



4th International Conference on Industry 4.0 and Smart Manufacturing

# Artificial Intelligence as a disruption technology to build the Harmonic Health Industry

Domenico Marino<sup>\*a</sup>, Demetrio Naccari Carlizzi<sup>b</sup>, Valeria Falcomatà<sup>c</sup>

<sup>a</sup>*Mediterranea University of Reggio Calabria- Via dell'Università Reggio Calabria, Italy*

<sup>b</sup>*P4C- Via Sant'Anna – Reggio Calabria, Italy*

<sup>c</sup>*GOMRC -Via Melacrino \_ Reggio Calabria, Italy*

## Abstract

Harmonic Health Industry is the new paradigm to make more efficient and more effective public health. Today, with the use of big data, artificial intelligence and deep learning techniques in healthcare, there is the possibility of effective predictive and preventive medicine, prior to the appearance of symptoms that are classified and evident to traditional medicine. For chronic and aggravating diseases, this is a considerable advantage. The paper describes the benefits that may accrue to healthcare systems from the introduction of new diagnostic and treatment technologies based on artificial intelligence. It will show how in the case of Italian healthcare this new approach can lead to a decrease in the gap between Northern and Southern regions. Finally, the concrete case of melanoma will show the potential inherent in this new approach.

© 2022 The Authors. Published by Elsevier B.V.

This is an open access article under the CC BY-NC-ND license (<https://creativecommons.org/licenses/by-nc-nd/4.0>)

Peer-review under responsibility of the scientific committee of the 4th International Conference on Industry 4.0 and Smart Manufacturing

*Keywords: Artificial Intelligence; Health economics; Predictive medicine*

## 1. Introduction

With the use of big data and artificial intelligence, the paradigm of evidence-based medicine, which presupposed an angle exclusively of the researcher, is changing. A medicine based on what is not evident to the individual human physician, but which can become evident and then subsequently explainable with the use of big data and deep learning techniques, which are able to consider and process much more information than is possible to a human being and deduce from extraordinary and otherwise impossible statistics connections and thus evidence. Today, with the use of

\* Corresponding author: Domenico Marino tel. +393389092929  
*Email Address:* [dmarino@unirc.it](mailto:dmarino@unirc.it)

big data in healthcare and deep learning techniques, there is the possibility of effective predictive and preventive medicine, prior to the appearance of symptoms that are classified and evident to traditional medicine. For chronic and aggravating diseases, this is a considerable advantage.

Telemedicine, then, is evolving very rapidly and is transforming the traditional model into digital and virtual healthcare, thanks also to the pandemic drive. The advantages of this approach are immediately apparent, both in terms of the time factor and the accessibility of services. Many people undergo a routine annual check-up. At this check-up, doctors take a thorough anamnesis, reconstruct the patients' family history, routinely check blood pressure, heart rate, analyse the results of the main tests that can be performed with a blood sample, discuss any further preventive screening and recommend healthy lifestyle habits. With telemedicine, all this becomes much simpler and less expensive. Using telemedicine tools to develop a virtual and digital health care system can therefore be a way to optimise and make routine medical examinations more efficient. First, because the costs of physical patient travel can be reduced, and a personalised and continuous patient monitoring system can be achieved. Secondly, because a more efficient and less costly healthcare recovers within itself the resources for the transformation of the model. But the transition to digital healthcare is neither simple nor obvious!

The Italian healthcare system has pushed hard over the years towards efficiency with a model that has reduced hospital beds and spends 37% less than other Western European countries. This path has shown its limits in recent years and the search for a containment of expenditure in the face of the many determinants that push up expenditure (ageing population, new diagnostic technologies, cost of new drugs, etc.) cannot take place without countering a changed social structure with a reprogramming of the care model on the digital paradigm. The British government, to give an example, has allocated, before Covid-19 and in 2019 alone, 6.2 billion pounds (450 of which are dedicated to AI technologies) within the framework of a planned increase of 33.9 billion until 2024.

## 2. What digital health model to build?

If the premise is that the traditional care model over the past decade has had a maintenance deficit, it should be noted that there has been an even greater failure to build a transition to a digital healthcare model. This would have provided new tools to ensure the required services, helping to close the current gap of the most disadvantaged territories and guarantee the Essential Levels of Care more uniformly. Failure to do so has reduced the sustainability of the NHS over time and relegated to fragmentary experiences the innovations introduced from the bottom up, which instead needed to be structured as a system. From the necessary modification of all phases of patient care, to the new models of data-based prevention, from treatment to post-hospitalisation, through tools such as online booking and payment systems for healthcare services, the electronic medical record and electronic health file, the use of telemedicine, the use of apps and wearable devices, and the spread of artificial intelligence and machine learning solutions.

