Digitalization in Healthcare: a new evolution

Dr. Pedro A. Moreno-Sánchez
Dr. Merja Hoffren-Mikkola

16.02.2021

SeAMK

Index

1. Context

- **Threats** of worldwide healthcare systems
  - Demographic change towards aging population
    - "Age-in-place" demands
  - Chronic diseases burden with a tremendous consumption of health resources
  - Decreasing capability of certain groups of people
    - Support for Activity of Daily Living (ADL) solutions and services
  - Covid19 Pandemic Crisis

1. Context

- **Deficiencies and challenges**

  - Healthcare systems are not patient centric.

  - Personalized assistance not provided (focus on population average).

  - Equitably accessibility is not guaranteed.

  - Holistic/data-driven approach to allow evidence-based medical decision.

  - High technical requirements for installing complex IT systems in hospitals.
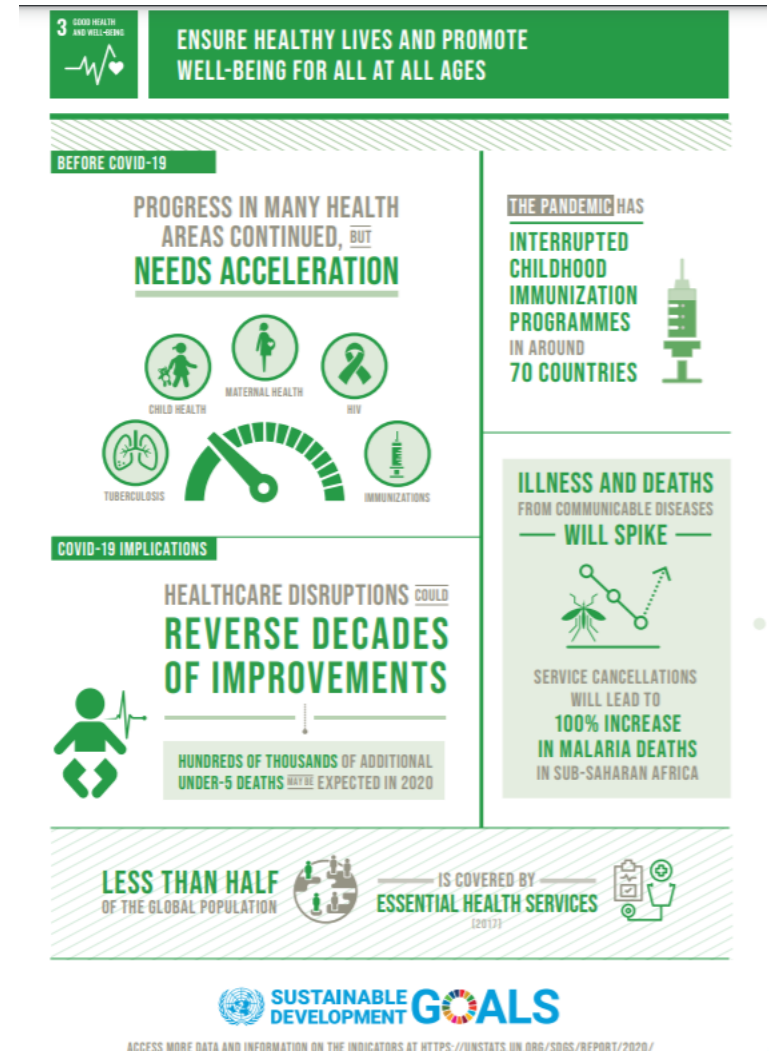
1. Context

- New evolution in healthcare - Hospital of the future

    - Service delivery from a clinic-centric to patient-centric treatment.

    - Healthcare agents are interconnected.

    - New hardware and software services facilitate seamless integration of digital health information into routine clinical practices.

    - Immense volume and heterogenous of medical data (25 billion of Gb in 2020).

