# COVID-19: The Importance of Artificial Intelligence and Digital Health During a Pandemic

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**Abstract**

The Covid-19 has brought about a major change in the way people live, work and interact. To face the challenges of the epidemic, health professionals and researchers have implemented several technologies from Industry 4.0. In order to elucidate the application of these technologies in the context of the pandemic, the objective of this article is to analyze the main research trends of the Technologies 4.0 from the main publications on the subject. Data collection was carried out in the Scopus database in September 2020 and 413 studies were identified. The gaps identified in this research were: Apply artificial intelligence and I4.0 technologies to support and speed up Covid-19 diagnosis, Implement Risk Management tools to prevent and mitigate new Covid-19 infection waves, Integrate I4.0 technologies into microbiology and clinical trials, Mapping and sharing data that identify transmission rates and Covid'19 diffusion routes, Search for treatment alternatives to Covid-19 through algorithms and artificial intelligence. The main academic contribution of this article was to systematize technological trends and understanding the influence of artificial intelligence and impact on the most urgent issues of the pandemic.

**Keywords**

Technologies · Industry 4.0 · Artificial intelligence · COVID-19 · SARS-CoV-2 · Digital health

## 4.1 Introduction

At the beginning of the twenty-first century, the SARS-CoV-1 epidemics occurred in 2002 and MERS-CoV in 2012. SARS-Cov-2 is the third disease from the same virus family in the past two decades [1]. The SARS-CoV-2 outbreak, which caused Covid-19, started in Wuhan in 2019 and soon reached a pandemic level with the statement by the World Health Organization (WHO) on 11 March 2020 [2].

Covid-19 has brought about a major change in the way people live, work, interact, requiring society to redesign living in public places and especially in closed environments, such as: homes, workplaces, public facilities and workplaces. Entertainment [3]. And to reduce coronavirus transmission, WHO and national disease control centers have issued several guidelines including social distance; frequent hand washing; and labels for sneezing and coughing, leaving the elbow flexed to contain the droplets of secretions [4].

To face the challenges of the epidemic, health professionals and researchers have implemented several technologies. Alternatives of a Deep Learning Model are being studied to detect Covid-19 in computed tomography scans and accurately distinguish possible cases of pneumonia [5]. The Taiwanese government has used the experience gained in combating Severe Acute Respiratory Syndrome in 2003 and using its Big Data to constantly inform the evolution of the pandemic and to respond in a precise and transpar-

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ent manner to its citizens [6]. Artificial Intelligence has been used constantly to improve the diagnosis of Covid-19, either through X-ray examinations or through computed tomography [7].

Although this research and others that make up this field of study have presented important perspectives, it is necessary to carry out more work to identify the contributions of advanced technologies to mitigate and solve the needs imposed by COVID-19. Given the above, the question that will guide this research is: what are the main paths taken by I4.0 technologies in the context of Covid-19? To answer it, the objective of this article is to analyze the main research trends of I4.0 technologies from the main publications on the subject.

In addition to this introduction section, the article will present the sections of the theoretical framework, research method, results, discussion, conclusion and references.

## 4.2 Theoretical Background

The new coronavirus (SARS-CoV-2), which causes COVID-19, is the cause of severe acute respiratory syndrome and transmission from person to person has caused it to spread rapidly in several countries since December 2019 [8]. Its symptoms may resemble those of a seasonal flu, but the potential diffuse alveolar damage means that in many cases its treatment requires advanced respiratory assistance, including artificial ventilation [9, 10].

COVID-19 has reached more than 3 million people and the speed of medical diagnosis is of great importance to enable agile isolation and treatment of infected patients, in order to prevent further spread of the virus [8]. In this context, information technologies such as Artificial Intelligence (AI) provide greater learning for doctors and have also been used to analyze the results of medical examinations and make the diagnosis faster and more accurate, while machine learning algorithms have been used to predict mortality and spread of the virus [5–7, 11, 12].

