Ethical and social impact of Artificial Intelligence in medicine, healthcare and well-being

Prof. Emilio Gómez González (in memoriam), Universidad de Sevilla

Emilia Gómez, European Commission, Joint Research Centre

https://ai-watch.ec.europa.eu/humaint_en

Context

Since 2018

Science for policy report (2020).

Unpublished work (2020-2022)

European Commission, Joint Research Centre, Gómez-González, E., Gómez, E., *Artificial intelligence in medicine and healthcare : applications, availability and societal impact*, Publications Office, 2020, **https://data.europa.eu/doi/10.2760/047666**

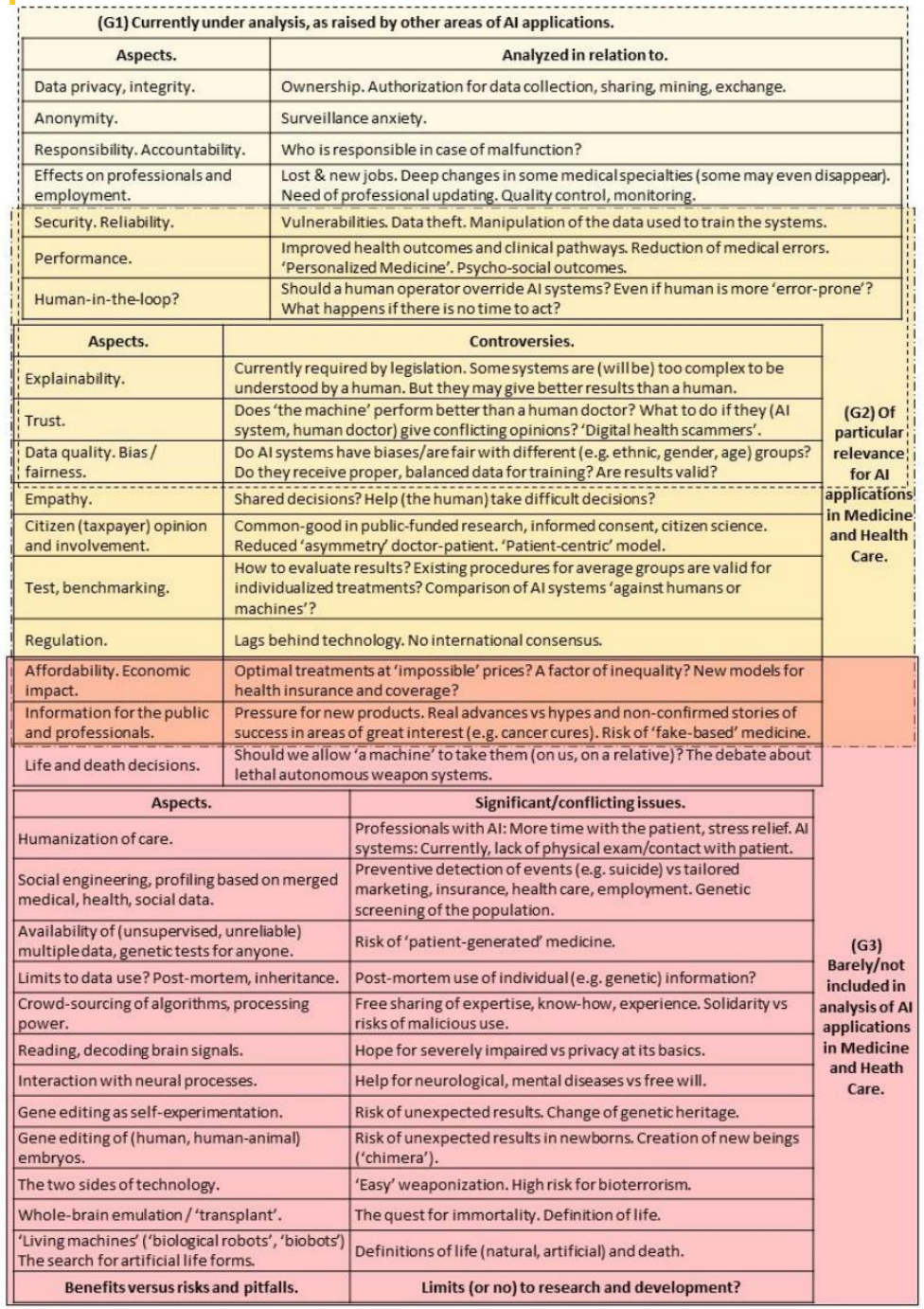
AI and AI-mediated technologies	Specific implementations.	TAL	Social Impact
Algorithms for computer-aided diagnosis.	SW for decision support in (most) clinical areas.	8, 9	Positive
Structured reports, eHealth.	SW for improved workflow, efficiency.	8, 9	
AR/VR, advanced imaging tools.	Tools for information visualization and navigation.	6, 7, 9	
	Image-guided surgery. Teleoperation.	4, 6, 9	
Digital pathology, 'virtopsy'.	SW for automated, extensive analysis.	4-9	
Personalized, precision medicine.	Tailored treatments. Prediction of response.	4-9	
	'In-silico' modeling and testing. The 'digital twin'.	4-8	
	Drug design.	4, 8	
Apps, chatbots, dashboards, online platforms.	The 'digital doctor' (assistance for professionals and for patients).	8, 9	
Companion and social robots.	For hospitalized persons, children & the elderly.	4-9	
Big Data collection and analysis.	Epidemiology, prevention and monitoring of disease outbreaks.	2-9	
	Fraud detection. Quality control, monitoring of physicians and treatments.	4-9	