2. Health 4.0: digital health new evolution
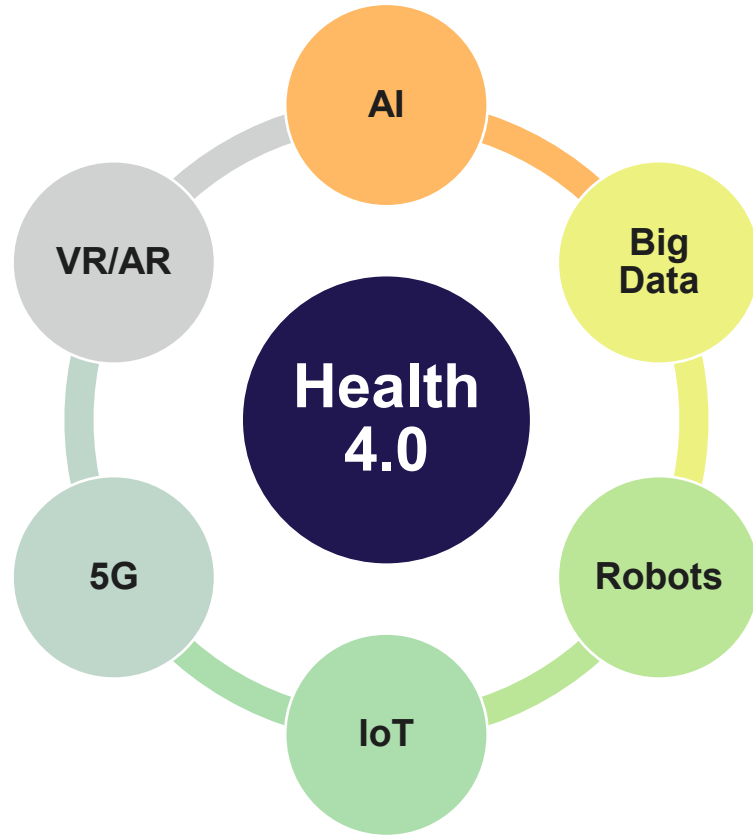
Health 4.0 definition:

- "… refers to the *shift from traditional hospital-centric* care to a more virtual, distributed care that heavily leverages the latest technologies (Wehde et al. IEEE Eng. Manag., 2019)"

- " … promises to transform health by providing more accurate and personalized service. *This personalization of medicine* will boost the emergence of increasingly effective and near realtime treatments " (Lopes et al. IEEE Technol. Soc. Mag., 2019)

2. Health 4.0: 5G

- Positioned as the most appropriate network to deploy health 4.0 services.

  - Brings security, seamless integration, comfortability, personalization, sustainability, scalabilty and smartness

- Applications.

  - Telesurgery

  - Service robots

  - Real-time telemedicine

  - In-home health monitoring

  - Internet of medical skills

2. Health 4.0: Big Data

- Emergence of large and high-quality healthcare datasets.

- **Big Healthcare Data Analytics**

  - Personalized health services

  - Identification of patient care risk

  - Clinical recommendation for patient empowerment

  - Disease prediction models

  - ER workflow enhancement

  - Epidemics tracking

- Challenges:

  - Data quality, privacy, security and interoperability is of high importance in BHDA to ensure confidentiality and integration among existing healthcare IT systems.

2. Health 4.0: IoMT

- **Internet of Medical Things** is an ecosystem of *interconnected numerous personal medical devices-healthcare providers-persons at anytime and anywhere.*

- Benefits
  - Increasing patient empowerment and satisfaction with better health self-management
  - Better health resources management and reducing costs in healthcare

- Challenges
  - Security and privacy vulnerabilities of medical data
  - Lack of interoperability due to heterogeneity of data sources and devices

2. Health 4.0: Virtual / Augmented Reality

- Applications:
  - Medical education and training
  - Surgical simulation, navigation and training
  - Assistive rehabilitation physical and cognitive
  - Reducing acute pain

- Benefits:
  - Real-time performance feedback
  - Involving patients in the decision making or preoperative process

- Challenges:
  - Poor ergonomics of haptics and head-mounted displays
  - Over-informed users that lead to distractions

Health 4.0: Robotics

- *Different types:*

  - Microsurgical robots, robots prostheses, Surgical robots (DaVinci), **Social Assistive Robots (SARs)**, rehabilitation robots, mobile manipulators, patient simulators exoskeletons.

  - Maintaining positive social life of people with health conditions. Reducing stress and anxiety.

- Challenges for robot's adoption in clinical routine:

  - Excessive engagement human-robot (user's privacy and autonomy issues)

