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Review Article

Harnessing AI for COVID-19 Mitigation in Indonesia

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Abstract *- The Corona Virus Disease (COVID-19) pandemic has significantly challenged healthcare systems around the world, especially in developing countries such as Indonesia. This research explores the application of Artificial Intelligence (AI) in addressing various aspects of the pandemic, including diagnosis, prediction, telemedicine, and public health management. A systematic review of literature and case studies was conducted to analyze AI-driven approaches implemented in Indonesia. The findings reveal that AI technologies such as intelligent diagnostic systems, machine learning models, and mobile-based health solutions have contributed to mitigating the spread and impact of COVID-19. Despite the progress, challenges remain, including data privacy concerns and limited access to AI-driven healthcare tools. The study highlights the need for further integration of AI in healthcare policies and proposes recommendations for enhancing AI-driven public health interventions. Future research should focus on improving AI accessibility and ethical considerations in developing nations.*

Keywords *- Machine Learning, Artificial Intelligence, Healthcare, COVID-19, Public Health.*

1. Introduction

The global impact of Artificial Intelligence (AI) in healthcare has been transformative, especially during the COVID-19 pandemic [1-4]. AI technologies have enabled rapid advancements in diagnostic tools, predictive analytics, and telemedicine, providing critical support to overwhelmed healthcare systems [5]. These innovations have not only improved patient outcomes but also demonstrated the potential of AI to address complex public health challenges on a global scale. Indonesia, as a developing nation, faced unique challenges during the pandemic, including limited healthcare infrastructure, uneven access to medical resources, and a high population density that exacerbated the spread of the virus [6-8]. Despite these obstacles, the country has made significant strides in leveraging AI to mitigate the impact of COVID-19 [9-11]. From AI-driven contact tracing applications to machine learning models for predicting case surges, Indonesia's efforts highlight the adaptability and resilience of its healthcare system [12-19]. Previous studies have extensively explored AI applications in healthcare, yet few have focused specifically on its role in mitigating COVID-19 in Indonesia. There is a lack of comprehensive analysis on the effectiveness, accessibility, and limitations of AI-based interventions in Indonesia's healthcare system. This study aims to bridge this gap by providing an in-depth examination of AI applications and evaluating their impact on pandemic response efforts in the country.

2. Theory of Artificial Intelligence

Artificial Intelligence (AI) represents a computer science discipline that enables machines to process information and make decisions through logical reasoning, similar to human cognitive processes. While Suyanto [20] and Suryadi emphasize AI's role as a rational agent system, Rich & Knight [21] focus on AI's ability to replicate human thought and behavior patterns. AI applications can be developed using four fundamental techniques, either independently or in combination, as shown in Figure 1.

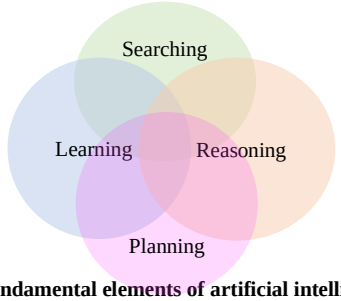

Fig. 1 The four fundamental elements of artificial intelligence [20].

In practice, AI operates through learning algorithms that fall into four categories: supervised learning (for classification and regression), unsupervised learning (for clustering, association, and dimension reduction), reinforcement learning (for gaming and robotics), and semi-supervised learning (for complex analysis, web content classification, and protein sequence analysis) [22]. This algorithmic foundation enables AI applications in various fields, including healthcare and medical technology [23-25].

3. Materials and Methods

A systematic review approach was adopted to evaluate AI applications in COVID-19 mitigation in Indonesia. The study employed the Publish or Perish 8 software to retrieve relevant literature. An initial search identified 117 research papers, which were screened based on relevance and quality, leading to the selection of 13 key studies. The selection process followed predefined criteria, including the use of AI in healthcare, Indonesian case studies, and peer-reviewed sources. Further screening through title and abstract review yielded 13 final papers for analysis, which were classified as shown in Table 1.

4. Results and Discussion

4.1. AI in Diagnosis and Prevention

Various AI models have been developed to assist in the early detection of COVID-19 cases. Notably, convolutional neural networks (CNNs) have been applied for medical image classification, while machine learning models have facilitated predictive analytics for outbreak monitoring. Indonesia has adopted AI-driven screening tools in select hospitals, though scalability remains an issue. For instance, James et al. (2020) successfully utilized a neural network model to classify X-ray medical images of patients exhibiting COVID-19 symptoms, employing a dataset comprising 160 COVID-19 cases and 160 normal cases. Similarly, Ansor et al. [26] developed an early detection system to identify mask usage using the TensorFlow framework on a Raspberry Pi platform.

