A REVIEW OF DATA INTELLIGENCE APPLICATIONS WITHIN HEALTHCARE SECTOR IN THE UNITED STATES

Clement Odooh[1]; Regina Robert[2]; Efijemue, Oghenekome Paul[3]

Department of Computer Science, Austin Peay State University,
Clarksville Tennessee, USA

ABSTRACT

Data intelligence technologies have transformed the United States healthcare sector, bringing about transformational advances in patient care, research, and healthcare management. United States is the focus due fact that many academic and research institutions in the country are at the forefront of healthcare data research, making it an attractive location for in-depth studies.This paper explores the diverse realm of Data Intelligence in Healthcare, examining its applications, challenges, ethical considerations, and emerging trends. Data Intelligence Applications encompass a spectrum of technologies designed to collect, process, analyze, and interpret data effectively. These apps enable healthcare practitioners to make more educated decisions, forecast health outcomes, manage population health, customize treatment, optimize workflows, assist research, improve data security, and drive healthcare analytics. However, the use of data intelligence applications raises issues and concerns about data privacy, fairness, transparency, data quality, accountability, fair data access, regulatory compliance, and the balance between automation and human judgment. Emerging themes include AI and machine learning domination, stronger ethical and regulatory frameworks, edge and quantum computing, data democratization, sustainability applications, and developing human-machine collaboration. Data intelligence has an impact that goes beyond healthcare delivery, influencing decision-making, scientific discovery, education, and economic growth. Understanding its potential and ethical responsibilities is paramount as data-driven insights redefine healthcare excellence and extend their influence across sectors.

KEYWORDS

Data-driven insights, Data Intelligence, Health sector, Data insights, Data analysis, Data Applications

1. INTRODUCTION

The amalgamation of data intelligence with healthcare has ushered in a new era of transformative potential, and within the United States of America, this synergy has become an instrumental force in reshaping the healthcare landscape. The convergence of data analytics and healthcare, often termed "Data Intelligence in Healthcare," stands at the forefront of modern healthcare innovation, promising substantial improvements in patient care, research, and healthcare management.

This study delves into the diverse world of Data Intelligence in Healthcare, particularly in the context of the United States. We delve into the intricate interplay between data analytics and the healthcare sector, meticulously examining the profound implications of systematic data collection, analysis, and interpretation on healthcare practices, policies, and patient experiences.

This topic's importance and urgency cannot be emphasized. The healthcare landscape in the United States is marked by a number of significant problems, including an aging population, an

DOI: 10.5121/ijsc.2023.14401

increasing prevalence of chronic diseases, and increasing demand to create cost-effective healthcare solutions. Against this backdrop, data intelligence emerges as a beacon of hope, offering a data-driven lifeline to address these complex issues.

The importance of this study stems from its ability to shed light on the critical role that data intelligence plays in healthcare transformation. By leveraging the power of large datasets derived from electronic health records, medical imaging, wearable devices, and a variety of other sources, healthcare professionals are given the tools they need to personalize patient treatments, forecast disease outbreaks, optimize resource allocation, and embark on ground-breaking research projects. Consequently, data intelligence empowers stakeholders across the healthcare spectrum to make decisions that are not just informed but are capable of altering the course of medical history.

In an age defined by data abundance and digital metamorphosis, the fusion of data intelligence and healthcare reverberates as a seismic shift in our perception of health and wellness. It is a catalytic agent for innovation, a vanguard for cost-effective healthcare delivery, and an unwavering guardian of patient privacy and data security.

As we embark on this comprehensive exploration of Data Intelligence in Healthcare in the United States, our objective is twofold: to shed a brilliant light on its transformative potential and to navigate the intricate web of ethical considerations that are intrinsic to its growth. This review aspires to be a guiding compass, providing a comprehensive roadmap to comprehend how data-driven insights are remodeling the healthcare landscape, pushing the boundaries of what is conceivable, and paving the way for an era of healthcare excellence.

The subsequent sections of this paper will scrutinize the various dimensions of Data Intelligence in Healthcare, from its applications in clinical decision support and population health management to its role in the emergence of precision medicine and telehealth services. Additionally, it will tackle issues surrounding data privacy, security, and ethics in this data-rich ecosystem.

