systems with partial and conditional automation already in clinical routine

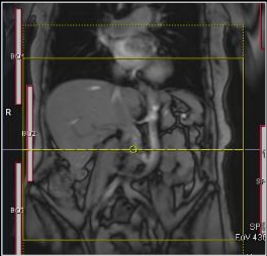


Example: Value of Artificial Intelligence along the entire MRI acquisition and processing chain

AI-powered
**Guidance &
Workflow**

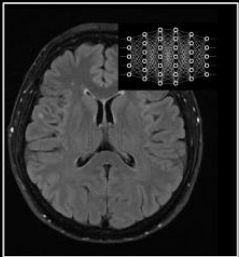


Accurate patient
positioning



Automated
procedure planning

AI-powered
**Acquisition &
Examination**

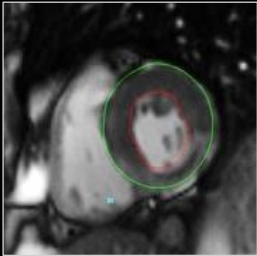


Fast, sharp, robust
imaging

AI-powered
**Processing &
Interpretation**

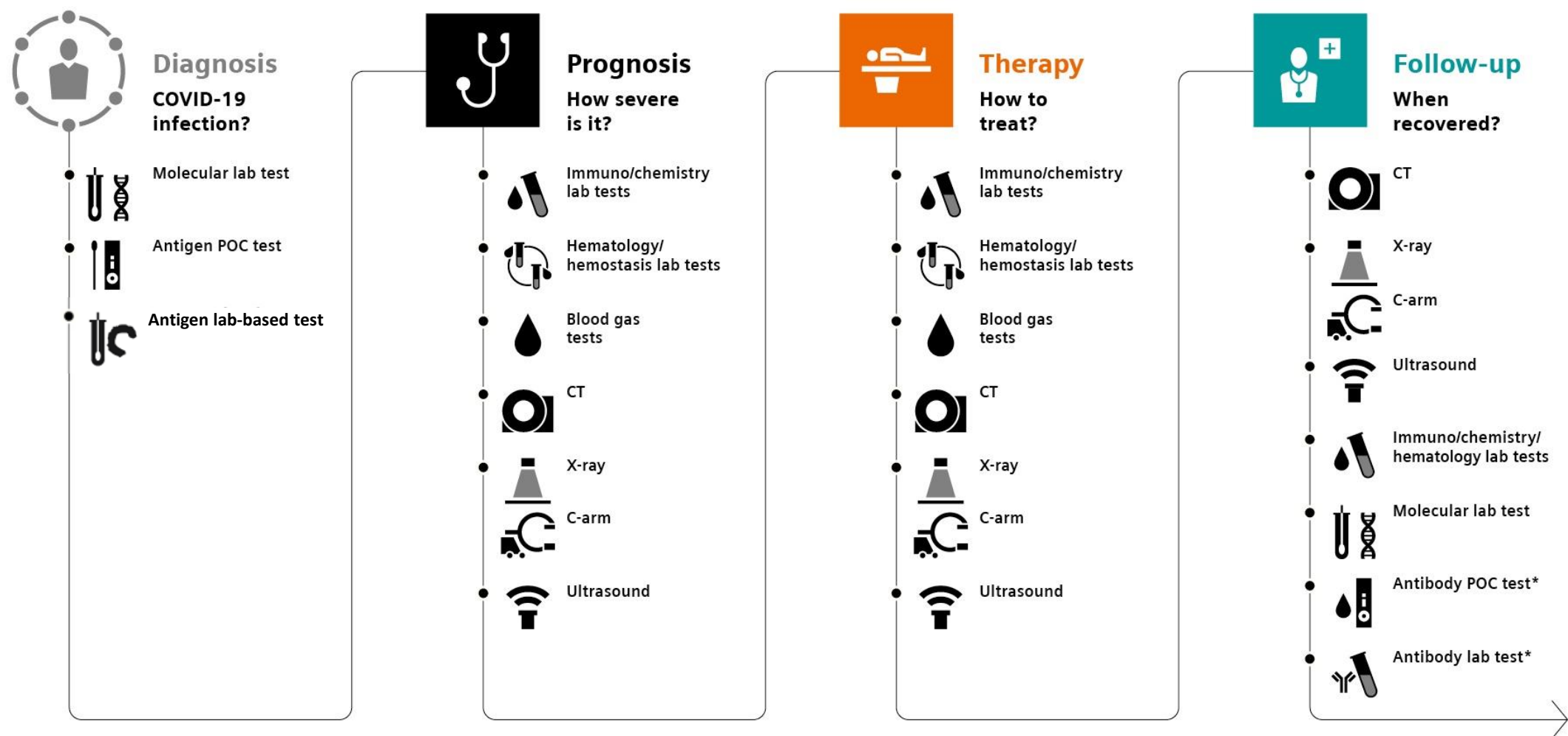


Replace tasks that
are labor intensive



Display
information for
fast interpretation

AI can play a vital role across the COVID-19 patient pathway



Digital Solutions | Remote operations, services and education | Artificial Intelligence

How else can AI help manage the challenges of COVID-19?



Temporary field hospital set at Ifema convention and exhibition in Madrid, Spain, April 2, 2020

Image by Manu Fernandez via AP¹

¹<https://abcnews.go.com/International/photos-field-hospitals-built-globe-coronavirus-pandemic-spreads/story?id=69962474>