Furthermore, Tenriawaru [27] designed a deep learning-based system capable of detecting mask usage and integrating augmented reality technology to assess social distancing compliance. Expanding on this field, Syarif et al. [28] implemented a deep convolutional neural network (CNN) to predict and detect the severity of COVID-19 in patients. Additionally, Hadi et al. [29] created an early warning system leveraging machine learning to monitor and detect adherence to physical distancing measures. Furthermore, Al-Hakim et al. [2] developed an Android-based application utilizing an AI-powered fuzzy expert system to diagnose individuals exhibiting COVID-19-like symptoms. This application effectively determines the confidence level of each diagnostic inference, providing users with a more accurate assessment of their condition. Complementing this effort, the Indonesian government introduced *PeduliLindungi*, a mobile application designed to manage COVID-19 through features such as contact tracing, tracking, self-diagnosis, and location reporting [30]. Further expanding on AI applications in public health, Al-Hakim et al. [31] implemented an Android-based system aimed at preventing the spread of COVID-19 by fostering community engagement and enhancing collaboration among healthcare workers. These diverse approaches highlight the potential of AI technologies in enhancing public health responses and mitigating the spread of COVID-19.

4.2. AI-Enabled Monitoring and Tracking

Government-backed initiatives, such as AI-powered contact tracing applications, have been implemented to curb the virus's spread. Compared to similar implementations in Singapore and South Korea, Indonesia's approach faces infrastructural and compliance challenges. A comparative analysis highlights strengths and limitations. Meanwhile, studies by Al-Hakim et al. [32] introduced a novel approach for determining the shortest route to COVID-19 referral hospitals across various regions in Java. This method leverages the Haversine formula to calculate the most efficient paths, providing a strategic solution for medical emergency responders and healthcare facilities in managing patients requiring urgent care. This system is designed to optimize emergency response times, potentially improving patient outcomes in critical situations. Building upon this research, Al-Hakim et al. developed a mobile-based application utilizing the Dijkstra algorithm to map and analyze COVID-19 case distributions. The application features distributed and location-based services that enable users to assess the proximity and density of COVID-19 cases within their area. This app was designed to be compatible with both Android and iOS platforms, enhancing accessibility and providing real-time insights for better personal and community health management.

4.3. AI as Emergency-Assisted Tools

To respond to the urgent need for rapid medical response during the COVID-19 pandemic, particularly in transporting patients to hospitals, Al-Hakim et al. [33] developed a mobile app called *Smart-iMbulance*. This application is designed to facilitate emergency medical services for individuals requiring immediate care, including victims of traffic accidents and patients in critical COVID-19 conditions. By streamlining the coordination between patients and healthcare providers, *Smart-iMbulance* ensures faster and more efficient medical responses.

The critical role of healthcare facilities in managing COVID-19 cases has been extensively emphasized in the literature. Studies by Klumpp et al. [34] and Toh & Brody [35] highlight the importance of efficient healthcare infrastructure and emergency medical services in handling pandemic-related emergencies.

Table 1. Review the result of this study

Authors	Type of Artificial Intelligence	Objectives of the Study	Language
(James et al., 2020)	CNN	Classification	English
(Ansor et al., 2020)	CNN	Detection	English
(Tenriawaru et al., 2021)	Deep Learning Architecture	Detection	English
(Syarif et al., 2022)	Deep Learning Architecture	Prediction	English
(Hadi et al., 2021)	Machine Learning	Detection	English
(Al Hakim, Rusdi, et al., 2020)	Expert System	Diagnosis	English
(Al Hakim, Billian, et al., 2020; Al Hakim, Muchsin, et al., 2021)	Shortest Path Algorithm	Prediction	Indonesian
(Al Hakim, Purwono, et al., 2022)	Shortest Path Algorithm	Prediction	English
(Al Hakim et al., 2021b; Al Hakim et al., 2021a)	Mobile-based Artificial Intelligent	Multi-purpose	English, Indonesian
(Nurhudatiana & Seo, 2020; Parikesit et al., 2021); (Nurhudatiana & Seo, 2020)	The Mobile Healthcare or Telemedicine	Diagnosis	English

The integration of mobile technology like *Smart-iMbulance* complements these healthcare efforts by enhancing the responsiveness and accessibility of emergency medical services. This innovation demonstrates how digital solutions can significantly improve emergency healthcare delivery, particularly during large-scale health crises like the COVID-19 pandemic.