AI allows for agile new drug development and reorientation of existing drugs [13]. Thus, learning algorithms are used to identify drugs that are capable of inhibiting inflammation and infections caused by SARS-CoV-2 [14]. In addition, from the AI it is possible to perform a safer, more accurate and efficient image diagnosis to assist in the clinical and diagnostic evaluation of the patient, identify possible outbreaks and predict their propagation nature, thus helping to assist in decision making and definition of strategies related to coronavirus [7, 15].

## 4.3 Method

The research can be classified as basic, exploratory and qualitative approach. As a technical procedure, the literature review was adopted. Exploratory research aims to gain greater familiarity with a given phenomenon or gain new insights on the researched theme [16].

Data collection was carried out in the Scopus database in September 2020. The search searched only for articles and publications made in events or books were dispensed with. The following terms were used in the titles and keywords, all in the English language, in the search: “Artificial Intelligence” or “Data Science” or “Machine Learning” or “Blockchain” or “Big Data” or “Algorithms” or “Data Visualization” or “Data Analysis” and “COVID-19”or “SARS-CoV-2”.

In the research, 413 indexed studies were identified. For the identification of scientific gaps related to the research, the 20 articles most cited in the database were used, considering the time frame of 2020. The delimitation of 20 articles was carried out through non-statistical sampling, as it determines the significant impact on the conduct of the research [17]. The data were treated using Microsoft Excel software.

## 4.4 Results

The 20 most relevant articles are presented, sorted from the most to the least cited documents, according to Table 4.1. All obtained at least 5 citations and 13 of the 20 articles had at least 10 or more citations, which may indicate that despite having been published in a short time, they have influenced the Covid-19 theme associated with the most sophisticated technologies in 2020.

According to Table 4.2, research gaps involving the main themes of Covid-19 and Technology were grouped, totaling five groups.

In “Apply artificial intelligence and I4.0 technologies to support and speed up Covid-19 diagnosis” the study opportunities are mentioned that propose application of algorithms to increase the efficiency in the detection of the new coronavirus. The algorithmic solution is suggested mainly in the X-ray and computed tomography exams in the chest [30]. Both tests have been shown to be more agile than RT-PCR, which although it is a test intended for a specific purpose and should not be missed in the detection of Covid-19 can take up to 2 days to complete [8, 20]. This procedure is important for emergency cases that may suggest immediate hospitalization.

**Table 4.1** Scientific gaps of the 20 most mentioned works

| Title | Authors | Source | Citation | Scientific gaps |
|---|---|---|---|---|
| Response to COVID-19 in Taiwan: big data analytics, new technology, and proactive testing | Wang et al. (2020) | Journal of the American Medical Association | 162 | Identify the effectiveness of using smart technologies to mitigate the impacts of new pandemics |
| Using artificial intelligence to detect COVID-19 and community-acquired pneumonia based on pulmonary CT: evaluation of the diagnostic accuracy | Li et al. (2020) | Radiology | 53 | Assess the ability of deep learning to diagnose COVID-19 |
| Investigating a serious challenge in the sustainable development process: analysis of confirmed cases of COVID-19 (new type of coronavirus) through a binary classification using artificial intelligence and regression analysis | Pirouz et al. (2020) | Sustainability | 26 | Identify the impacts of COVID-19 on social sustainability |
| Review of artificial intelligence techniques in imaging data acquisition, segmentation and diagnosis for COVID-19 | Shi et al. (2020) | IEEE Reviews in Biomedical Engineering | 20 | Identify the effectiveness of artificial intelligence in the diagnosis of COVID-19 |
| Artificial intelligence (AI) applications for COVID-19 pandemic | Vaishya et al. (2020) | Diabetes and Metabolic Syndrome: Clinical Research and Reviews | 19 | Analyze the effectiveness of artificial intelligence in preventing COVID-19 |
| Real-time estimation and prediction of mortality caused by COVID-19 with patient information based algorithm | Wang et al. (2020) | Science of the Total Environment | 18 | Use patient information based algorithm to estimate the spread rate of a virus in real time |
| Identification of COVID-19 can be quicker through artificial intelligence framework using a mobile phone-based survey when cities and towns are under quarantine | Srinivasa et al. (2020) | Infection Control and Hospital Epidemiology | 16 | Evaluate the effectiveness of machine learning in the identification of COVID-19 cases |
| First data analysis about possible COVID-19 virus airborne diffusion due to air particulate matter (PM): the case of Lombardy (Italy) | Bontempi et al. (2020) | Environmental Research | 15 | Propose the use of artificial intelligence to identify the broadcast and transmission routes of COVID-19 |
| A British Society of Thoracic Imaging statement: considerations in designing local imaging diagnostic algorithms for the COVID-19 pandemic | Nair et al. (2020) | Clinical Radiology | 13 | Identify the effectiveness of using algorithms in COVID-19 imaging diagnosis |
| Analyzing the epidemiological outbreak of COVID-19: a visual exploratory data analysis approach | Dey et al. (2020) | Journal of Medical Virology | 11 | Propose the implementation of technologies to mitigate new waves of COVID-19 infection |
| Machine learning using intrinsic genomic signatures for rapid classification of novel pathogens: COVID-19 case study | Randhawa et al. (2020) | PLoS One | 11 | Evaluate the feasibility of using artificial intelligence for genomic classification of the COVID-19 virus in time |
| Artificial intelligence and machine learning to fight covid-19 | Alimadadi t al. (2020) | Physiological Genomics | 11 | Propose the use of smart technologies that facilitate access to COVID-19 data |
| Integrated radiologic algorithm for COVID-19 pandemic | Sverzellati et al. (2020) | Journal of Thoracic Imaging | 10 | To assess the accuracy of the prognosis integrated radiological algorithm for screening patients with suspected COVID-19 |
| Artificial intelligence–enabled rapid diagnosis of patients with COVID-19 | Mei et al. (2020) | Nature Medicine | 9 | Identify the benefits of artificial intelligence to diagnose patients with COVID-19 through computed tomography analysis |

