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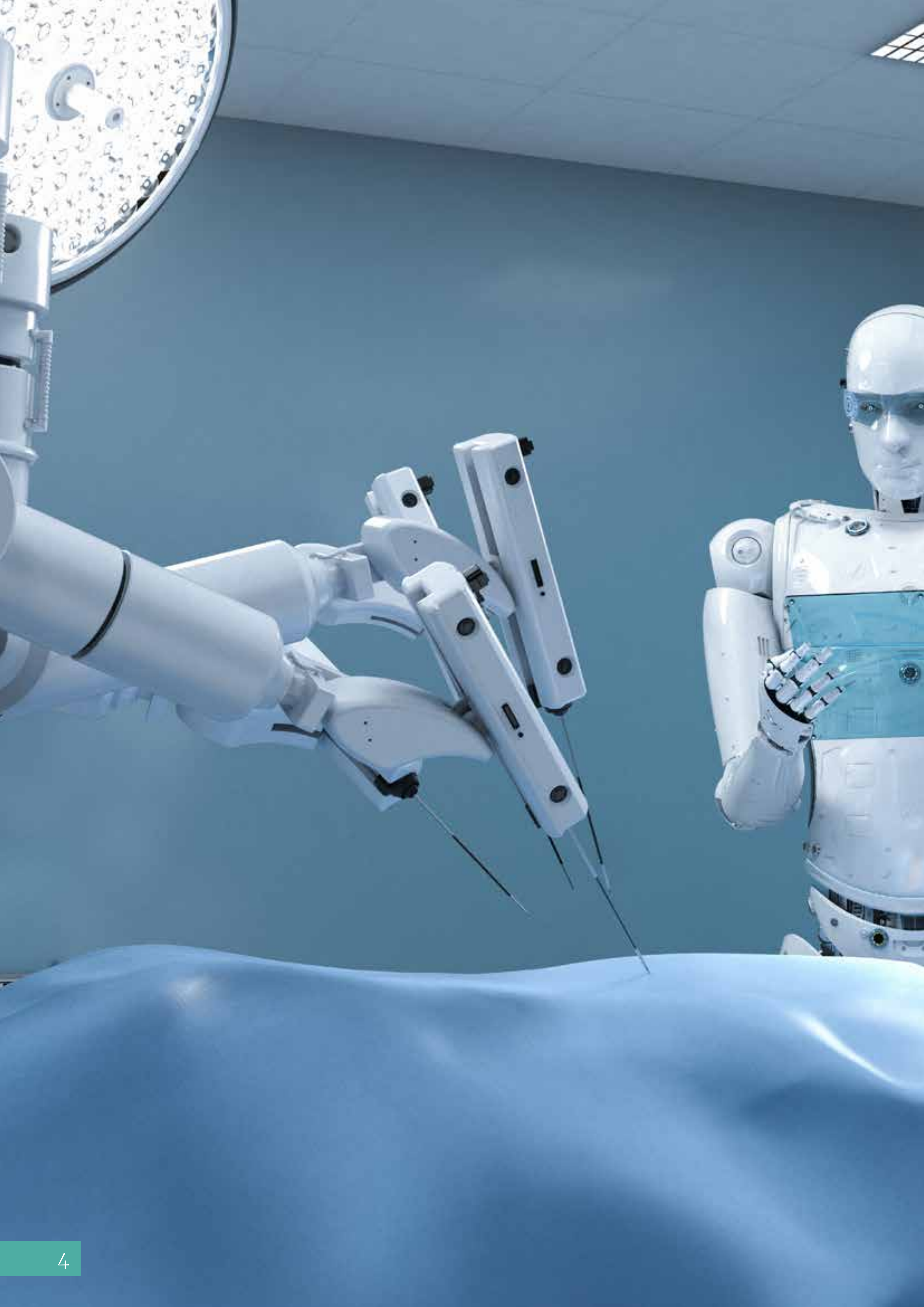

Towards a new standard of health services

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The Fourth Industrial Revolution (Industry 4.0) is blurring the boundaries between the physical, digital and organic worlds. The development of technologies aimed at capturing and exploiting data to optimize and automate decisions and actions promises to radically change the world in which we live. In recent years, IoT sensors, 3D printers, robotics and artificial intelligence have contributed to generating realities that until just a decade ago seemed like only visionary ideas, almost as if they were science fiction.

Healthcare, and especially where innovation plays a leading role in reducing costs and optimizing processes, is a sector that has become particularly receptive to this opportunity. Moreover, the recent pandemic, with the enormous pressure exerted on even the more advanced health systems, has transformed this sense of opportunity into a more important necessity. The integration of some of the above-mentioned technologies in the drug evaluation processes—from risk prediction to diagnosis, and from prognosis to therapy—combined with new discoveries in the field of genetics became an important resource during the darkest days of the pandemic crisis, actually accelerating processes that would have previously required more time and resources, both human and economic.