4.4. Tele-Health and Tele-Medicine

Indonesia has seen significant progress in telemedicine through mobile healthcare applications (*mHealth*), with *Halodoc* and *Alodoc* emerging as leading platforms [36, 37]. These applications have been instrumental in supporting COVID-19 patients by offering AI-based chatbot features that provide instant health consultations. This technology enables users to receive preliminary health assessments, reduces the need for in-visitation and minimizes exposure to the virus.

Additionally, both apps allow users to chat directly with healthcare professionals, including general practitioners, medical specialists, and psychologists. They also offer convenient services for booking medical tests, scheduling laboratory check-ups, and accessing drug information. This comprehensive range of features makes *Halodoc* and *Alodoc* vital tools for improving healthcare accessibility and efficiency, particularly during the COVID-19 pandemic.

These platforms demonstrate how integrating AI and digital health solutions can enhance patient care and streamline medical services, especially in times of public health crises.

4.5. Future Directions

Based on various studies, it has been clearly demonstrated that Artificial Intelligence (AI) has made significant contributions to combating COVID-19 in Indonesia. The rapid advancement of AI in the health and medical sectors has provided innovative solutions for managing the pandemic. While COVID-19 may not yet be entirely curable, AI has played a crucial role in supporting diagnosis, prevention, and management efforts, particularly in resource-limited settings like Indonesia.

As a developing country, Indonesia continues to explore and implement AI-driven research and innovations to enhance its healthcare capabilities. This momentum is expected to persist beyond the pandemic, presenting vast opportunities for expanding AI applications in public health, medical diagnostics, and disease prevention.

The research provides valuable insights into the development of AI's role in Indonesia's struggle with COVID-19 and highlights future prospects for integrating AI technologies into the nation's healthcare infrastructure. The findings can serve as a foundation for advancing AI research and fostering sustainable healthcare innovations in the post-pandemic era.

4.6. Discussion

Quantitative data were incorporated to assess AI adoption trends. All of the studies presented tabular and graphical data visualizations to illustrate AI's role in various public health interventions. Case studies on Indonesia's AI-driven healthcare platforms provide practical insights. Although Artificial Intelligence (AI) applications are

currently focused on solving specific problems, ongoing advancements in algorithms and methodologies have paved the way for groundbreaking innovations that were previously unimaginable. One clear example is AI's role in the early detection and diagnosis of COVID-19, which has significantly contributed to pandemic control efforts in Indonesia and holds promising potential for broader global applications.

Moreover, AI-driven approaches have accelerated the discovery of vaccines, drugs, and therapeutics, addressing limitations in existing medical knowledge and offering innovative solutions aimed at improving human health. These advancements underscore AI's transformative impact on healthcare, enabling faster and more efficient responses to public health crises. However, the integration of AI into healthcare systems also raises critical ethical considerations, particularly concerning data privacy, bias in decision-making, and the responsible use of technology. As noted by Braun et al. [38], extensive ethical research is essential to ensure that AI technologies are developed and applied responsibly, prioritizing human welfare and societal benefit.

The integration of Artificial Intelligence (AI) with other mobile technologies has proven to be highly effective in enhancing system performance, particularly in healthcare applications. To achieve optimal performance, AI often needs to be combined with complementary technologies, creating more robust and efficient solutions [35], [39], [40], [41], [42].

Several key technologies that synergize well with AI include:

- Internet of Things (IoT): IoT makes it possible for interconnected devices to collect and exchange real-time data, which can be analyzed by AI to improve healthcare decision-making and patient monitoring [5], [42].
- Internet of Medical Things (IoMT): IoMT extends IoT concepts specifically for medical devices, allowing AI to process data from various health monitoring tools to support diagnostics and treatment plans [43].
- Microcontrollers: AI algorithms embedded in microcontrollers enhance real-time data processing, particularly in portable medical devices for patient monitoring and diagnostics [44].
- Wearable Medical Devices: Wearables integrated with AI offer continuous health tracking, enabling early detection of health anomalies and proactive medical interventions [13].