  - Healthcare capabilities enhancement vs "Fear" to be displaced or substituted
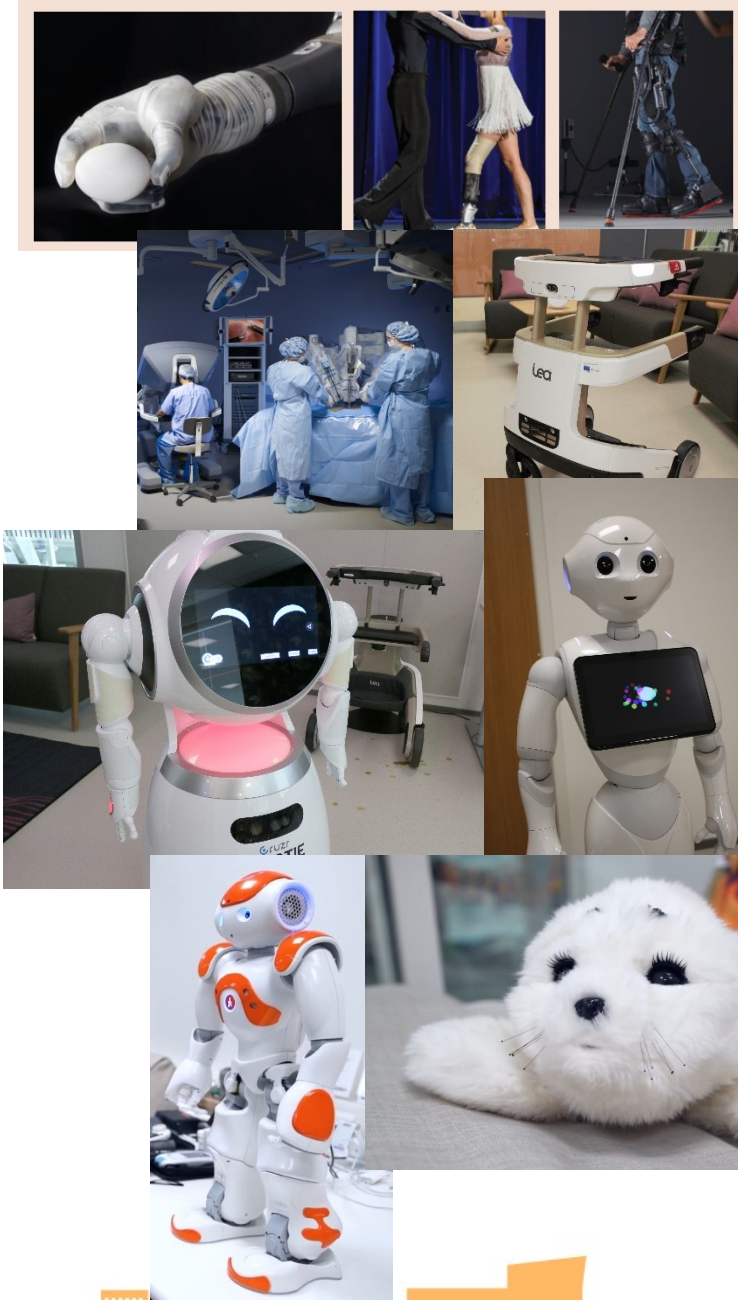
Health 4.0: Artificial Intelligence (AI)

- AI allows discover **underlying features in healthcare** rich but yet underutilized information to achieve the *precision medicine.*

- The **input information** is cornerstone to ensure the reliability of AI algorithms (EHR, medical images, wearables, sensors and smartphones)

- **Biomedical data**: High-dimensionality, domain complexity, heterogeneity, temporal dependency, sparsity, bias, noise, redundancy and irregularity (missing values).

- Applications:

  - Early detection and diagnosis, patient risk predictions, learning embedded medical concepts from EHRs, optimization of existing resources.

Health 4.0: Artificial Intelligence (AI)

- Challenges:

  - Interpretability of AI results to open black-box algorithms → eXplainable Artificial Intelligence.

  - Collaboration AI and healthcare professional's VS "Fear" of being replaced

  - Confidentiality, access authorization and tracking, integrity and availability of patient data.

  - Appropriate infrastructure and interoperability of health information systems; and data standards or regulatory frameworks.

Conclusions

- Health 4.0 technologies are promising solutions to address current and new needs of worldwide healthcare systems. (e.g. Covid19 crisis)

- Numerous challenges to tackle for achieving a fully adoption of these technologies in a clinical routine.

- Patient and healthcare professionals as drive factors of health 4.0 technologies success.

Recent and Current Projects @SeAMK

- **Dialogue, digitalization and networking for Finnish farm workers (2017-2019)**: Self-measurements with wearable sensors to enhance work wellbeing

- **Creation of a multiprofessional simulation coaching concept for SME staff in health and social services (2017-2019):** Coaching programme for professionals, collaboration between the Hospital District and local educational institutions

- **Baltic cities tackle lifestyle related diseases (2017-2020):** New technologies in health promotion interventions, cocreation between health care professionals, customers and IT SMEs

- **@gingOnline (2017-2020):** Creation of mobile application through cocreation process in order to enhance older adults' social relationships and participation in meaningful social activities

Recent and Current Projects @SeAMK

- **Product Validation in Health (2017-2020):** Cooperation between Living Labs in Baltic Sea region, sharing best practices

- **Social and Health care SMEs: pathway to growth (2018-2020)**: Tools to enhance digitalisation in social and health care SMEs

- **Artificial Intelligence, mHealth and Robotics as reformers of the welfare sector in Southern Ostrobothnia (2019-2021)**: To build the demonstration environment, increase the knowledge of social and health care SMEs and their customers

- **Smart, Easy and Independent Living (2019-2022)**: Combine the competences of technical, safety and health care education in order to boost the technological focus in health care education by applying a cross sectoral teaching and learning approach.