In the short term, this process could lead to the complete conversion of two of the fundamental pillars of the current healthcare standard:

a. transferring attention, in practice, from treatment to prevention;

b. abandoning the one-size-fits-all approach, thus leaving space for personalized, precision and participatory community medicine.

In this issue of e-Health Innovation, we have put together a review of international interventions that can offer the reader a broad and detailed overview of the technological transformations that are affecting the healthcare sector globally, looking at these critically and based on the most recent scientific evidence in the case of the use of artificial intelligence algorithms.

Despite enormous national differences, the entire planet has embarked on a path of digitalization that seems to have passed the point of no return. The US is driving it, compelled by the need to stimulate the private system to adopt the value-based healthcare rationale in which healthcare service providers are compensated not according to the amount of services offered, but on the basis of the outcomes obtained in relation to spending, both in the short and the long term (for example, through data analysis). The US case is therefore the largest national outpost for the adoption of new technologies in the healthcare sector, considering that the US spends almost 17% of GDP on healthcare (5% private), i.e., more than 3.7 trillion dollars (about 10 thousand dollars per capita), with a growth trend forecast for the next decade. Healthcare spending is therefore one of the major drivers for adopting new models and technological tools in healthcare. Asia and Europe follow the US, driven respectively by the need to expand the population base that is able to benefit from healthcare services (democratization) and the need to make the inexorable demographic trend of an aging population sustainable, which increases pressure on the healthcare system. On the other hand, it is estimated that an individual who is over 65 uses three times the number of services used by a citizen of working age and five times those of a child.

The following will therefore be a path that analyzes the most interesting aspects of the use of artificial intelligence algorithms in healthcare. A *common thread* that runs through the most significant trends, describing processes and models that, in practice, are benefiting most from the adoption of synthetic intellects and big data analyses. To provide a clear and prospective overview, able to support even the least experienced reader, we have selected researchers from economic, medical and engineering disciplines, with the intention of communicating the disruptive transformation that is taking place using scientific language and according to the most recent evidence from literature.

Our attention will be guided by the drivers that are forcing the new care needs globally—i.e., the economic, demographic and managerial aspects—to the more strictly clinical aspects, from prevention to diagnosis, as quickly as possible, up to the discovery of new treatments and the personalization of treatments, particularly from a pharmacological point of view. We will discuss bioethics, which unites and distinguishes human intellect and artificial intelligence, and we will then turn to mental health and the most up-to-date epidemiological analysis models, which played such an important role during the pandemic crisis caused by SARS-CoV-2. Future topics dealing with space and the protection of health outside of the earth's orbit will also be part of the discussion.

Our ultimate aim is to stimulate the study, understanding and analysis of the subject matter among clinicians, surgeons, healthcare providers and managers. We aim to instill awareness, shared by the international scientific community, that healthcare is close to a paradigm shift like never before, focused on the data evidence.

Ours is a project that starts with research and is aimed at catalyzing a community that is capable of actively translating the technological innovation we are witnessing into a tool for ensuring health protection.

Artificial intelligence in the healthcare sector: analyses and economic prospects

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Artificial intelligence (AI) has been defined as an exponential technology that is used in various sectors and that could have a significant economic impact in the next ten years. In particular, there has been a lot of attention on the impact that AI could have on healthcare, a sector that is faced with some difficulties, such as a growing expenditure and demand for healthcare services in the face of an increasingly elderly population and a rigid healthcare offering. Given the returns in recent AI applications in the sector, particularly in *imaging* and diagnostics, global investment in AI-healthcare start-ups has grown exponentially in recent years, but Europe is still a long way from seeing the same results as the US market. In any case, despite the various applications and the increase in productivity expected for the healthcare sector, there are still some critical issues to face, ranging from living with and trusting data-driven technologies, to the ethics of potentially having to interact with automatic/robotic decision-making mechanisms, up to the actual difficulty of obtaining data with which to operate on a large scale. Finally, if at the macroeconomic level the application of AI can lead to *displacement*, i.e., to the replacement of workers with technology, the healthcare sector would not suffer any potentially negative impact, but would benefit more given the current and future shortage of medical staff in the face of a growing health demand.