Additionally, the role of healthcare practitioners remains vital in leveraging AI technologies effectively. Medical professionals often utilize AI-based tools to support clinical decisions, optimize treatment plans, and improve patient outcomes [45].

Furthermore, Artificial Intelligence (AI) has shown significant potential in advancing omics-based research, which includes fields such as genomics, transcriptomics, proteomics, and metabolomics. These omics disciplines, often referred to as molecular high-throughput techniques in bioinformatics, generate vast amounts of complex biological data that require advanced computational methods for analysis and interpretation. AI algorithms, particularly in the form of machine learning and deep learning, are well-suited for managing and analyzing these massive datasets, enabling researchers to uncover hidden patterns and relationships within biological systems. One notable application is in the management and analysis of data from biological banks, where AI facilitates efficient data integration, storage, and retrieval for large-scale studies. For example, a study by Stute et al. [46] employed transcriptomics to examine how different reproductive lifestyle tiers impact the transcriptional profile of the mammary gland in a primate model. This approach illustrates how omics data can provide deep insights into biological processes, contributing to the development of targeted treatments and interventions. Furthermore, non-human primates serve as vital animal models for vaccine and drug development due to their physiological similarities to humans. This relevance was particularly evident during the COVID-19 pandemic, where transcriptomics and other omics techniques were utilized to accelerate the discovery and testing of vaccines and therapeutics [47-53].

5. Conclusion

This study underscores AI’s significant contributions to COVID-19 mitigation efforts in Indonesia, highlighting its role in diagnosis, prediction, telemedicine, and monitoring. However, challenges such as limited AI infrastructure, data privacy concerns, and accessibility barriers hinder widespread adoption.

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References

[1] Marc Lipsitch, David L. Swerdlow, and Lyn Finelli, "Defining the Epidemiology of Covid-19 — Studies Needed," *The New England Journal of Medicine*, vol. 382, no. 13, pp. 1194-1196, 2020. [CrossRef] [Google Scholar] [Publisher Link]

[2] Rosyid Ridlo Al Hakim, Erfan Rusdi, and Muhammad Akbar Setiawan, "Android Based Expert System Application for Diagnose COVID-19 Disease: Cases Study of Banyumas Regency," *Journal of Intelligent Computing and Health Informatics*, vol. 1, no. 2, pp. 27-38, 2020. [CrossRef] [Google Scholar] [Publisher Link]

[3] A.A.M. Kumar Wani, and I. Ahmed, "Covid-19 Structure of Virus, Progression of Disease & Present Status: A Review," *International Journal of Current Advanced Research*, vol. 9, no. 5, pp. 22040-22043, 2020. [Google Scholar]

[4] M. Palacios Cruz et al., "COVID-19, A Worldwide Public Health Emergency," *Spanish Clinical Journal (English Edition)*, vol. 221, no. 1, pp. 55-61, 2021. [CrossRef] [Google Scholar] [Publisher Link]

[5] Raju Vaishya et al., "Artificial Intelligence (AI) Applications for COVID-19 Pandemic," *Diabetes and Metabolic Syndrome: Clinical Research and Reviews*, vol. 14, no. 4, pp. 337-339, 2020. [CrossRef] [Google Scholar] [Publisher Link]

[6] Argyo Demartoto et al., "Life Story of Patient with Supervision's Fighting Against Covid-19 in Surakarta Indonesia," *Journal of Sociological Analysis*, vol. 9, no. 2, pp. 423-435, 2020. [CrossRef] [Google Scholar] [Publisher Link]

[7] Hannah Ritchie et al., Coronavirus Pandemic (COVID-19), Our World in Data. [Online]. Available: https://ourworldindata.org/coronavirus

[8] Subian Saidi, Netti Herawati, and Khoirin Nisa, "Modeling with Generalized Linear Model on Covid-19: Cases in Indonesia," *International Journal of Electronics and Communications Systems*, vol. 1, no. 1, pp. 25-33, 2021. [CrossRef] [Google Scholar] [Publisher Link]

[9] Rijal Ramdani, Agustiyara, and Eko Priyo Purnomo, "Big Data Analysis of COVID-19 Mitigation Policy in Indonesia: Democratic, Elitist, and Artificial Intelligence," *IOP Conference Series: Earth and Environmental Science*, vol. 717, pp. 1-7, 2021. [CrossRef] [Google Scholar] [Publisher Link]