IoT, wearables, mHealth.	Automated clinical/health surveillance in any environment/institution.	7, 8	
	Monitoring, automated drug delivery.	7-9	
Gene editing.	Disease treatment, prevention.	7, 8	
Merging of medical and social data. 'Social' engineering.	Prevention of episodes with clinical relevance (e.g. suicide attempts).	6, 8	Controversial
	Tailored marketing (e.g. related to female cycles).	6, 8	
Reading and decoding brain signals. Interaction with neural processes.	Treatment of diseases. Restoring damaged functions.	3-8	
	Brain-machine inferfaces.	5-8	
	Control of prostheses, exoskeletons. 'Cyborgs'.	2-7	
	Neurostimulation. Neuromodulation.	4-8	
	Neuroprostheses (for the central nervous system).	2-5	
	Mind 'reading' and 'manipulation'.	1-3	
Genetic tests. Population screening.	Disease tests. Direct-to-consumer tests.	4-9	
Personalized, precision medicine.	Individual profiling. Personalized molecules (for treatment) at 'impossible' prices.	3-8	
Gene editing.	'Engineered' humans.	2, 6	
	Gene-enhanced 'superhumans'.	2	
	Self-experimentation medicine. Biohacking.	2, 6	
Fully autonomous AI systems.	The 'digital doctor'.	2-5	
	'Robotic surgeon'.	2, 4	
Human-animal embryos.	Organs for transplants.	2, 4, 5	
	Hybrid beings ('chimera').	2, 4	
The quest for immortality.	Whole-brain emulation / 'transplant'.	1, 2	
The search for artificial life forms.	'Living machines' ('biological robots', 'biobots')	4, 6	
	Military.	2, 3	
Evil biohacking.	Targeting specific individuals or groups.	1, 2	
Weaponization.	From 'small labs' to military labs.	1, 2	
Bioterrorism.	From 'small labs'.	1, 2	Negative