The critical issues of the healthcare system and the economic-social landscape

The healthcare system in Western countries is in a significant transitional phase. Many studies show this is becoming increasingly less sustainable and that there is a need for a paradigm shift in the management, allocation and provision of healthcare services.[1] The main critical issues that make the healthcare system unsustainable are somehow interconnected, and are the following:

1. aging of the population;
2. growing healthcare expenditure;
3. inefficiencies in the healthcare sector

1. The world's population is getting older. Specifically, focusing on the Western world, it is now clear that people live longer and have a greater life expectancy at birth, and this in itself is an excellent result. Overall, however, the increase in life expectancy is not balanced by a simultaneous increase in the birth rate, which is in fact in constant decrease, and this entails sustainability problems for welfare systems in the main Western

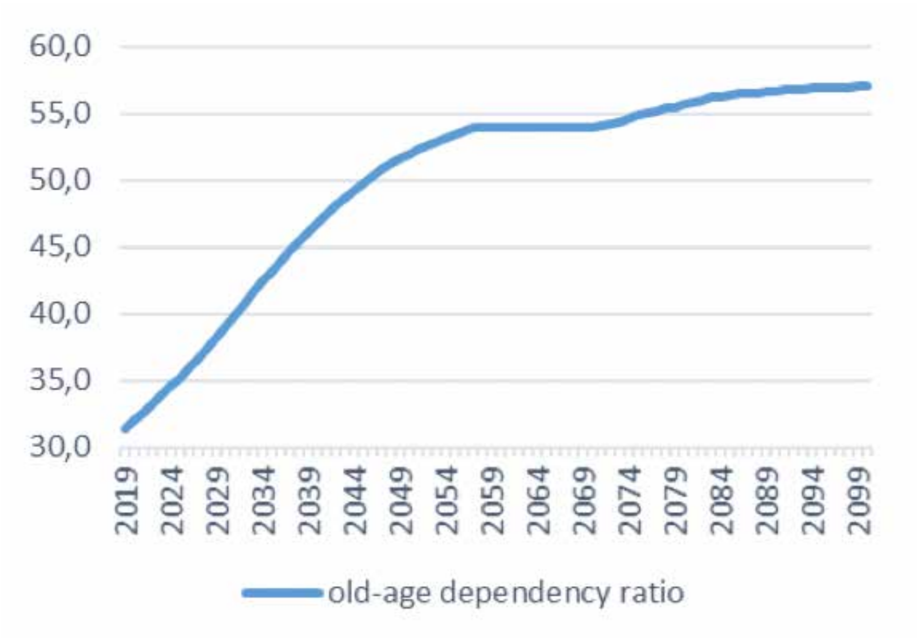

Figure 1. Old-age dependency ratio (UE27 Average) projection - Data source: Eurostat.

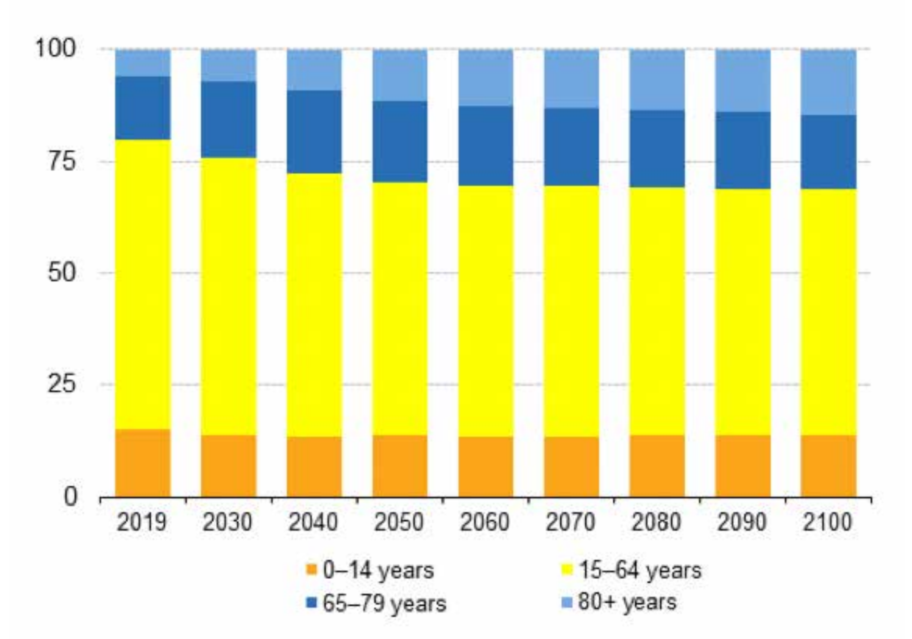

Figure 2. Population structure by age group, EU-27 (% total population) - Data source: Eurostat.