[10] Sankaraiah Sreeramula, and Deny Rahardjo, "Estimating COVID-19 R_t in Real-time: An Indonesia Health Policy Perspective," *Machine Learning with Applications*, vol. 6, pp. 1-8, 2021. [CrossRef] [Google Scholar] [Publisher Link]

[11] Yoser Thamtono, Aye Moa, and Chandini Raina MacIntyre, "Using Open-Source Intelligence to Identify Early Signals of COVID-19 in Indonesia," *Western Pacific Surveillance and Response Journal*, vol. 12, no. 1, pp. 40-45, 2021. [CrossRef] [Google Scholar] [Publisher Link]

[12] Safaa N. Saud Al-Humairi et al., "Conceptual Design: A Novel Covid-19 Smart AI Helmet," *International Journal on Emerging Technologies*, vol. 11, no. 5, pp. 389–396, 2020. [Google Scholar]

[13] Robin Barnes, and Katarina Zvarikova, "Artificial Intelligence-enabled Wearable Medical Devices, Clinical and Diagnostic Decision Support Systems, and Internet of Things-based Healthcare Applications in COVID-19 Prevention, Screening, and Treatment," *American Journal of Medical Research*, vol. 8, no. 2, pp. 9–22, 2021. [Google Scholar] [Publisher Link]

[14] Muhammad Haikal Satria, Ariep Jaenul, and Adhes Gamayel, "Design of Solar Powered Vaccine Backpack," *Proceedings of the 4th Forum in Research, Science, and Technology (FIRST-T1-T2-2020)*, vol. 7, pp. 590-594, 2021. [CrossRef] [Google Scholar] [Publisher Link]

[15] Larry L. Mweetwa et al., "Development of first Generation COVID-19 Vaccines: State-of the-Art Technologies and Future Implications!," *Medical Research Archives*, vol. 10, no. 9, pp. 1-12, 2022. [CrossRef] [Google Scholar] [Publisher Link]

[16] Sali Abubaker Bagabir et al., "Covid-19 and Artificial Intelligence: Genome Sequencing, Drug Development and Vaccine Discovery," *Journal of Infection and Public Health*, vol. 15, no. 2, pp. 289-296, 2022. [CrossRef] [Google Scholar] [Publisher Link]

[17] Gunjan Arora et al., "Artificial Intelligence in Surveillance, Diagnosis, Drug Discovery and Vaccine Development against Covid-19," *Pathogens*, vol. 10, no. 8, pp. 1-21, 2021. [CrossRef] [Google Scholar] [Publisher Link]

[18] Rosyid R. Al Hakim, Glagah E. Setyowisnu, and Agung Pangestu, "An Expert System Dataset for Checking the Potential for Administering a Covid-19 Vaccine in Indonesia: Forward- Chaining Inference Machine Approach," *Journal of Global Engineering Research & Science (J-GERS)*, vol. 1, no. 1, pp. 1–4, 2022. [CrossRef] [Google Scholar] [Publisher Link]

[19] Quentin Haas et al., "Vaccine Development in the Time of COVID-19: The Relevance of the Risklick AI to Assist in Risk Assessment and Optimize Performance," *Frontiers in Digital Health*, vol. 3, pp. 1-5, 2021. [CrossRef] [Google Scholar] [Publisher Link]

[20] Suyanto, *Artificial Intelligence: Searching, Reasoning, Planning, dan Learning*, 3rd ed., Informatics Bandung, 2021. [Google Scholar] [Publisher Link]

[21] Elaine Rich, and Kevin Knight, *Artificial Intelligence*, McGraw-Hill, pp. 1-621, 1991. [Google Scholar] [Publisher Link]

[22] Rifkie Primartha, *Algoritma Machine Learning*, Informatika Bandung, 2021. [Google Scholar] [Publisher Link]

[23] Enti Hariadha et al., "Using Certainty Factor for Symptoms Diagnosis of Thyroid Disorders," *2022 International Conference on ICT for Smart Society (ICISS)*, Bandung, Indonesia, pp. 1-5, 2022. [CrossRef] [Google Scholar] [Publisher Link]

[24] M. Haider Abu Yazid et al., "Artificial Neural Network Parameter Tuning Framework for Heart Disease Classification," *2018 5th International Conference on Electrical Engineering, Computer Science and Informatics (EECSI)*, Malang, Indonesia, pp. 674-679, 2018. [CrossRef] [Google Scholar] [Publisher Link]