Diagnosis

Security threads

European Commission, Joint Research Centre, Gómez-González, E., Gómez, E., *Artificial intelligence in medicine and healthcare : applications, availability and societal impact*, Publications Office, 2020, **https://data.europa.eu/doi/10.2760/047666**

European Commission



(G1) Currently under analysis, as raised by other areas of AI applications.

Aspects.	Analyzed in relation to.
Data privacy, integrity.	Ownership. Authorization for data collection, sharing, mining, exchange.
Anonymity.	Surveillance anxiety.
Responsibility. Accountability.	Who is responsible in case of malfunction?
Effects on professionals and employment.	Lost & new jobs. Deep changes in some medical specialties (some may even disappear). Need of professional updating. Quality control, monitoring.
Security. Reliability.	Vulnerabilities. Data theft. Manipulation of the data used to train the systems.
Performance.	Improved health outcomes and clinical pathways. Reduction of medical errors. 'Personalized Medicine'. Psycho-social outcomes.
Human-in-the-loop?	Should a human operator override AI systems? Even if human is more 'error-prone'? What happens if there is no time to act?

(G2) Of particular relevance for AI applications in Medicine and Health Care.

Aspects.	Controversies.
Explainability.	Currently required by legislation. Some systems are (will be) too complex to be understood by a human. But they may give better results than a human.
Trust.	Does 'the machine' perform better than a human doctor? What to do if they (AI system, human doctor) give conflicting opinions? 'Digital health scammers'.
Data quality. Bias / fairness.	Do AI systems have biases/are fair with different (e.g. ethnic, gender, age) groups? Do they receive proper, balanced data for training? Are results valid?
Empathy.	Shared decisions? Help (the human) take difficult decisions?
Citizen (taxpayer) opinion and involvement.	Common-good in public-funded research, informed consent, citizen science. Reduced 'asymmetry' doctor-patient. 'Patient-centric' model.
Test, benchmarking.	How to evaluate results? Existing procedures for average groups are valid for individualized treatments? Comparison of AI systems 'against humans or machines'?
Regulation.	Lags behind technology. No international consensus.
Affordability. Economic impact.	Optimal treatments at 'impossible' prices? A factor of inequality? New models for health insurance and coverage?
Information for the public and professionals.	Pressure for new products. Real advances vs hypes and non-confirmed stories of success in areas of great interest (e.g. cancer cures). Risk of 'fake-based' medicine.
Life and death decisions.	Should we allow 'a machine' to take them (on us, on a relative)? The debate about lethal autonomous weapon systems.

(G3) Barely/not included in analysis of AI applications in Medicine and Heath Care.

Aspects.	Significant/conflicting issues.
Humanization of care.	Professionals with AI: More time with the patient, stress relief. AI systems: Currently, lack of physical exam/contact with patient.
Social engineering, profiling based on merged medical, health, social data.	Preventive detection of events (e.g. suicide) vs tailored marketing, insurance, health care, employment. Genetic screening of the population.
Availability of (unsupervised, unreliable) multiple data, genetic tests for anyone.	Risk of 'patient-generated' medicine.
Limits to data use? Post-mortem, inheritance.	Post-mortem use of individual (e.g. genetic) information?
Crowd-sourcing of algorithms, processing power.	Free sharing of expertise, know-how, experience. Solidarity vs risks of malicious use.
Reading, decoding brain signals.	Hope for severely impaired vs privacy at its basics.
Interaction with neural processes.	Help for neurological, mental diseases vs free will.
Gene editing as self-experimentation.	Risk of unexpected results. Change of genetic heritage.
Gene editing of (human, human-animal) embryos.	Risk of unexpected results in newborns. Creation of new beings ('chimera').
The two sides of technology.	'Easy' weaponization. High risk for bioterrorism.
Whole-brain emulation / 'transplant'.	The quest for immortality. Definition of life.
'Living machines' ('biological robots', 'biobots') The search for artificial life forms.	Definitions of life (natural, artificial) and death.
Benefits versus risks and pitfalls.	**Limits (or no) to research and development?**

(1) Similar, e.g. privacy

(2) Particularly relevant, e.g. explainability

(3) Not addressed, e.g. humanization of care

European Commission, Joint Research Centre, Gómez-González, E., Gómez, E., *Artificial intelligence in medicine and healthcare : applications, availability and societal impact*, Publications Office, 2020, https://data.europa.eu/doi/10.2760/047666