Recent and Current Projects @SeAMK

- **INnovation and Technology ENhancing Customer OrIented Health SerVicEs (2019-2023):** European e-health good practices related to elderly population

- **Wellbeing to rural regions (2020-2022):** Culture and physical activity services via remote connections

- **Technological innovations enhancing wellbeing at work (2020-2023):** Increase enterprises' knowledge and expertise on workload and factors affecting it, develop a novel solution to detect and verify strain-factors

Q&A. Discussions

pedro.morenosanchez@seamk.fi
Merja.HoffrEn-Mikkola@seamk.fi

References

- SeAMK's e-magazine:

    - https://lehti.seamk.fi/hyvinvointi-ja-luovuus/augmented-and-virtual-reality-enhance-the-healthcare-experience/

    - https://lehti.seamk.fi/hyvinvointi-ja-luovuus/robots-new-actors-that-will-help-to-meet-needs-of-healthcare-systems-and-patients/

    - https://lehti.seamk.fi/hyvinvointi-ja-luovuus/big-data-as-a-solution-to-exploit-the-enormous-existing-volume-of-health-data/

    - https://lehti.seamk.fi/hyvinvointi-ja-luovuus/internet-of-things-will-contribute-to-shift-healthcare-services-delivery/

    - https://lehti.seamk.fi/hyvinvointi-ja-luovuus/artificial-intelligence-solutions-and-its-impact-in-healthcare-services-part-ii/

    - https://lehti.seamk.fi/hyvinvointi-ja-luovuus/artificial-intelligence-solutions-and-its-impact-in-healthcare-services-part-i/

    - https://lehti.seamk.fi/2020/5g-networks-on-next-generation-digital-health-services/

- Images:

    - https://www.hfmmagazine.com/media/photos/84-the-patient-room-of-the-future

    - https://www.business.att.com/content/dam/attbusiness/briefs/5g-healthcare-ebook-brief.pdf

    - https://www.labnews.co.uk/article/2030711/5g-could-support-telesurgery-during-covid-19-pandemic

    - https://connectedhomeliving.com/cms-proposal-defines-remote-patient-monitoring-encourages-use-in-home-health/

    - https://www2.deloitte.com/fi/fi/pages/life-sciences-and-healthcare/articles/medtech-internet-of-medical-things.html

    - I. Ud Din, A. Almogren, M. Guizani, and M. Zuair, "A Decade of Internet of Things: Analysis in the Light of Healthcare Applications," *IEEE Access*, vol. 7, pp. 89967–89979, 2019, doi: 10.1109/ACCESS.2019.2927082.

References

- Images:

  - https://thelearningrooms.com/elearning-healthcare-industry/

  - https://datafloq.com/read/ten-major-challenges-big-data-analytics-healthcare/3988

  - https://blogs.ucl.ac.uk/pcph-blog/2018/01/23/google-flu-trends-is-dead-long-live-google-trends/

  - https://www.scientificanimations.com/apple-is-making-augmented-reality-more-accessible/

  - https://digitalsalutem.com/healthcare-in-virtual-reality/

  - https://www.medicaldevice-network.com/features/virtual-reality-surgical-training/

  - https://apnews.com/article/35ba06aa00784732969b5ad161e43a3c

  - "CSE Entertainment." https://cse.fitness/en/rehabwall/ (accessed May 13, 2020). M. Shishehgar, D. Kerr, and J. Blake, "A systematic review of research into how robotic technology can help older people," Smart Health, vol. 7–8, pp. 1–18, Jun. 2018, doi: 10.1016/j.smhl.2018.03.002.

  - https://www.carolinaeasthealth.com/services/surgical-services/minimally-invasive-robotic-surgery/

  - https://mc.ai/ai-the-future-of-artificial-intelligence-ai-in-healthcare/

  - https://es.wikipedia.org/wiki/Alan_Turing

  - https://iot.eetimes.com/what-is-ais-impact-on-real-time-data/

  - https://www.mathematica.org/commentary/ethics-and-artificial-intelligence-in-health-care-the-pivot-point

SeAMK

SEINÄJOEN AMMATTIKORKEAKOULU

SEINÄJOKI UNIVERSITY OF APPLIED SCIENCES