countries, particularly in Europe. This is a problem because, in the face of an increasingly elderly population (over 65 years of age), there will be a smaller population of working age people (15-65 years of age) that can contribute to healthcare and social security costs. The data on the population trend is not encouraging: looking at the European average, the *old-age dependency ratio*, i.e., the percentage ratio between those over the age of sixty-five compared to the working age population, was standing at 31.4% in 2019, or for each "elderly" (retired) person, there are about three workers who generate income to pay social security and welfare expenses. These projections indicate an increasing trend in the index, which will reach 50% over the next 25 years (Fig. 1).[2] Furthermore, analyzing the average age of the population between 2009 and 2019, it can be seen that this is growing in all European countries (except in Sweden). With an average age of 43.7 years, Italy is the oldest country on the continent and one of the oldest in the world, whose population is expected to decrease due to the decrease in the birth rate from 60.6 million residents in 2017 to 54.1 million in 2065.[3] Therefore, the scenario that awaits is clear: a less populous society, consisting of older people (light and dark blue bars, Fig. 2) and relatively fewer people of working age (yellow bar, Fig. 2).

2. It is easy to understand that the direct consequence of an older population is a growing healthcare expenditure. The trend in healthcare spending in Europe shows how, starting in the 2000s, it has grown steadily, going from less than 1,500 dollars at the beginning of the century to over 3,000 dollars per capita in 2018 (blue curve, Fig. 3). The same increasing trend is visible in the relationship between domestic healthcare spending in relation to GDP: in this case, it went from 6.5% to approximately 7.5% following the financial crisis of 2009, and then stabilized at about average until 2018 (orange curve, Fig. 3). The increase in the relationship between healthcare spending and GDP in 2009 is arithmetically justified by the denominator effect given the drastic reduction in income in all EU countries with equal expenditure. The growth in healthcare spending over this period of time has also been confirmed in Italy: since 2000, healthcare spending has grown by 69% in nominal terms and 22% in real terms, considering inflation. The largest increase, in line with European data, was in the first ten years of 2000, going from 68.3 billion to 113.1 billion euros in 2010, and then stabilizing until 2018.[4]

3. The healthcare sector is not very efficient. In addition to the obvious increasing trend in healthcare expenditure, in the face of an increasingly elderly population affected by chronic diseases, which represent the cause of 60% of deaths,[5] the healthcare sector is affected by many inefficiencies, in which historically a true and proper managerial approach has never been adopted. In fact, the WHO estimates indicate that for every 10 euros of expenditure, about 2 euros represents possible waste, and this is up to 5 euros in the United States (Berwick and Hackbarth, 2012). This style of management has become the center of a debate among experts, and an alternative that is increasingly popular is the *value-based approach.*[6] Created by M. Porter, the value-based approach is seen as the return in terms of health results, resulting in well-being and overall health, compared to the resources invested and the costs incurred. On the one hand, this approach would enable us to put a price on the services according to the value offered, and on the other hand, make the healthcare system more efficient overall, identifying areas of overuse of resources, inefficiencies and lack of coordination.

Keeping these critical issues in mind, it is essential to define possible developments in the healthcare system thanks to the application of new technologies. Despite the vastness of technological innovations at the service of healthcare, this analysis focuses on the potential of artificial intelligence (AI), one of the most disruptive technological innovations, which is receiving particular interest from private and institutional investors worldwide, especially due to the high returns and current efficient applications in the healthcare sector.

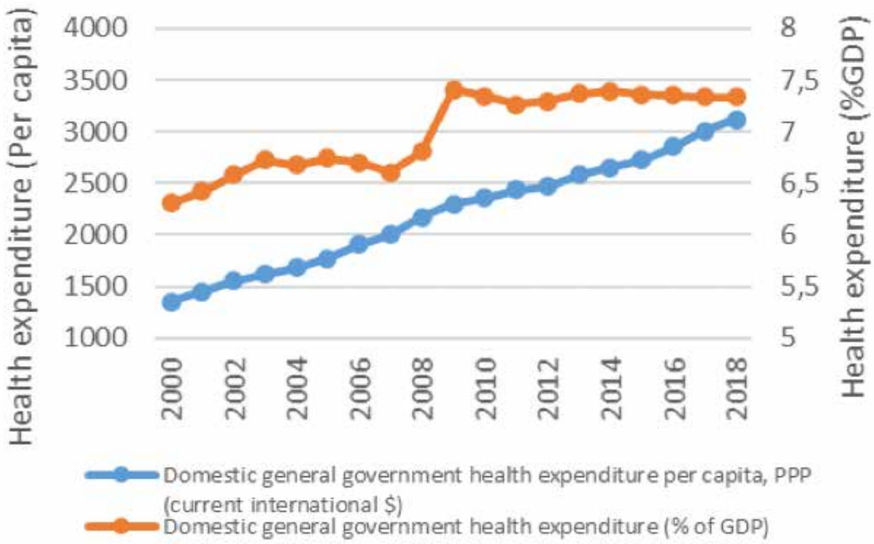

Figure 3. Health expenditure trend (UE27 Average) - Personal processing based on Eurostat data.