[25] M. Haider Abu Yazid et al., "Neural Network on Mortality Prediction for the Patient Admitted with ADHF (Acute Decompensated Heart Failure)," *2017 4th International Conference on Electrical Engineering, Computer Science and Informatics (EECSI)*, Yogyakarta, Indonesia, pp. 1-6, 2017. [CrossRef] [Google Scholar] [Publisher Link]

[26] Acep Ansor, Ritzkal Ritzkal, and Yuggo Afrianto, "Mask Detection Using Framework Tensorflow and Pre-Trained CNN Model Based on Raspberry Pi," *Mantik Journal*, vol. 4, no. 3, pp. 1539–1545, 2020. [Google Scholar]

[27] Andi Tenriawaru et al., "Social Awareness and Safety Assistance of COVID-19 Based on DLN Face Mask Detection and AR Distancing," *International Journal of Artificial Intelligence Research*, vol. 5, no. 2, pp. 111-122, 2021. [CrossRef] [Google Scholar] [Publisher Link]

[28] Abdusy Syarif et al., "UNAS-Net: A Deep Convolutional Neural Network for Predicting Covid-19 Severity," *Informatics in Medicine Unlocked*, vol. 28, pp. 1-10, 2022. [CrossRef] [Google Scholar] [Publisher Link]

[29] Abdullah Hadi, Rizka Reza Pahlevi, and Vera Suryani, "Early Warning System for Physical Distancing Detection in the Prevention of COVID-19 Spread," *2021 International Conference on Data Science and Its Applications, ICoDSA*, Bandung, Indonesia, pp. 252-256, 2021. [CrossRef] [Google Scholar] [Publisher Link]

[30] Ali Mustopa et al., "Analysis of User Reviews for the Pedulilindungi Application on Google Play Using the Support Vector Machine and Naive Bayes Algorithm Based on Particle Swarm Optimization," *2020 5th International Conference on Informatics and Computing, ICIC*, Gorontalo, Indonesia, pp. 1-7, 2020. [CrossRef] [Google Scholar] [Publisher Link]

[31] Rosyid Ridlo Al Hakim, "Prevention of Covid-19 Transmission Based on Android Applications as Implementation of Covid-19 Thematic KKN Activities in Sokanegara Purwokerto Banyumas," *Community Engagement and Emergence Journal (CEEJ)*, vol. 2, no. 1, pp. 7–13, 2020. [CrossRef] [Google Scholar] [Publisher Link]

[32] Rosyid Ridlo Al Hakim et al., "Closest Distance Postulate Approach to Covid-19 Referral Hospital in BARLINGMASCAKEB Indonesia Using Haversine Formula," *KONSTELASI: Konvergensi Teknologi dan Sistem Informasi*, vol. 1, no. 1, pp. 12-19, 2021. [CrossRef] [Google Scholar] [Publisher Link]

[33] Rosyid Ridlo Al Hakim et al., "Design and Development Smart-iMbulance for Efficiency of Road Emergency Priorities," *Journal of Innovation Research and Knowledge*, vol. 1, no. 2, pp. 167-172, 2021. [CrossRef] [Google Scholar] [Publisher Link]

[34] Matthias Klumpp et al., "Artificial Intelligence for Hospital Health Care: Application Cases and Answers to Challenges in European Hospitals," *Healthcare*, vol. 9, no. 8, pp. 1-24, 2021. [CrossRef] [Google Scholar] [Publisher Link]

[35] Christopher Toh, and James P. Brody, "Applications of Machine Learning in Healthcare," *Smart Manufacturing - When Artificial Intelligence Meets the Internet of Things*, 2021. [CrossRef] [Publisher Link]

[36] Arfika Nurhudatiana, and Jae Young Seo, "An mHealth Application Redesign based on Nielsen's Usability Heuristics: A Case Study of Halodoc," *Proceedings of the 2020 The 6th International Conference on E-Business and Applications*, Kuala Lumpur Malaysia, pp. 85–89, 2020. [CrossRef] [Google Scholar] [Publisher Link]

[37] Arli Aditya Parikesit, Nanda Rizqia Pradana Ratnasari, and Dito Anurogo, "Application of Artificial Intelligence-Based Computation in the Health Sciences to Ward off the COVID-19 Pandemic," *International Journal of Human and Health Sciences*, vol. 5, no. 2, pp. 177–184, 2021. [CrossRef] [Google Scholar] [Publisher Link]