(continued)

**Table 4.1** (continued)

| Title | Authors | Source | Citation | Scientific gaps |
|---|---|---|---|---|
| Laparoscopy at all costs? Not now during COVID-19 outbreak and not for acute care surgery and emergency colorectal surgery: a practical algorithm from a hub tertiary teaching hospital in northern Lombardy, Italy | Saverio et al. (2020) | Journal of Trauma and Acute Care Surgery | 9 | Assess which surgical method is safer during a pandemic: laparoscopy or laparotomy |
| An algorithm for managing QT prolongation in coronavirus disease 2019 (COVID-19) patients treated with either chloroquine or hydroxychloroquine in conjunction with azithromycin: possible benefits of intravenous lidocaine | Mitra et al. (2020) | HeartRhythm Case Reports | 9 | Investigate whether this algorithm can be applied to patients positive for COVID-19 who need this therapy |
| Mechanism of baricitinib supports artificial intelligence-predicted testing in COVID-19 patients | Stebbing et al. (2020) | EMBO Molecular Medicine | 8 | To evaluate the efficiency and safety of treatment with baricitinib in randomized clinical trials |
| Laboratory data analysis of novel coronavirus (COVID-19) screening in 2510 patients | Yun et al. (2020) | Clinica Chimica Acta | 8 | Assess whether there is competition between COVID-19 and Influenza viruses and what is the relationship between eosinophils and the severity of COVID-19 infection |
| Use of CT and artificial intelligence in suspected or COVID-19 positive patients: statement of the Italian Society of Medical and Interventional Radiology | Neri et al. (2020) | Medical Radiology | 7 | Validate the efficiency of using artificial intelligence as an auxiliary method of diagnosis and prognosis for patients with COVID-19 |
| Artificial intelligence approach fighting COVID-19 with repurposing drugs | Ke et al. (2020) | Biomedical Journal | 7 | To evaluate the efficiency against COVID-19 of the drugs suggested by artificial intelligence in vitro and in vivo |