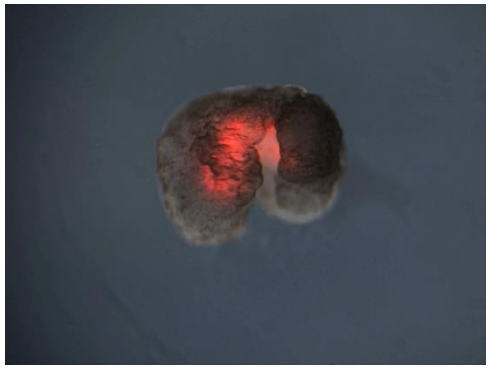
European Commission

8 identified issues

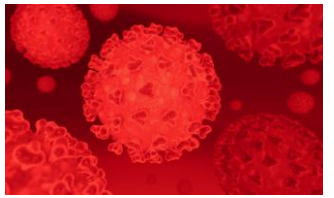
1. Balance between benefits and risks
2. Changes for professionals
3. Empowerment and the new role of patients
4. Data-driven extended personalised medicine
5. Conflict between several types of Medicine: patient generated, scientifically tailored
6. Disinformation, fake medicine, and digital health scammers
7. Affordability and inequality
8. Link with sensitive areas: neuroscience & genetics

From 2020 to 2023

- Covid 19 post-pandemic
- Ucranian war (February 2022)
- 1st documented case of autonomous weapons killing humans (United Nations 2021 - Libya)



- First publication on ‘living machines’ (2020) – xenobots
- The cost of medical errors: US data mentioned 250.000 deaths/year results from medical errors, being the third leading cause of death (vs 39.000 deaths/year due to car accidents (in 2020)).



8 Lessons learnt from covid

1. Telemedicine ha settled: acceptance, stronger tools.
2. Online platforms for psychological support arrived to stay: chatbots, social media.
3. Assistant robots, from reticence to adoption: disinfection, work in contaminated areas, temperature measure, companion and social assistance.
4. Success of AI-mediated drug discovery and genetic data analysis: covid-19 vaccines, PCRs.
5. AI-mediated data analysis to support epidemiology.
6. The boost of AI-mediated personal devices for health monitoring, e.g. sensors, mobile devices.
7. The “failure” of diagnostic AI-mediated tools: data limitations, biases.
8. Society demands trustworthy systems and information.

3 Lessons learnt from war period

1. The potential of eHealth in conflict areas, e.g. training, triage, surgical guidance.
2. The enhanced need to safeguard health data, e.g. genome sequences.
    - Prepare for a ‘rebuild from nothing’ scenario.
    - Secure access, to avoid misuse.
3. New uses of AI, e.g. facial recognition in conflict zones.

Other areas of development

- Personalized medicine
- Trustworthy AI
- Policy documents
  - WHO - Guidance on AI for Health (June 2021)
  - WHO - Digital solutions to health risks raised by the COVID-19 (June 2022).
  - Council of Europe - Neurotechnologies and Human Rights (June 2022)
  - European Parliament - Genome Editing on Humans (June 2022)
  - Creation of the Health Emergency Preparedness and Response Authority (europa.eu) (HERA, July 2022).

5 uses of AI in health with strong social impact

1. Mental health
2. Gene edition
3. Epidemiology and health data monitoring
4. Neurotechnologies
5. Neurodiversity.

Feature	Scale
Maturity	Technology Readiness Level (TRL)
Availability	Technology Availability Level (TAL)
Controversy	Technology Controversy Level (TCL)
Sustainability	Technology Sustainability Level (TSL) for SDG 3
	Technology Sustainability Level (TSL) for all SDGs
Extent of Adoption	Technology Extent Level (TEL)

AI tools for mental health

- Opportunities: detection of mental state and the definition of interventions.
- Risks: manipulation.