² <https://hbr.org/2020/04/how-hospitals-are-using-ai-to-battle-covid-19>

*In development. Not available for sale. Features listed are development design goals. Future availability cannot be guaranteed.
Not all product offerings are available in all countries.

HOOD05162003186327

New problems to be solved

When space is limited, how do you prioritize allocation of precious ICU beds?

How do you determine which patients are at highest risk of severe illness and complications?

Harvard Business Review: How Hospitals Are Using AI to Battle Covid-19 – April 3, 2020

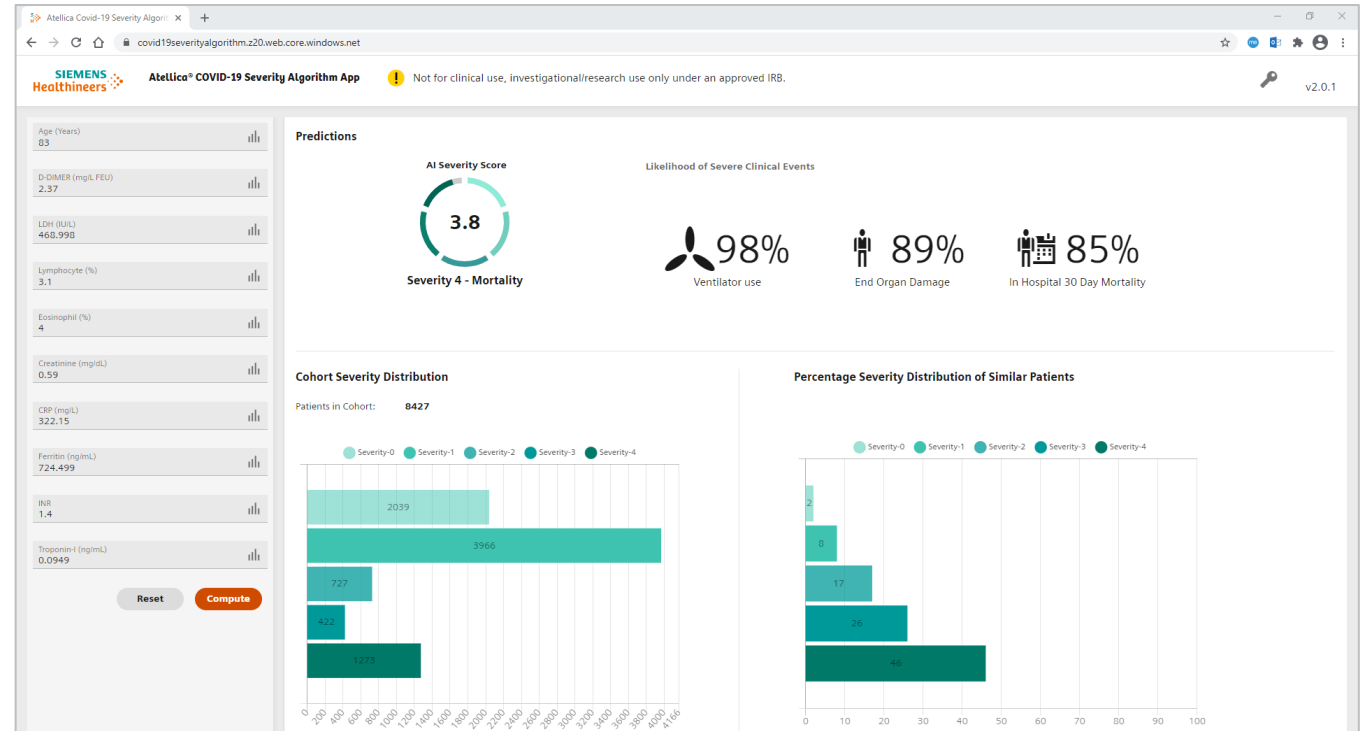
“The spread of Covid-19 is stretching operational systems in health care and beyond. The reason is both simple: Our economy and health care systems are geared to handle linear, incremental demand, while the virus grows at an exponential rate. Our national health system cannot keep up with this kind of explosive demand without the rapid and large-scale adoption of digital operating models.”²