2. LITERATURE REVIEW

The transformative impact of data intelligence in the healthcare sector has garnered much scholarly attention. This literature review provides an extensive overview of the existing body of knowledge in the domain of Data Intelligence in Healthcare, with a specific focus on its applications, challenges, and ethical considerations in the context of the United States. One of the pivotal applications of data intelligence in healthcare lies in Clinical Decision Support Systems (CDSS). Numerous studies have demonstrated the effectiveness of CDSS in aiding healthcare professionals by providing real-time, evidence-based recommendations. These systems use patient data to assist in diagnosis, treatment planning, and medication management, thus improving the overall quality of care [1][2]. Data intelligence is critical in population health management. Research has shown that predictive analytics and data-driven interventions can help healthcare providers identify at-risk populations, optimize preventative care measures, and reduce healthcare costs [3][4]. The advent of precision medicine has been significantly accelerated by data intelligence. Studies in this field have highlighted how genomic data, combined with advanced analytics, can lead to tailored treatment plans that consider an individual's genetic makeup, enhancing treatment outcomes and minimizing adverse effects [5][6]. The COVID-19 pandemic has catapulted telehealth into the mainstream of healthcare delivery. Research shows that data intelligence technologies, such as remote monitoring and telemedicine platforms, have the potential to revolutionize how healthcare is accessed and delivered, ensuring broader and

more equitable healthcare access [7][8]. A recurring theme in the literature is the paramount importance of safeguarding patient data. The intricate nature of healthcare data makes it a prime target for cyberattacks. Researchers have stressed the importance of strong cybersecurity measures and the creation of frameworks to protect patient data privacy [9][10]. Data quality and integration challenges persist in the healthcare sector. Studies have identified issues related to data accuracy, completeness, and interoperability between various healthcare systems. Addressing these issues is crucial for data intelligence programs to succeed. [11][12]. The ethical implications of data intelligence in healthcare have garnered much scholarly attention. Researchers investigated concerns such as informed consent, data ownership, and the possibility of bias in healthcare decision-making algorithms [13][14]. AI and ML techniques are on the cutting edge of healthcare innovation. Deep learning techniques have recently been investigated for use in medical imaging, predictive analytics for illness detection, and natural language processing for mining electronic health information [15][16]. Blockchain technology is gaining popularity in healthcare because of its promise to improve data security and integrity. Research has explored the use of blockchain for medical record management, drug traceability, and secure sharing of patient data [17][18]. The development of robust data governance and regulatory frameworks is a burgeoning area of research. Scholars have concentrated on the development of standards and guidelines to ensure the ethical and compliant use of data in healthcare [19][20]. This literature review emphasizes the varied character of Data Intelligence in Healthcare, highlighting its numerous uses, ongoing problems, and emerging trends that have the potential to reshape healthcare in the United States. We will delve deeper into these features as we go through this research, shedding light on the complicated processes that define this expanding subject.

3. DATA INTELLIGENCE APPLICATIONS WITHIN HEALTH DOMAIN IN THE UNITED STATES

The U.S. healthcare sector operates within a comprehensive regulatory data framework designed to enhance a robust and secured data intelligence applications systems. These Applications in the U.S healthcare encompass an extensive array of technologies and methodologies meticulously crafted to collect, process, analyze, and interpret data with efficiency and precision. The following are key applications of data intelligence in the U.S healthcare.

3.1. Clinical Decision Support (CDS)

Clinical Decision Support systems, harmoniously integrated with data intelligence, harness patient data derived from Electronic Health Records (EHRs) to empower healthcare professionals in making well-informed decisions. CDS systems are adept at:

i. Offering real-time alerts and reminders to mitigate medical errors.

ii. Recommending evidence-based treatment options, aligned with the patient's medical history.

iii. Analyzing diagnostic test results to provide insights into potential diagnoses.

iv. Monitoring patient conditions and issuing notifications when interventions are warranted[19].

CDS improves not only patient safety but also the entire quality and efficiency of healthcare delivery.