AI for the Development of Healthcare

AI is being used in various areas and production sectors, and analysts largely agree that its aggregate impact on the economy will be significant and exponential:[7] by 2030, world GDP will potentially grow by 14% thanks to AI, with an additional annual average growth of 1.2%; moreover, 70% of companies globally will adopt at least one AI application in their own business model.[8]

In particular, AI has enormous potential and is immediately applicable in healthcare, to the extent that, according to a PwC report, it is the sector in which AI will find the greatest applicability.[9] Based on existing literature, there are mainly four categories of AI application in healthcare:

1. diagnosis and classification;
2. assessment of the risk of mortality or morbidity;
3. prediction, treatment and management of the disease;
4. monitoring of results and policy-making.

In each of the four areas of application, AI provides the opportunity to save time and substantial financial resources for healthcare workers, resulting in increased value and productivity. In practical terms, AI applications in medicine can be classified in several ways, such as those reported below:[10]

- By means of wearable accessories (wearables), such as bracelets and *smart watches*, it is possible to monitor health indicators and prevent various diseases;
- By means of imaging, diseases such as cancer and respiratory diseases can be identified and diagnosed;
- Thanks to *big data* analyses and the accuracy of forecast, testing and classification analyses, AI makes laboratory research less expensive and more efficient;
- *Physiological monitoring* through AI enables the monitoring of health status and potential anomalies;
- With *real world data* (RWD), i.e., large-scale population databases, AI can be useful for analyzing the efficacy of new drugs;
- *Virtual caregivers* can support professionals in their contact with patients and with remote medicine. Some examples are bots or *smart speakers* used to transcribe clinical data and extract information automatically, saving significant time and resources;
- Customized *apps* provide for a continuous analysis tailored to the patient, so as to influence their daily habits through devices and with remote virtual nurses;
- Finally, *robotics* can support professionals and technicians in various areas, such as in assisted surgery.

More generally, it can be argued that AI applications lead to a reduction in inefficiencies and increased resources available to those who adopt it in their production environment. The potential effects of AI in the healthcare sector can be divided into short, medium and long term. In the short term, AI is easy to apply and enables care and contact practices with patients to be sped up, as well as the rapid transcription and classification of clinical data. In the medium term, we can expect a deeper penetration of AI into diagnostic choices based on *big data*analysis and greater use of remote medicine. In the long term, robotics may support, or even replace, professionals in the analysis and surgical treatment of patients. Due to the consequences of the above two issues, the debate about AI in healthcare is open, ongoing and raises some concerns, which will be discussed in the final section of this analysis. Despite this, several economic indicators show a growing enthusiasm in the AI market, particularly in the healthcare sector. The direct economic effects that AI can have in the healthcare sector can be evaluated based on the amount of financial resources saved and the greater time available to medical staff. The potential financial resources saved annually, on average between the various European countries, also considering opportunity cost, amounts to approximately 200 billion euros.[11] These results are in line with those of the US market, where a net estimated savings of approximately 150 billion dollars per year is expected up to 2026.[12] Thanks to AI applications, Goldman Sachs estimates there will be 45 billion dollars in cost savings per year in the healthcare sector.[13] The most substantial savings, in terms of financial resources, are obtained through the application of AI in laboratory testing, with wearable accessories (*wearables*) and in monitoring. Added to this is the time saved by workers who, using virtual assistance technology such as voice-to-text transcription, experience time savings of 17% for physicians and 51% for nurses.[14] The most common AI applications, which represent those with the most funding, are those that apply AI with wearable accessories (wearables) and imaging techniques for diagnosis.

AI financial overview in Europe: investors and companies in the healthcare sector

As mentioned at the beginning of the previous section, the market for AI companies is growing exponentially given the potential economic impact. Globally, AI can contribute more than 15 trillion dollars by 2030, with around half of this coming from productivity growth (9.9% increase and 11.5% GDP in North and South Europe respectively).[15] Given the lack of empirical evidence available, these projections are processed using simulations of general economic equilibrium models, and, despite this, there appears to be unanimity among researchers on the huge impact of AI on the economy.