Leveraging AI to help triage and manage patient workload

The Atellica COVID-19 Severity Algorithm*

Atellica® COVID-19 Severity Algorithm*

- Support to help predict which COVID-19 positive patients may experience severe illness
- Collaboration with healthcare institutions in Atlanta, Houston, NY, and Madrid to collect and analyze de-identified patient data
- Created AI-based algorithm to predict likelihood of:
 - acute respiratory failure
 - end organ failure
 - In-hospital 30-day mortality
- Trained algorithm using combined data source of ~14,500 cases
- Age plus 9 lab biomarkers generated within the first 3 days of hospitalization (D-Dimer, LDH, Lymph %, Eos %, CREAT, CRP, FER, INR, Troponin-I)
- Investigational Use Only evaluations in progress to assess clinical utility and benefit



*In development. Not available for sale. Features listed are development design goals. Future availability cannot be guaranteed.
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Assessing economic impact of a predictive algorithm for COVID-19 disease progression

Evidence about the health economic outcomes of a diagnostic test is often lacking and has been mentioned as a common reason for diagnostics failing to obtain appropriate coverage¹.

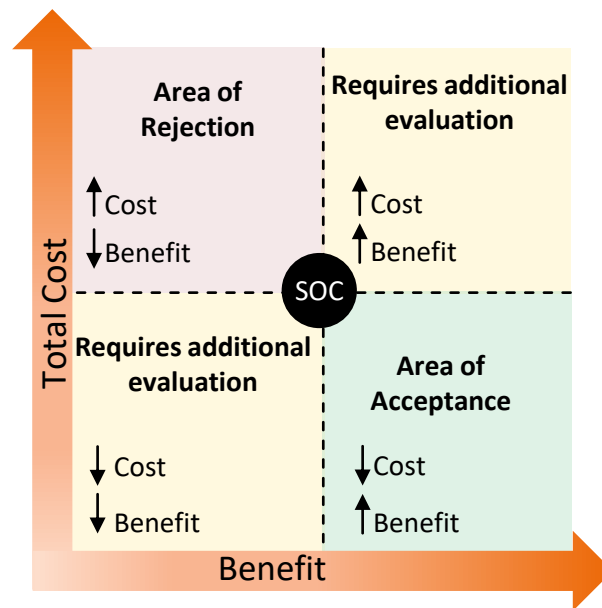
Cost-Benefit Analysis (CEA) of Predictive Algorithm for COVID-19



Costs include:

- ☐ **direct health care costs**
- ☐ **direct non-health care costs** (i.e., transportation, meals for patients/caregivers, loan interest to pay off medical fees, etc.)
- ☐ **indirect costs**, including lost or impaired leisure activity, premature mortality, etc.