[38] Matthias Braun et al., "Primer on an Ethics of AI-Based Decision Support Systems in the Clinic," *Journal of Medical Ethics*, vol. 47, no. 12, pp. 1-8, 2021. [CrossRef] [Google Scholar] [Publisher Link]

[39] Arvin Agah, *Medical Applications of Artificial Intelligence*, CRC Press, pp. 1-526, 2013. [Publisher Link]

[40] Valentina E. Balas, Raghvendra Kumar, and Rajshree Srivastava, *Recent Trends and Advances in Artificial Intelligence and Internet of Things*, 1st ed., Springer Cham, 2020. [CrossRef] [Google Scholar] [Publisher Link]

[41] Eric J. Topol, "High-Performance Medicine: The Convergence of Human and Artificial Intelligence," *Nature Medicine*, vol. 25, pp. 44-56, 2019. [CrossRef] [Google Scholar] [Publisher Link]

[42] Amtul Waheed, and Jana Shafi, "Successful Role of Smart Technology to Combat COVID-19," *2020 Fourth International Conference on I-SMAC (IoT in Social, Mobile, Analytics and Cloud) (I-SMAC)*, Palladam, India, pp. 772-777, 2020. [CrossRef] [Google Scholar] [Publisher Link]

[43] Desislava Ivanova, "Artificial Intelligence in Internet of Medical Imaging Things: The Power of Thyroid Cancer Detection," *2018 International Conference on Information Technologies (InfoTech)*, Varna, Bulgaria, pp. 1-4, 2018. [CrossRef] [Google Scholar] [Publisher Link]

[44] Andrei Velichko, "A Method for Medical Data Analysis Using the LogNNet for Clinical Decision Support Systems and Edge Computing in Healthcare," *Sensors*, vol. 21, no. 18, pp. 1-21, 2021. [CrossRef] [Google Scholar] [Publisher Link]

[45] Ashish Viswanath Prakash, and Saini Das, "Medical Practitioner's Adoption of Intelligent Clinical Diagnostic Decision Support Systems: A Mixed-Methods Study," *Information & Management*, vol. 58, no. 7, 2021. [CrossRef] [Google Scholar] [Publisher Link]

[46] Petra Stute et al., "Life Stage Differences in Mammary Gland Gene Expression Profile in Non-human Primates," *Breast Cancer Research and Treatment*, vol. 133, pp. 617–634, 2011. [CrossRef] [Google Scholar] [Publisher Link]

[47] Qiang Gao et al., "Development of an Inactivated Vaccine Candidate for SARS-CoV-2," *Science*, vol. 369, no. 6499, pp. 77–81, 2020. [CrossRef] [Google Scholar] [Publisher Link]

[48] Mimi Guebre-Xabier et al., "NVX-CoV2373 Vaccine Protects Cynomolgus Macaque Upper and Lower Airways against SARS-CoV-2 Challenge," *Vaccine*, vol. 38, no. 50, pp. 7892–7896, 2020. [CrossRef] [Google Scholar] [Publisher Link]

[49] Roujian Lu et al., "Genomic Characterisation and Epidemiology of 2019 Novel Coronavirus: Implications for Virus Origins and Receptor Binding," *The Lancet*, vol. 395, no. 10224, pp. 565–574, 2020. [CrossRef] [Google Scholar] [Publisher Link]

[50] Shuaiyao Lu et al., "Comparison of Nonhuman Primates Identified the Suitable Model for COVID-19," *Signal Transduction and Targeted Therapy*, vol. 5, pp. 1-9, 2020. [CrossRef] [Google Scholar] [Publisher Link]

[51] Giulia Russo et al., "A Multi-Step and Multi-Scale Bioinformatic Protocol to Investigate Potential SARS-CoV-2 Vaccine Targets," *Briefings in Bioinformatics*, vol. 23, no. 1, pp. 1-9, 2022. [CrossRef] [Google Scholar] [Publisher Link]

[52] Hilal Tayara, Ibrahim Abdelbaky, and Kil To Chong, "Recent Omics-based Computational Methods for COVID-19 Drug Discovery and Repurposing," *Briefings in Bioinformatics*, vol. 22, no. 6, pp. 1-15, 2021. [CrossRef] [Google Scholar] [Publisher Link]

[53] Jingyou Yu et al., "DNA Vaccine Protection against SARS-CoV-2 in Rhesus Macaques," *Science*, vol. 369, no. 6505, pp. 806–811, 2020. [CrossRef] [Google Scholar] [Publisher Link]