3.2. Predictive Analytics

Predictive analytics capitalizes on historical patient data to predict future health outcomes. Its capabilities encompass:

i. Identifying people who are at high risk of developing specific disorders or ailments.

ii. Prediction of readmission risks, facilitating proactive interventions.

iii. Optimization of resource allocation through forecasts of patient admissions and discharges.

iv. Anticipation of disease outbreaks, enabling the allocation of resources in a timely manner.

By delivering actionable insights, predictive analytics foster early interventions and optimal resource allocation, thereby improving patient outcomes.

3.3. Population Health Management

Data intelligence fuels population health management platforms, aimed at enhancing the health of entire patient populations. These platforms excel at:

i. Analyzing population health trends to identify areas necessitating intervention.

ii. Implementing preventive care strategies to curtail disease prevalence.

iii. Targeting high-risk patient cohorts for proactive care and disease management.

iv. Evaluating the effectiveness of population health initiatives through data-driven metrics.

Such systems play an instrumental role in advancing public health objectives and narrowing healthcare disparities [10].

3.4. Personalized Medicine

Data intelligence tailors’ medical treatments to individual patients by taking genetic, clinical, and lifestyle information into account. Its functionalities encompass:

i. Identification of specific biomarkers or genetic markers influencing treatment responses.

ii. Recommendations for personalized drug regimens, rooted in a patient's genetic profile.

iii. Prediction of a patient's response to a particular treatment, thereby minimizing adverse effects.

iv. Facilitation of targeted therapies for rare diseases.

Personalized medicine elevates treatment efficacy, reduces side effects, and enhances patient satisfaction.

3.5. Efficiency and Workflow Optimization

Data intelligence automates administrative activities, reduces paperwork, and optimizes resource allocation in healthcare workflows. It is proficient in:

i. Automating appointment scheduling and patient registration processes.

ii. Optimizing staff allocation through forecasts of patient admission and discharge times.

iii. Enabling inventory management and automated supply reordering.

iv. Enhancing billing and claims processing through data-driven analytics.

Gains in efficiency result into cost savings, allowing healthcare providers to devote more time to patient care [18].

3.6. Research and Clinical Trials

Data intelligence platforms provide researchers with access to de-identified patient data from EHRs, facilitating medical research and clinical trials. These platforms are adept at:

i. Efficient identification of eligible participants for clinical trials.

ii. Real-time monitoring of trial progress, enabling necessary adjustments.

iii. Comprehensive analysis of trial outcomes and generation of insights for scientific discoveries.

iv. Secure data sharing, fostering collaboration with other research institutions.
Such platforms expedite the development of novel treatments and therapies.

3.7. Data Security and Privacy

Data intelligence fortifies data security and privacy within the healthcare domain through:

i. The implementation of advanced encryption methods to safeguard patient data.

ii. Adoption of multi-factor authentication for secure access.

iii. Detection and response to security breaches using auditing and monitoring tools.

iv. Compliance with data protection regulations such as HIPAA (Health Insurance Portability and Accountability Act).

Strong security safeguards preserve the confidentiality and security of sensitive patient information.

3.8. Healthcare Analytics

Data intelligence-driven healthcare analytics generate comprehensive reports and insights. These analytics:

i. Provide information about patient demographics, disease prevalence, and treatment efficacy.

ii. Facilitate strategic planning by providing data-driven decision support.

iii. Identify cost-cutting and resource-optimization opportunities.

iv. Measure the impact of healthcare initiatives and quality improvement programs.

Healthcare analytics drive continuous enhancement in care delivery and outcomes.
Data Intelligence Applications in healthcare are multifaceted and transformative. They augment patient care, enhance operational efficiency, advance medical research, and secure patient data. As technology continues its evolution, data intelligence will increasingly play a pivotal role in shaping the future of healthcare [13].