The national scene has thus naturally been characterised by the geographical inhomogeneity of innovation, the lack of interoperability of systems, and in general by a latent and insufficient awareness of the opportunities on the part of the average health worker and citizen. Due to the continuing absence of a national strategy and the limited resources available to date, healthcare spending on AI is still marginal. In this context, the NHS will not be able to maintain an adequate standard and such a demanding universalist model without freeing itself from what is a real approach of distrust or resistance to innovation management, which is absent from the culture of many health care companies, especially in the South, but is not even to be found in the mission of the Ministry, which over the years has abdicated its functions of guiding certain unifying processes and has only recently realised that resolving its role in a frantic search for cuts would lead to a disconnect between the constitutional standard of health services and the reality of their provision. A plan for an organisational redesign of services well beyond traditional schemes and course corrections on DM 70 and 71 is therefore urgently needed.

Already in 2019, the WHO had issued new guidelines recommending the use of digital health in several areas:

- as decision-making support for health workers;
- to strengthen telemedicine services and ensure a different mobile first take-up of targeted patients;

- to ensure digital tracking of health status and customer services;
- to fluidify communications with patients;
- to promote mobile learning for healthcare professionals.

Recently, the Ema (European Medicines Agency) big data task force and the heads of the pharmaceutical agencies proposed ten priority actions for the European medicines regulatory network to make the best use of big data to support innovation and public health. The report makes several recommendations, ten of which are considered priorities. The most ambitious of these is the establishment of an EU platform to access and analyse health data from across the EU.

### 3. Italian digital strategy for health

Just to stay within the European grammar, we need a digital strategy for healthcare that identifies the essential points that will have to be developed by the Ministry of Health in tandem with the Ministry for Technological Innovation and Digitisation to avoid that, once the emergency is over, we end up with the same health system only patched up, sliding towards the downsizing of services, degrading the country's main social infrastructure into a system in crisis, underfunded, geographically unequal, without human resources planning, and unable to foresee and manage the emergencies of a globalised world.

Let us focus on five starting points:

1. A digital transition programme that identifies objectives, targets and strategies that are compliant with the WHO guidelines, and, above all, that redesigns the organisation and governance of the system and of public enterprises in a digital key, placing the citizen at the centre of the processes of prevention and care and enabling better and faster and safer access to health information and services.
2. An improvement in the national regulatory framework with the enactment of more incisive laws regulating and incentivising the adoption of Telemedicine and the application of Artificial Intelligence solutions.
3. A specific declination of the national AI strategy on possible applications of artificial intelligence in healthcare that identifies opportunities, methods, risks, implications and responsibilities, overcoming the current limitations related to aspects of security, privacy, technological maturity and skills.
4. A national plan for the dissemination of innovative experiences in regional systems that would enable the many health authorities (especially in the south of Italy) to access best practices in support of the construction of real plans for the redevelopment of health services.
5. A standard monitoring system of the level of implementation of digitisation with specific indicators dedicated to the transition that would complement the new system of evaluation of the LEAs and make it possible to perceive the strategic consideration enjoyed by the digital transformation in the drive of the National Government.

It was only in April 2022 that the Ministry of Health released the guidelines of the digital model for the implementation of home care. The document that will be submitted to the regions defines the organisational model for implementing services telemedicine services in home care. It appears, therefore, necessary design the organisational model in detail and above all adapt it to the needs of the territory. The design of a diagnostic-assistance pathway based on a personalised electronic health record, is capable of responding to the demands of diagnosis, prognosis and treatment services that are increasingly effective, efficient and of quality for the patient, whose trade-off between service level and implementation costs can be mitigated thanks to the application of innovative technologies, systems and procedures to manage the clinical process according to an e-Health Service Management logic.

According to some estimates, simply tele-monitoring cardiology patients at home would reduce the number of days spent in hospital by 26% and save 10% in healthcare costs, with a 15% increase in survival rates. Today, with the use of big data and deep learning techniques, it is time to redesign the organisational model of healthcare companies to access rapid and precision patient care and enable effective preventive medicine with significant results in terms of efficiency, sustainability, guarantee and effectiveness of care.

The creation of the electronic health record, which is continually enriched with the monitoring of remotely recorded

values, contributes to making many pathologies diagnosable at a very early stage, to identifying risk situations, and to remotely managing care and treatment. Health status monitoring, the prevention of critical situations and the support of daily activities therefore represent an emerging field of application in healthcare, with particular reference to frail, elderly and chronically ill persons.