This has pushed many investors, especially private investors such as venture capitalists, but also public investors, to bet on start-ups that use AI. The panorama of companies using AI is growing sharply in Europe, although our continent is still far from the size of the US market, which leads in the number of start-ups operating with AI. In Europe (UK included), there are 769 start-ups in the AI field, distributed mainly between the UK (245), Germany (109) and France (106).[16] The United States has about 1,400 AI start-ups, equal to 40% of the world's total start-ups, based primarily at hubs in San Francisco, Bay Area and New York-Boston. The absence in the European market of big technological players is a clear disadvantage in the financing of AI start-ups by private investors, and this justifies the fact that, in 2016, six times less was invested in artificial intelligence in Europe than in the United States. For this reason in recent years, in addition to the investments planned within the Horizon 2020 program, the EU has put a real and proper plan in place to attract financial resources into AI. The European Commission presented the Digital Europe Programme, a 7.5 billion euro program to make European companies more digital, 2.1 billion euros of which has been allocated to AI companies.[17] Furthermore, at the end of 2020, the European Investment Bank (EIB) and the European Investment Fund (EIF) made 150 million euros available to support AI companies across Europe.[18]

As mentioned above, the potential of AI can therefore be observed in the healthcare sector, where various applications have already been tested. Globally, funding to start-ups using AI in the medical-healthcare sector is growing exponentially: compared to 2014, the year in which the market was valued at 600 million dollars, the 2021 expected value increased 11 times, equal to 6.6 billion dollars, with an average compound annual growth rate (CAGR) of 40%.[19] An estimated similar rate of growth in the AI-healthcare market (39.4%) is foreseen by *Global Market Insights*, which estimates a revenue of over 10 billion dollars worldwide by 2024.[20] Furthermore, the number of *deals*, i.e., financing agreements concluded between start-ups and *venture capital*, more than tripled in 2019 compared to 2015 (Fig. 4). Among these start-ups, 29% applies to AI for *imaging* and diagnosis.[21]

In order to recover ground compared to the US market, the EU is financing the *EIT health investment network* in order to accelerate the funding phase for promising start-ups that apply new technologies such as AI in the healthcare sector, with funding of between 500 thousand and 10 million euros.[22] In the past year, EIT has financed various start-ups for an amount of 18 million euros. Among the promising European start-ups in the AI-healthcare sector that have received financial support from EIT, we find (in the field of medical imaging): *Gleamer*, a French start-up funded for 7.5 million euros, which develops AI-based software to track abnormalities in medical images to increase the productivity of radiologists; *InHearth*, a French start-up that collected 3.7 million euros for the analysis of cardiac status through medical imaging and AI; and QUIBIM, a Spanish biotech start-up funded for 8 million euros, which develops biomarkers for imaging. Some start-ups were also funded in Italy by EIT: one is *Riatlas s.r.l.*, a spinoff of the Università di Salerno [University of Salerno], which exploits AI for precision medicine; another is *Restorative Neurotechnologies*, a spinoff of the Università di Palermo [University of Palermo], which has collected one million euros of investment to develop medical devices (Mindlenses Professional) for cognitive rehabilitation. In addition to those just mentioned, there are many other start-ups that apply AI to healthcare, and the largest operate primarily in the US market.[23]

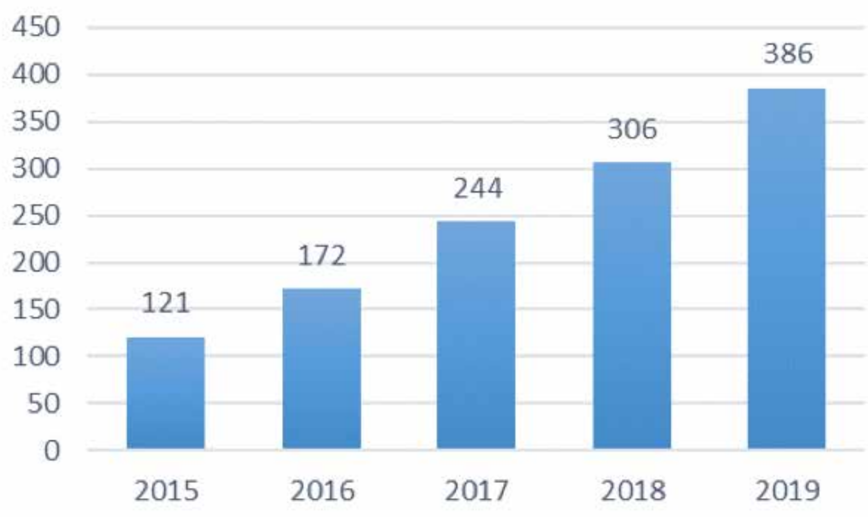

Figure 4. Health expenditure trend (UE27 Average) - Personal processing based on Eurostat data.