4. ETHICAL CONSIDERATIONS

The use of data intelligence applications is accompanied by a variety of problems and ethical concerns. As organizations rely more and more on data for decision-making and innovation, it is critical to be aware of these concerns and take proactive steps to solve them [35]. We will look at the ethical issues and challenges that data intelligence applications present:

4.1. Data Privacy And Security

i. Challenge: Maintaining data privacy and security in the face of massive data quantities is a daunting task. Data breaches can have serious consequences for organizations, including financial losses and brand damage deaths of patients [45].

ii. Ethical Consideration*:* Safeguarding the personal information of individuals constitutes a fundamental ethical requirement. Individuals should retain control over their data, and data collection, storage, and processing must comply with privacy laws and regulations.

4.2. Bias and Fairness

i. Challenge: Biases embedded in data and algorithms can lead to wrong medical treatment of specific groups or individuals patients in the hospital. This is especially important in areas such as financing, hiring, and criminal justice in addition to health sectors where biased judgments can have far-reaching consequences [47].

ii. Ethical Consideration: Ensuring fairness in data intelligence applications is an ethical imperative. Developers must strive to eliminate bias in both algorithms and datasets to prevent discriminatory outcomes.

4.3. Transparency and Explainability

i. Challenge: Many complex machine learning models, especially deep neural networks, are frequently referred to be "black boxes" due to their obfuscated decision-making processes. This lack of transparency poses significant challenges.

ii. Ethical Consideration: The capacity to elucidate the rationale behind a decision is indispensable, particularly in applications that affect individuals' lives. Transparency serves as a cornerstone for trust and accountability [28].

4.4. Data Quality and Accuracy

i. Challenge: Subpar data quality can lead to erroneous insights and decisions, exemplifying the adage "garbage in, garbage out" (GIGO) in data analysis.

ii. Ethical Consideration: Hospitals within health domain bear an ethical responsibility to ensure the accuracy and reliability of data used in intelligence applications. Misleading or incorrect information can result in detrimental consequences.

4.5. Algorithmic Accountability

i. Challenge: Determining accountability when automated systems make decisions can be intricate. For example, who should be held accountable if an autonomous medical tools causes death?

ii. Ethical Consideration: It is critical to establish clear lines of accountability and duty. Ethical frameworks should be in place to address complex scenarios effectively [7].

4.6. Data Access and Equity

i. Challenge: Not all individuals have equitable access to data or the advantages afforded by data intelligence applications. This inequality can exacerbate existing societal disparities.

ii. Ethical Consideration**:** Ensuring equitable access to data and the benefits it offers is of paramount importance. Initiatives should be undertaken to bridge the digital divide.

4.7. Regulatory Compliance

i. Challenge: The landscape of data regulations is intricate and continually evolving. Organizations, especially health institutions, must navigate a complex web of laws and standards.

ii. Ethical Consideration: Adherence to relevant legislation and industry standards is not just a legal requirement, but also an ethical commitment [39].

4.8. Overreliance on Automation

i. Challenge: Relying too heavily on automated systems without human control might lead to disastrous blunders.

ii. Ethical Consideration**:** Striking a judicious balance between automation and human intervention is imperative. Human judgment remains indispensable in critical decision-making processes.

While data intelligence applications hold immense potential, they also entail significant responsibilities. Addressing these issues and ethical concerns is critical for harnessing data's power for the greater good while minimizing potential harm. By doing so, health related organizations can ensure that their data-driven initiatives are not only effective but also ethically sound [17].

5. IMPACT AND FUTURE TRENDS

The influence of data intelligence applications in various domains is undeniable, shaping the present and paving the way for a transformative future. This section explores the impact of these applications on society and outlines the anticipated trends that will further redefine the landscape of data intelligence.

Impact on Society:

Data intelligence applications have left an indelible mark on society, transcending traditional boundaries and catalyzing substantial changes:

I. **Enhanced Healthcare Delivery:** In the healthcare sector, data intelligence has revolutionized patient care, offering personalized treatments and predictive insights that optimize outcomes and minimize adverse effects. This change has the potential to considerably reduce illness burden and improve general well-being [20].

II. **Informed Decision-Making:** Across industries, data-driven decision-making has become the norm. Companies can now make strategic decisions based on actionable insights gained from massive datasets. This shift has led to increased efficiency, resource optimization, and competitive advantages.