It seems opportune to propose a test scheme on the National Health System's digitisation gargantuan that provides an assessment of the level of implementation of the Digital Agenda with the intention of taking a snapshot of its position with respect to the possibilities offered by digital transformation and to suggest possible solutions to improve its performance.

The aim should be to obtain a 'balance sheet of local digital change' by providing a scientific method (based on the measurement of KPI-Key Performance Indicators) aimed at increasing the level of knowledge of the implementation of the Digital Agenda in the territories and helping the level of government to identify priorities and resources to be deployed according to needs.

Digital maturity is measured against six dimensions of analysis:

1. GOVERNANCE to investigate policy, strategy, structure, organisation and resources for managing innovation and monitoring impacts;
2. OPENESS to measure the level of transparency, openness and communication of the functioning of the management-administrative machine;
3. COOPERATION to know the condition of adhesion to national initiatives and platforms and regulatory provisions;
4. SERVICES to photograph the degree of digitisation of processes, procedures, services and applications;
5. INFRASTRUCTURES to estimate the level of modernity, robustness and capacity of the technological infrastructures and networks in place;
6. SKILLS to assess the adequacy of digital competencies and beyond to promote, accompany and support the company's digital transformation.

#### **4. Melanoma case study**

Artificial Intelligence and Big Data change the patient management model to which a path of prevention and early diagnosis of Melanoma is applied. The goal is to focus on the patient, improve the accuracy in the prevention and diagnosis of the territorial hospitals, break down the waiting lists, up to "socialize" and make efficient the services of taking charge by modifying the interaction between Hospital-Territory-Patient. The focus is on "precision" prevention campaigns with the Real-World Evidence of Big Data for Preventive, Predictive, Personalized and Participatory digital healthcare. Trained deep neural networks and Deep Learning techniques obtain more accurate precision than dermatologists on Melanoma with the analysis of dermoscopic images and patient's information (age, sex, phototype, residence, familiarity, lifestyles). Trained algorithms improve the diagnostic accuracy and support the doctors. The project therefore aims the creation of a Digital Platform for the remote take charge of patients, the collection of data and images from heterogeneous sources (BD), their processing using AI/DL algorithms to support non-expert doctors and the Hub center. The patient can be taken in charge and enrolled in different innovative ways through: -sending images from a smartphone with a mobile App (which sets the standard criteria for image acquisition and collects information for anamnesis); -acquisition of images with automatic video-dermatoscopy (self-service) systems by expanding the Dermatoscopy, a Melanoma diagnostic tool, from the Hub to territory. The data collected on the Platform feed the databases to train the algorithms used to select the patients to be visited and to define the target of the prevention campaign. The patient's report of a suspect neo, validated by algorithm, leads to taking charge directly in the Hub, determining timely treatment and care. Figure 1 details the process.

Less advanced systems as in Southern Italy have a negative spread of 43.5%, compared to those of the North in the incidence of Melanoma. This difference is determined by a greater capacity to prevent the health systems of the Center-North. The proposed system costs much less than the recruitment and training of specialists do not present on the market today and allows to reduce the incidence of the disease, treatment costs, mortality and social costs.

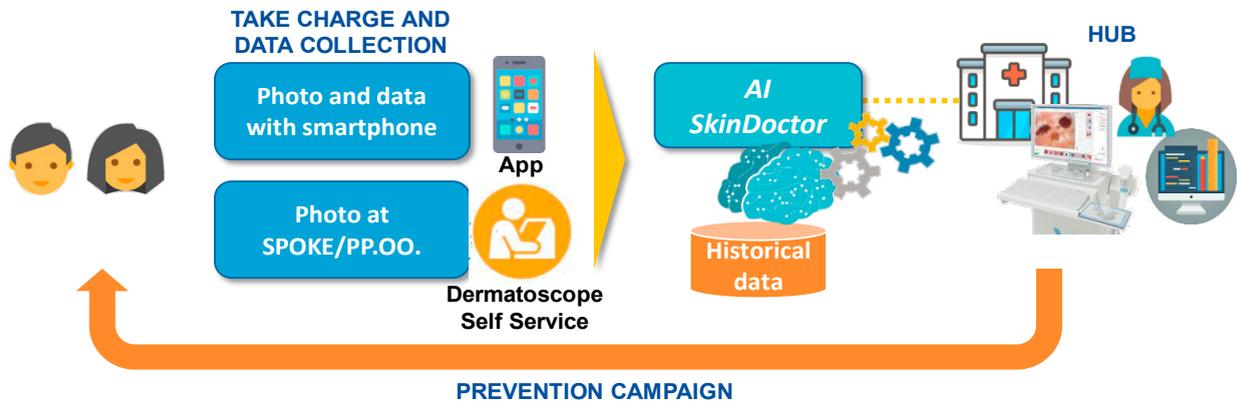


Figure 1.- ML & AI, image classification and recognition for improving the early diagnosis of Melanoma