Feature	Scale	Value
Maturity	Technology Readiness Level (TRL)	8
Availability	Technology Availability Level (TAL)	9
Controversy	Technology Controversy Level (TCL)	+1
Sustainability	Technology Sustainability Level (TSL) for SDG 3	1
	Technology Sustainability Level (TSL) for all SDGs	0.29
Extent of Adoption	Technology Extent Level (TEL)	6

e-Perinatal: Universal prevention of maternal perinatal mental disorders and its implementation as normalize routine practice', ERC Starting Grant-2021 by Emma Motrico (Loyola Andalucía)

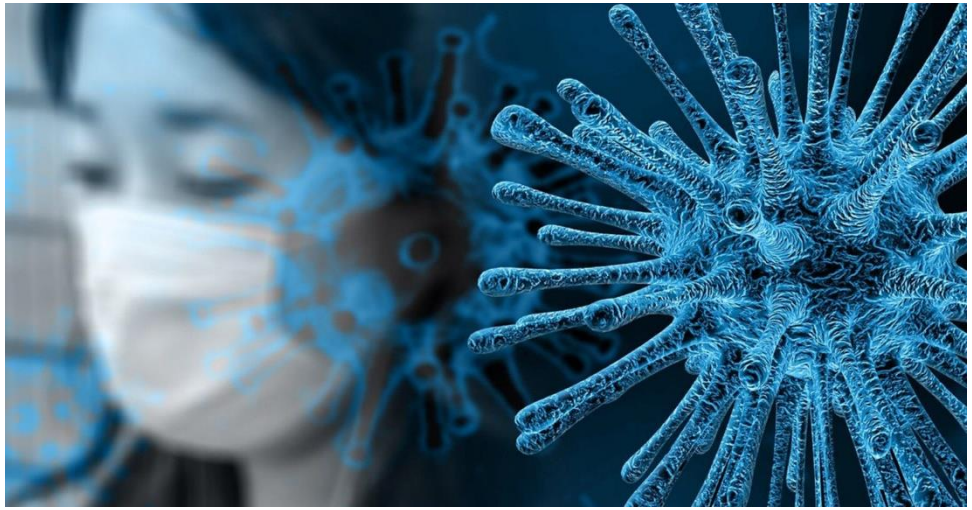
AI-mediated gene edition

- AI technologies to explore genetic information and design synthetic life forms (e.g. viruses), combined with gene manipulation technology (e.g. CRISP) is an area with rapid evolution and strong ethical considerations.
- Opportunities
  - Drug discovery.
- Risks
  - Human augmentation.
  - Development of novel biological threats.

Feature	Scale	Value
Maturity	Technology Readiness Level (TRL)	5
Availability	Technology Availability Level (TAL)	6
Controversy	Technology Controversy Level (TCL)	2
Sustainability	Technology Sustainability Level (TSL) for SDG 3	1
	Technology Sustainability Level (TSL) for all SDGs	0.18
Extent of Adoption	Technology Extent Level (TEL)	4

AI tools for epidemiology and health data monitoring

- Data gathering on a large-scale.
- Opportunities
  - Public health management.
- Risks
  - Social scoring and classificatior
  - Fundamental rights.
  - Conflict situation.



Feature	Scale	Value
Maturity	Technology Readiness Level (TRL)	1
Availability	Technology Availability Level (TAL)	2
Controversy	Technology Controversy Level (TCL)	3
Sustainability	Technology Sustainability Level (TSL) for SDG 3	1
	Technology Sustainability Level (TSL) for all SDGs	0.17
Extent of Adoption	Technology Extent Level (TEL)	2