Critical Issues and Challenges

Although artificial intelligence can have a positive and significant impact on transforming the healthcare sector, there are some important cultural and social challenges to be faced. These range from educating direct stakeholders, such as patients and physicians, to living with and trusting data-driven technologies, to the ethics of potentially having to interact with automatic/robotic decision-making mechanisms, to the actual difficulty of obtaining data with which to operate on a large scale.

This last point is particularly critical. For many people, the combination of privacy and health has always been considered a real dichotomy; in fact a fundamental question to consider when it comes to technological innovation in healthcare is the recording or archiving of a substantial amount of sensitive data (personal and healthcare), for which correct security must be ensured. In Italy, the directive that governs the processing of personal data in the healthcare sector is 95/46/EC. This directive was subsequently repealed and amended by the European Parliament and Council in 2016, with the *General Data Protection Regulation* (GDPR) note, which came into force on May 25, 2018, which highlights the points relating to specific consent and information regarding the use, correctness, confidentiality and responsibility relating to data processing. It is essential to remember that the same directive already had some exceptions, prior to Art. 14 of Legislative Decree no. 14/2020, which made it possible to grant authorization for the processing of personal data in a simplified manner in specific cases, such as reasons of relevant health-related public interest.
The discussion in relation to data management and security is one of the biggest challenges to start with in order to better integrate artificial intelligence into healthcare. The strength of AI, which can be seen as an engine for the transition of healthcare, is represented by the amount of data available and its ability to process and learn over time. For this reason, in order for the impact on the healthcare sector to be significant, policy makers have the task of creating the conditions to ensure the correct collection, sharing and safekeeping of data, on the one hand to protect public interest through big data-based healthcare innovation and research, and on the other hand to protect the interest of the individual with regard to their privacy. On this matter, the European Union, with the *Digital Europe Programme*, will invest more than 2 billion euros in artificial intelligence by 2027 with the aim, among others, of creating a European Data Space to ensure the interoperability of the data, with secure access and accurate storage of large databases in respect of privacy.

Some reflections on the impact of AI on productivity and work

As mentioned previously, poor empirical evidence may be a critical factor in making accurate predictions on the impact of AI on the economy. Yet, there is unanimity among researchers that AI can increase the average level of productivity of workers. Although this is a goal to be achieved for the well-being of the economy, especially in countries such as Italy where productivity growth is now stagnant, it may involve contraindications from a social point of view, particularly in the short term: transition and implementation costs and an increase in the unemployment rate, resulting in an increase in public expenditure in subsidies. To better understand this dynamic, we examine the index that is most used in practice to assess the well-being of a society: the per capita GDP (y). This is given by the ratio between total income or added value in production (Y) and population (P). This indicator can in turn be broken down as a product of two sub-indicators, as shown in Equation 1:

Eq. 1: Breakdown of the per capita GDP

$$\frac{Y}{P} = \frac{Y}{L} * \frac{L}{P}$$

Where L represents the number of employees.

The first ratio, $\frac{Y}{L}$, represents work productivity, i.e., how much on average a worker produces for each work unit (hour); the second, $\frac{L}{P}$, represents the employment rate.

Karabarbounis and Neiman (2014) show how the labor share (ratio between work and added value) has actually decreased continuously since the 1980s, mainly due to the relative convenience of the ICT technological production factors compared to the work factor. Autor and Salomons (2017) examine the inverse relationship between productivity growth and employment level in a panel of 19 countries for more than 35 years, confirming the theory of substitutability between technology and work.

Yet, despite the many arguments supporting the substitutability between work and innovation, in this case AI, the idea that the inverse relationship between productivity and work is only verified in the short term is widely accepted. Gregory et al. (2018) confirm the effect of replacement and reduction of employment in Europe between 1999 and 2010, but demonstrate how the complementary effects of innovation outweigh the short-term employment decline for an aggregate positive technology impact. This supports the stylized fact-based thesis of Kaldor's economic growth (1961), according to which the long-term unemployment rate remains stable.

Regarding the role of AI in the labor market, Acemoglu and Restrepo (2016) confirm the *displacement* effect, with an increase in labor productivity and wages against a relative reduction in the labor share of national income. However, this thesis was subsequently criticized due to the fact that AI, unlike the technological innovations used in empirical research, is an unrivaled factor. For example, robots are rival production factors because they can only be used for one task in

one location, while algorithms can be applied cross-sectionally and exponentially once created.

In any case, the debate is open, and many research studies indicate that the healthcare sector faces a potential shortage of medical staff, particularly nursing and technical staff, to meet the growing demand for healthcare services in the face of an increasingly elderly population. In healthcare, there is already excess demand compared to supply. As confirmation of this, in the US healthcare system, the number of vacant places for nurses in 2020 was over 1 million units, and approximately 20% of the estimated demand excess will be able to be met by AI applications by 2026.[24] For this reason, unlike many other sectors, healthcare would not suffer any potentially negative impact of the displacement effect, but would benefit more given the stringent supply of healthcare services. AI can drastically reduce workloads, and this would cancel out any expected *shortages* in healthcare and clinical staff over the short and medium term.