## 5. Conclusions

Harmonic Health Industry is a new paradigm that can improve Italian healthcare by eliminating the imbalance between North and South. The Covid 19 has fully grasped the real delay that the Italian healthcare system shows with services in the trenches crushed by the emergency to the extent of not having a plan to play a role in Big Data healthcare, which instead remains entrusted to the investments of large private players that are already venturing into frontier solutions such as the use of social for prevention purposes and instant access to the entire data set can make it possible to predict the evolution of the clinical picture through decision support algorithms that make the entire process more efficient.

If the public role in digital health remains as it was before Covid-19 without a convinced choice and the construction of a public strategic vision, it will be like saying that health services will no longer be the unifying citizenship infrastructure of the country. And Italy will be characterised by a healthcare system that is financially and socially unsustainable because it is even more unequal than the current one!

## References

- [1] Alessandro Andronio (2003) "I livelli essenziali delle prestazioni sanitarie nella sentenza della Corte Costituzionale 13-27 marzo 2003, n.88" Federalismi.it
- [2] R. Bin, Il governo delle politiche pubbliche tra costituzione ed interpretazione del giudice costituzionale, in *Le Regioni*, 3/2013, 509 ss. (e in [www.robertobin.it](http://www.robertobin.it)) ([http://www.robertobin.it/ARTICOLI/Roma\\_LeRegioni.pdf](http://www.robertobin.it/ARTICOLI/Roma_LeRegioni.pdf))
- [3] Marino D, Quattrone G, (2019), Proposal for a new index to evaluate hospital resource allocation, "European research on management and business economics", n. 25 pp. 23-29, ISSN: 2444-8834
- [4] Marino Domenico, Et Al., (2019) Telemedicine and Impact of Changing Paradigm in Healthcare, in: Calabrò Francesco Della Spina Lucia Bevilacqua Carmelina, *New Metropolitan Perspectives*, Springer Nature, Berlino -, ISBN: 978-3-319-92099-3.
- [5] Marino Domenico, Miceli A, Quattrone G, (2019), Artificial Intelligence and Changing Paradigm in Healthcare, in: J. Gil Lafuente D. Marino F. C. Morabito, *Economy, Business and Uncertainty*, Palgrave Macmillan Springer Nature, Cham, ISBN: 978-3-030-00676-1
- [6] Donatella Morana "La tutela della salute fra competenze statali e regionali: indirizzi della giurisprudenza costituzionale e nuovi sviluppi normativi" Osservatorio AIC

- [7] C. Panzera, (2013) I livelli essenziali delle prestazioni fra sussidiarietà e collaborazione, in *Le Regioni*, 4/2010 (e in [www.forumcostituzionale.it](http://www.forumcostituzionale.it)); Id., Mediazione politica e immediatezza giuridica dei livelli essenziali delle prestazioni, in *Le Regioni*, 6/2013
- [8] Report Osservatorio GIMBE 2/2020
- [9] Naccari Carlizzi Demetrio, D'errigo Filippo, Falcomatà Valeria, Parlagreco Mario, Agata Quattrone, Vannuzzi Paolo, Hassan Giulio, Marchese Mario, Alessandra Alessandro, (2019), ML & AI, image classification and recognition for the remote take charge of patients and the improving of Melanoma early diagnosis, *Global Clinical Engineering Journal* Vol. 2 (2019): Special Issue 2: 3rd ICEHTMC (International Clinical Engineering and Health Technology Management Congress) Proceedings
- [10] Argenziano G, Soyer HP., (2001) Dermoscopy of pigmented skin lesions--a valuable tool for early diagnosis of melanoma. *Lancet Oncol.* Jul;2(7):443-9. doi: 10.1016/s1470-2045(00)00422-8. PMID: 11905739.
- [11] G. Pagnanelli, H.P. Soyer, G. Argenziano, R. Talamini, R. Barbati, L. Bianchi, E. Campione, I. Carboni, A.M. Carrozzo, M.S. Chimenti, I.DE Simoni, V. Falcomatà, I.filipe Neto, F. Francesconi, A. Ginebri, J. Hagman, G.C. Marulli, F. Palamara, A.P. Vidolin, P. Piemonte, R. Soda, (2008), Diagnosis of pigmented skin lesions by dermoscopy: web-based training improves diagnostic performance of non-experts, *BR J. Dermatology*, 148. 698- 702