III. **Empowering Scientific Discovery:** Data intelligence fuels scientific research and innovation. Researchers can now gain access to massive information in domains such as genetics, materials science, and environmental studies, allowing them to make faster discoveries. This accelerated pace of discovery promises solutions to complex global challenges.

IV. **Advancing Education:** Education benefits from data intelligence through personalized learning experiences, early intervention for struggling students, and the optimization of educational resources. These developments are influencing the future of education, making it more accessible and effective [40].

V. **Economic Growth:** Data-driven businesses and startups that power health systems have emerged as economic powerhouses. They provide a substantial contribution to health institutions, innovation, and job creation by supporting a vibrant entrepreneurial ecosystem [8].

Future Trends:

Anticipating the future of data intelligence applications reveals exciting prospects and trends that will further shape society:

I. **Artificial Intelligence (Ai) Dominance:** AI and machine learning will continue to dominate the data intelligence landscape. Deep learning techniques, natural language processing, and reinforcement learning will enable more sophisticated applications in healthcareand autonomous systems.

II. **Ethics and Regulation:** As data intelligence applications proliferate, ethical considerations and regulations will take center stage. Stricter data privacy laws, algorithmic transparency requirements, and ethical AI frameworks will shape the responsible use of data.

III. **Edge Computing:**Edge computing, which processes data closer to its source, will become more popular. This trend will enhance real-time analytics, reduce latency, and support applications in remote or resource-constrained environments leading to real-time patient health monitoring.

IV. **Quantum Computing:** Quantum computing holds promise for tackling complex problems that are currently intractable for classical computers. Quantum computing will bring in a new era of possibilities in sectors such as encryption, materials research, and drug development.

V. **Data Democratization:** The democratization of data access and analysis tools will empower individuals and smaller organizations. This trend will lead to increased data literacy and a more inclusive data-driven society within health ecosystem.

VI. **Sustainability and Data:** Data intelligence will play a crucial role in sustainability efforts. Applications will focus on optimizing resource use, reducing waste, and addressing environmental challenges such as climate change and biodiversity preservation that impact not only animal but also human adaption.

VII. **Human-Machine Collaboration:** Human-machine collaboration will evolve, emphasizing the augmentation of human capabilities rather than replacement. Augmented intelligence will enhance decision-making and problem-solving across industries.

6. CONCLUSION

The amalgamation of data intelligence with the healthcare sector in the United States has ushered in a new era of transformative potential, promising substantial improvements in patient care, research, and healthcare management. This review has explored the diverse world of Data Intelligence in Healthcare, emphasizing its profound implications for systematic data collection, analysis, and interpretation on healthcare practices, policies, and patient experiences.

Data intelligence applications, spanning clinical decision support, predictive analytics, population health management, personalized medicine, workflow optimization, research, data security, and healthcare analytics, have the potential to revolutionize healthcare delivery. They empower healthcare professionals to make informed decisions, optimize resource allocation, and foster

groundbreaking research projects. However, the adoption of data intelligence applications raises significant ethical considerations. Issues of data privacy, fairness, transparency, data quality, accountability, regulatory compliance, and the balance between automation and human judgment must be addressed to ensure responsible and ethical use of healthcare data.

Looking ahead, several trends are anticipated to shape the future of data intelligence applications in healthcare. These trends include the dominance of artificial intelligence, strengthened ethical and regulatory frameworks, the rise of edge and quantum computing, data democratization, sustainability applications, and the development of human-machine collaboration. The impact of data intelligence extends beyond healthcare delivery, influencing decision-making, scientific discovery, education, and economic growth.

7. FURTHER RESEARCH

Further research in the realm of data intelligence applications within the healthcare sector in the United States presents numerous exciting avenues for exploration. As technology continues to advance and data-driven insights become increasingly integral to healthcare, researchers can delve into various aspects to drive innovation and address emerging challenges. Here are some potential areas for further research:

i. **Advanced AI and Machine Learning Applications:** With the dominance of artificial intelligence (AI) and machine learning in healthcare, there is ample room for in-depth research into the development of more sophisticated AI models. Researchers can investigate how deep learning, natural language processing, and reinforcement learning can further enhance clinical decision support, predictive analytics, and personalized medicine. The focus can be on improving accuracy, interpretability, and real-time decision support.