**Table 4.2** Scientific gap groups

| Macro grouping | Scientific gaps |
|---|---|
| Apply artificial intelligence and I4.0 technologies to support and speed up Covid-19 diagnosis | Li et al. (2020); Mei et al. (2020); Nair et al. (2020); Neri et al. (2020); Shi et al. (2020); Srinivasa Rao and Vazquez (2020); Sverzellati et al. (2020). |
| Implement Risk Management tools to prevent and mitigate new Covid-19 infection waves | Dey et al. (2020); Di Saverio et al. (2020); Pirouz et al. (2020); Vaishya et al. (2020); Wang et al. (2020). |
| Integrate I4.0 technologies into microbiology and clinical trials | Ke et al. (2020); Randhawa et al. (2020); Yun et al. (2020). |
| Mapping and sharing data that identify transmission rates and COVID'19 diffusion routes | Alimadadi et al. (2020); Bontempi (2020); L. Wang et al. (2020). |
| Search for treatment alternatives to Covid-19 through algorithms and artificial intelligence | Mitra et al. (2020); Stebbing et al. (2020). |

In the "Implement Risk Management tools to prevent and mitigate new Covid-19 infection waves" cluster, research opportunities are based on resources that can mitigate the effects of the pandemic on society. The possibility of using the Group Method of Data Handling (GMDH) algorithm to understand the correlations of average temperatures and humidity in the number of infections in Covid-19 is mentioned [21]. Another important opportunity for the prevention of pandemics is a database that understands and integrates information from various locations in the world, so that the development of pandemics can be tracked in real time and thus stop its spread more quickly [22].

Regarding the "Integrate I4.0 technologies into microbiology and clinical trials" cluster, research opportunities are presented around the application of the method combines supervised Machine Learning, improving the quality of teaching learning and consequently the quality of life. Digital Signal Processing (MLDSP), providing analyzes of more than 5000 unique viral sequences [24, 31]. Studies are also indicated to improve the diagnoses that can distinguish Covid-19 from Influenza A/B, mainly be-

cause the research indicates that despite the outbreak of the new coronavirus, contamination by Influenza A/B is still greater and that it is difficult to diagnose a patient with both pathologies [25].

In "Mapping and sharing data that identify transmission rates and COVID'19 diffusion routes" one of the proposed tools is the use of Patient Information Based Algorithm (PIBA) to estimate in real time the mortality rate provided by the outbreak of the new coronavirus [6]. Studies are proposed that seek to measure the correlation between air pollution and the transmissibility of the new coronavirus, with the particulate matter (PM) being possibly responsible for the diffusion [27]. Scientists working in the fields of artificial intelligence and machine learning have been looking for ways to identify data from infected by Covid-10 through physiological characteristics, involuntary body gestures and therapeutic results [28].

In the "Search for treatment alternatives to Covid-19 through algorithms and artificial intelligence" cluster, the use of AI is proposed to identify old drugs that may be efficient for the treatment of SARS-CoV-2 and for the identification of more specific drugs, which they allow a more in-depth analysis of those who obtained a satisfactory result in small samples [13, 14, 29]. It is worth remembering that in the case of treatment options against the virus, there is a speed of studies that is very intensified and that changes constantly [14].

## 4.5 Conclusion

The objective of the work to analyze the main research trends of I4.0 technologies from the main publications on the subject was duly achieved.

The main academic contribution of this article was to systematize trends, allowing a better understanding of how I4.0 technologies are impacting the most urgent issues of the pandemic.

The most important applied contribution was to promote the solutions developed by hospitals, health professionals and the entire scientific community, so that the governments of the municipal, regional and federal levels can promote or even invest to fight the Covid-19 outbreak, as well as obtain the know-how for possible future pandemics.

It is desirable that the results of this research can reach the public, to make them aware of the efforts made to combat the pandemic, employing immeasurable technological and financial human resources. The dissemination of this information can help the various public health stakeholders, economic agents and public authorities to combat the ignorance of groups such as "antivaccines" and even those who completely despise the severity of the new coronavirus.

The main limitation of studies has been the linear number of information that has impacted on a constant change from the current recommendations, mainly because of the resources employed, as it has not been seen in the scientific and health community for a long time.

As a proposal for future studies, bibliographic reviews or even bibliometric studies are recommended that delimit the various technologies of I4.0 applied to Covid-19, to catalog and measure scientific production and serve as possible theoretical structuring scripts to be replicated in other potentials pandemics.

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