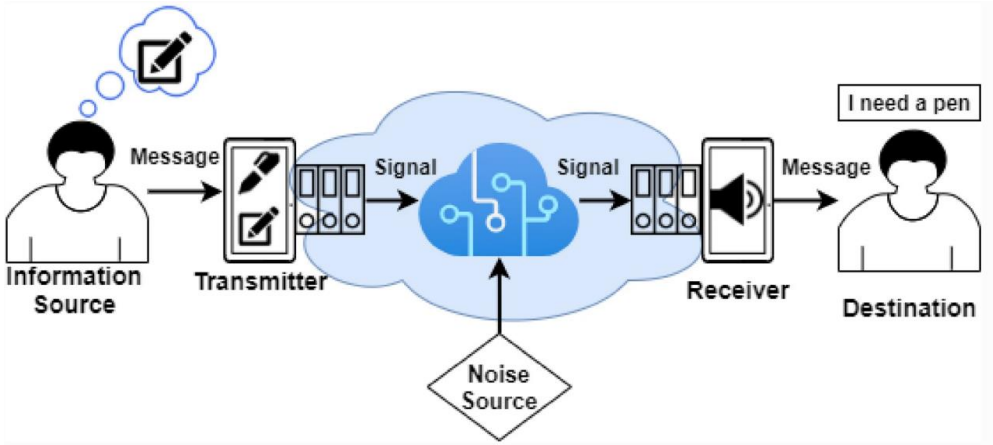
AI-mediated neurotechnologies

- Reading, decoding and manipulation of cognitive signals of the human brain.
- Opportunities
  - Improved control of prosthesis and brain-computer and machine interfaces.
- Risks
  - Non-invasive intrusion in persons' minds, cognitive surveillance.
- Neuroethics, neurorights.

Feature	Scale	Value
Maturity	Technology Readiness Level (TRL)	3
Availability	Technology Availability Level (TAL)	4
Controversy	Technology Controversy Level (TCL)	1
Sustainability	Technology Sustainability Level (TSL) for SDG 3	1
	Technology Sustainability Level (TSL) for all SDGs	0.24
Extent of Adoption	Technology Extent Level (TEL)	1

AI-mediated inclusion of neurodiversity.

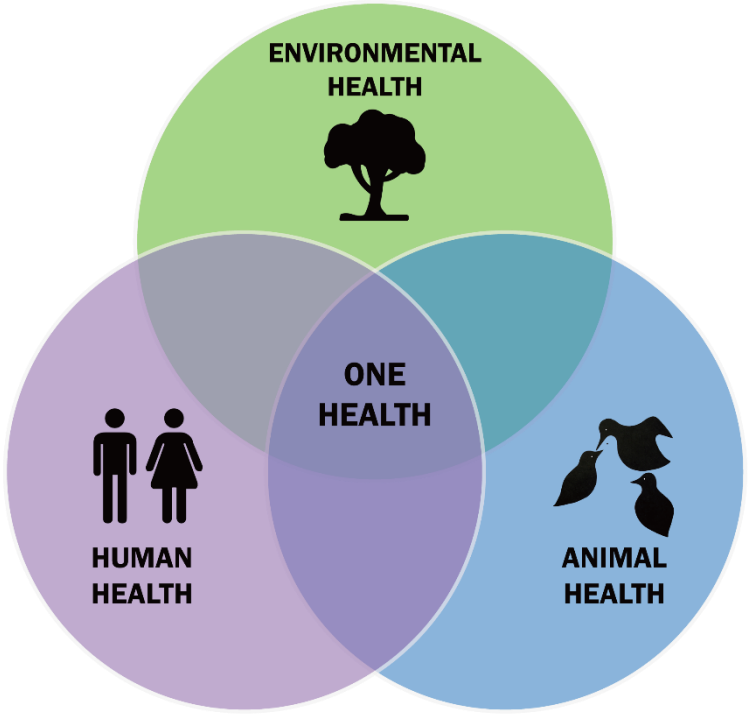
- Autism spectrum, Dyslexia,...



Feature	Scale	Value
Maturity	Technology Readiness Level (TRL)	1
Availability	Technology Availability Level (TAL)	2
Controversy	Technology Controversy Level (TCL)	-3
Sustainability	Technology Sustainability Level (TSL) for SDG 3	1
	Technology Sustainability Level (TSL) for all SDGs	0.3
Extent of Adoption	Technology Extent Level (TEL)	0

Conclusions

- Promote One Health
- Minimize risks and leverage oportunities
- Ensure data protection in conflict scenarios.
- Carry out risk assessment in terms of social impact.
- Define a precautionary approach for R&D in certain domains
- Foster institutional and international collaboration
- Promote trustworthy information and an educated citizen debate
- Towards the technological sovereignty



Ethical and social impact of Artificial Intelligence in medicine, healthcare and well-being

Prof. Emilio Gómez González (in memoriam), Universidad de Sevilla

Emilia Gómez, European Commission, Joint Research Centre

https://ai-watch.ec.europa.eu/humaint_en