ii. **Ethical and Regulatory Frameworks:** The ethical considerations surrounding data intelligence in healthcare are evolving. Researchers can contribute by examining the ethical implications of specific applications, such as AI in diagnostics, and propose ethical frameworks tailored to these technologies. Additionally, research on the impact of changing healthcare regulations, like those related to data privacy, can provide insights into the compliance challenges faced by healthcare organizations.

iii. **Edge and Quantum Computing:** Investigating the practical applications of edge computing in healthcare can be a compelling research area. How edge computing can improve real-time patient monitoring, telehealth services, and data processing in remote or resource-constrained environments is worth exploring. Moreover, research on the potential of quantum computing in healthcare, particularly in areas like drug discovery and encryption, can shed light on the transformative possibilities of this emerging technology.

iv. **Data Democratization and Healthcare Equity:** Addressing issues of data equity and accessibility is crucial. Further research can examine initiatives aimed at democratizing access to healthcare data and data intelligence tools, especially for underserved populations. Evaluating the impact of such initiatives on healthcare disparities and patient outcomes can provide valuable insights.

v. **Sustainability and Healthcare Data:** As sustainability becomes increasingly important in healthcare, researchers can explore how data intelligence applications can contribute to sustainability efforts. This might involve optimizing resource utilization, reducing waste,

and addressing environmental challenges, such as the role of data in climate change mitigation and biodiversity preservation.

Further research in the domain of data intelligence applications in healthcare should address the evolving landscape of technology, ethics, and regulations. By exploring these areas, researchers can contribute to the responsible and effective implementation of data intelligence in healthcare, ultimately improving patient care and healthcare management in the United States and beyond.

DECLARATION OF NON-COMPETING INTEREST

The authors affirm that no financial conflicts of interest or personal affiliations exist that might have influenced the content or findings presented in this paper.

REFERENCES

[1] Bates, D. W., et al. "Effect of computerized physician order entry and a team intervention on prevention of serious medication errors." JAMA, 289(1), 1-5 (2003).

[2] Kuperman, G. J., et al. "Medication-related clinical decision support in computerized provider order entry systems: A review." Journal of the American Medical Informatics Association, 14(1), 29-40 (2007).

[3] Kindig, D. A., & Stoddart, G. "What is population health?" American Journal of Public Health, 93(3), 380-383 (2003).

[4] Sholle, E. T., et al. "Analytics for population health: Building a research agenda." Journal of the American Medical Informatics Association, 20(2), 446-453 (2013).

[5] Ginsburg, G. S., & McCarthy, J. J. "Personalized medicine: Revolutionizing drug discovery and patient care." Trends in Biotechnology, 19(12), 491-496 (2001).

[6] Hamburg, M. A., & Collins, F. S. "The path to personalized medicine." New England Journal of Medicine, 363(4), 301-304 (2010).

[7] Bashshur, R., et al. "Telemedicine and the COVID-19 pandemic, lessons for the future." Telemedicine and e-Health, 26(5), 571-573 (2020).

[8] Ohannessian, R., Duong, T. A., & Odone, A. "Global telemedicine implementation and integration within health systems to fight the COVID-19 pandemic: A call to action." JMIR Public Health and Surveillance, 6(2), e18810 (2020).

[9] Efijemue, O., Obunadike, C., Taiwo, E., Kizor, S., Olisah, S., Odooh, C., &Ejimofor, I. "Cybersecurity Strategies for Safeguarding Customers Data and Preventing Financial Fraud in the United States Financial Sectors." International Journal of Soft Computing, Vol. 14, No.3, 10.5121/ijsc.2023.14301 (2023).

[10] Malin, B. A., & Emam, K. E. "Information technology and research ethics: theoretical and practical perspectives." Journal of the American Medical Informatics Association, 20(2), 261-264 (2013).

[11] Hripcsak, G., & Albers, D. J. "Next-generation phenotyping of electronic health records." Journal of the American Medical Informatics Association, 20(1), 117-121 (2013).

[12] Kahn, M. G., et al. "A harmonized data quality assessment terminology and framework for the secondary use of electronic health record data." EGEMS, 1(1), 1014 (2012).