Benefit evaluated in non-monetary units (e.g. reduced mortality or morbidity, life years gained)



Considerations for COVID-19 Predictive Algorithm

- Predictive algorithm for COVID-19 that helps identify patients most prone to developing severe disease manifestations likely to be **cost-effective** if it leads to **improved outcomes** relative to all **resources expended**
- Predictive algorithm may result in **cost savings** if it leads to **reduced overall** total health care **costs** via reduced LoS, treatments, etc.
- Diagnostics test cost is a small component of overall health care costs

CEA of a **Predictive Algorithm** for **COVID-19** provides key decision-makers and stakeholders a **quantitative framework** to assess the relative and comparative **benefit** of all health care programs and interventions.

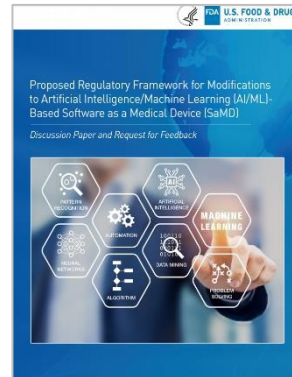
¹Oosterhoff et al. Appl Health Econ Health Policy, 2016. 14:51-65.

²<https://www.nlm.nih.gov/nichsr/hta101/ta10107.html>

FDA started public discussions¹ on how to regulate AI/ML

April 2019

Proposed Regulatory Framework for Modifications to AI/ML Based SaMD



Key Highlights

Define the regulatory framework

1. Defines software as a medical device (SaMD)
2. Categorization by risk and state of healthcare condition (IMDRF principles)
3. Total product lifecycle and quality systems
4. Good machine learning practices (GMLP)

Jan 2021

AI/ML Based SaMD Action Plan



Key Highlights

Outlines five actions and goals:

1. Update the proposed regulatory framework, including a draft guidance on predetermined change control plan;
2. Encourage the harmonized GMLP;
3. Foster a patient-centered approach, including device transparency to users;
4. Develop methods to evaluate and improve machine learning algorithms; and
5. Advance real world performance (RWP) monitoring pilots

¹<https://www.fda.gov/medical-devices/software-medical-device-samd/artificial-intelligence-and-machine-learning-software-medical-device>

Self-driving autos, latter-day EHRs and monsters under the bed. AI will benefit patients and physicians through value-based care.



- Patients and physicians have a **fear of augmented intelligence** analogous to autonomous vehicles and the overpromise of EHRs.
- Artificial Intelligence is not EHR and supports the key aspects of the **Quadruple Aim²**:
 1. Improving the patient experience of care (including quality and satisfaction)
 2. Improving the health of populations
 3. Reducing the per capita cost of health care
 4. **Improving work-life of health care providers**, including clinicians and staff
- Physicians would need to read 13 articles daily to keep up with medical literature
- Physicians that consult AI are in a position to **consider greater medical knowledge**
- Incentives will enable equitable access geographically and socioeconomically
- AI as a companion along the care pathway can help **alleviate challenges with access to care** complicated by a growing shortage of physicians
- Vanquish the monsters under the bed. **Value and invest in** clinical decision making **AI**
- Let's reap the benefits of new standards of care based on operationalizing data for **outcomes that matter to patients**

¹Self driving Uber vehicles. Accessed 2021-04-06 <https://www.businessinsider.com/self-driving-cars-dont-prevent-most-common-accidents-crash-study-2020-6>

²<https://health.oliverwyman.com/2020/02/digital-health-and-its-impact-on-the-quadruple-aim.html>

10 hypothesis on what we can learn from the COVID-19 crisis

- 1 Healthcare will become part of a country's critical infrastructure
- 2 Technology development and production: Global teamwork wins out over independent national initiatives
- 3 More technology and greater efficiency for more humanity
- 4 Expansion of precision medicine
- 5 Facts instead of opinions
- 6 Digital will be the "new normal"...
- 7 Patients will become consumers
- 8 Health will become a community task
- 9 Faster innovation cycles
- 10 Fairer payment