All macroeconomic forecasts indicate that, in aggregate, the impacts of AI will be significantly greater than the "destroyed" part of the economy. Yet a major challenge for policy makers is to predict how these will be distributed across sectors and the categories of workers (skilled/unskilled) to make the impact less distorting and as fair as possible. In fact economic literature evidences the phenomenon whereby technological improvement is not neutral on the employment factor, but changes its composition in favor of more skilled workers (SBTC), or those who carry out more complex tasks (TBTC).[25] This makes the distribution of income from work more polarized, resulting in a reduction in middle class income.[26]

For this reason, in addition to the critical issues listed in the previous paragraph, it is essential that institutions strive to implement redistributive policies between the AI winners and losers, move taxation from work to capital, as indicated by Korinek and Stiglitz (2017), and support workers in the transition phase for potential re-skilling and reintegration into the labor market.

NOTES

[1] Atella V., Kopinska, J., (2014) "Health care policies and aging: challenges for the system sustainability", Italian Journal of Pharmacoeconomics and Pharmacouse 2014.

[2]Source: Eurostat

[3] Source ISTAT: https://www.istat.it/it/files//2018/05/previsioni_demografiche.pdf [https://www.istat.it/it/files//2018/05/forecasts_demografics.pdf]

[4] Gerotto, L. (2020): "The evolution of healthcare spending" Italian Public Account Observatory.

[5] World Health Organization, Global Report: "Preventing chronic diseases: a vital investment"

[6] Pasquale Cacciatore et al., (2017) "Value based Healthcare: operational solutions for the relaunch and growth of the National Health Service", High-level Health Policy Workshop Report

[7] Francesco Corea, (2017) Artificial Intelligence and Exponential Technologies: Business Models Evolution and New Investment Opportunities, SpringerBriefs in Applied Sciences and Technology.

[8] PwC's Global Artificial Intelligence Study: Exploiting the AI Revolution "What's the real value of AI for your business and how can you capitalise?"; Assessing the Economic Impact of Artificial Intelligence, The International Telecommunication Union (ITU), contributed by the McKinsey Global Institute (MGI).

[9] For an in-depth analysis of all potential AI-Healthcare applications: Gómez-González, E., Artificial Intelligence in Medicine and Healthcare: applications, availability and societal impact, Gomez Gutierrez, E. editor(s), EUR 30197 EN, Publications Office of the European Union.

[10] Deloitte, (2020) "The socio-economic impact of AI in healthcare"

[11] Deloitte, (2020) "The socio-economic impact of AI in healthcare"

[12] Accenture, (2020) "Artificial Intelligence: Healthcare's New Nervous System"

[13] Goldman Sachs, (2016) "Profiles in Innovation: AI".

[14] Accenture, (2020) "Artificial Intelligence: Healthcare's New Nervous System"

[15] PwC's Global Artificial Intelligence Study: Exploiting the AI Revolution "What's the real value of AI for your business and how can you capitalise?"

[16] Berger, R., "Artificial Intelligence: A strategy for European startups, Recommendations for policymakers".

[17] Source: https://ec.europa.eu/digital-single-market/en/artificial-intelligence

[18] Source: https://ec.europa.eu/digital-single-market/en/news/new-eu-financing-instrument-eu150-million-support-european-artificial-intelligence-companies

[19] Accenture, (2020) "Artificial Intelligence: Healthcare's New Nervous System"

[20] Global Market Insights, (2017) "Healthcare AI Market Size, Competitive Market Share & Forecast, 2024".

[21] CB Insights, (2019) "AI In Numbers: Global Funding, Exits, And R&D Trends In Artificial Intelligence".

[22] Source: https://eithealth.eu/project/investor-network/

[23] See:
- https://www.lek.com/sites/default/files/insights/pdf-attachments/2059-AI-Challenges-for-European-Healthcare-Sector.pdf;
- https://cbi-research-portal-uploads.s3.amazonaws.com/2019/09/12113953/90-Healthcare-AI-Startups-To-Watch-export-3000x2250-4.png;
- The Next Generation of Medicine: Artificial Intelligence and Machine Learning, TM Capital Industry Spotlight

[24] Accenture [Estimates], TMCapital

[25] Skill Biased Technical Change, Task Biased Technical Change.

[26] Van Reenen

BIBLIOGRAPHY MENTIONED IN THE TEXT

Accenture, (2020) "Artificial Intelligence: Healthcare's New Nervous System".