[13] Mittelstadt, B. D., et al. "The ethics of algorithms: Mapping the debate." Big Data & Society, 3(2), 2053951716679679 (2016).

[14] O'Neil, C. "Weapons of math destruction: How big data increases inequality and threatens democracy." Broadway Books (2016).

[15] Esteva, A., et al. "Dermatologist-level classification of skin cancer with deep neural networks." Nature, 542(7639), 115-118 (2017).

[16] Rajkomar, A., et al. "Scalable and accurate deep learning with electronic health records." NPJ Digital Medicine, 1(1), 1-10 (2018).

[17] Ekblaw, A., et al. "A case study for blockchain in healthcare: “MedRec” prototype for electronic health records and medical research data." In: Proceedings of IEEE Open & Big Data Conference, 2016, 228-231.

[18] Mense, A., & Fornaciari, W. "Blockchain for health data and its potential use in health IT and health care related research." In: Proceedings of the 2017 ACM International Conference on Management of Data, 1969-1970 (2017).
[19] El Emam, K., et al. "A globally optimal k-anonymity method for the de-identification of health data." Journal of the American Medical Informatics Association, 21(2), 212-218 (2013).
[20] Obermeyer, Z., & Emanuel, E. J. "Predicting the future—big data, machine learning, and clinical medicine." The New England Journal of Medicine, 375(13), 1216-1219 (2016).
[21] Shaikh, M., et al. "Blockchain-based secure healthcare system for telemedicine applications." In: Proceedings of the 2017 IEEE International Congress on Big Data, 44-51 (2017).
[22] Arnerić, J., et al. "Ethical considerations in the use of predictive analytics in clinical trials." Contemporary Clinical Trials Communications, 17, 100504 (2020).
[23] Ross, J., et al. "The use of big data in healthcare: Ethical concerns and potential benefits." Health Information Science and Systems, 5(1), 1-6 (2017).
[24] Jain, S. H., & Harris, D. "Using digital technology to better generate evidence and deliver evidence-based care." Journal of General Internal Medicine, 33(12), 2187-2188 (2018).
[25] Alami, H., Gagnon, M. P., & Fortin, J. P. "Some multidimensional unintended consequences of telehealth utilization: A multi-project evaluation synthesis." International Journal of Health Policy and Management, 5(7), 491-503 (2016).
[26] 26.Sastry, N., Helf, C., & DeFilippo, D. "Cybersecurity in healthcare: A systematic review of modern threats and trends." Technology and Health Care, 27(5), 437-447 (2019).
[27] Rathore, M. M., Paul, A., & Ahmad, A. "Enhancing the security of electronic health records using attribute-based cryptography." Journal of Medical Systems, 40(2), 49 (2016).
[28] Kuziemsky, C. E. "Review of ethical and privacy issues in health IT." Studies in Health Technology and Informatics, 228, 954-958 (2016).
[29] Raisaro, J. L., et al. "Protecting privacy in genomic data sharing: A case study for responsible algorithms." Scientific Reports, 8, 1-14 (2018).
[30] Zeevi, D., Korem, T., & Segal, E. "Interindividual variability in human gut microbiota: Patterns, mechanisms, and their role in pathogenesis." Frontiers in Cellular and Infection Microbiology, 10, 39 (2020).
[31] Asghar, I., Cang, S., & Yu, H. "Challenges and opportunities of blockchain adoption for the pharmaceutical industry." Computer Methods and Programs in Biomedicine, 184, 105073 (2020).
[32] Patil, H., et al. "Artificial intelligence in precision medicine." Artificial Intelligence in Medicine, 103, 101785 (2020).
[33] Zhang, X., et al. "Deep learning in the analysis of EEG and ERP big data: A review." NeuroImage, 200, 107581 (2019).
[34] Masic, I., et al. "Medical informatics in Bosnia and Herzegovina - 20 years of science and research." Acta Informatica Medica, 21(3), 196 (2013).
[35] Sun, L., et al. "Development of EHR (electronic health record) system and decision support for central diabetes insipidus patients." In: Proceedings of the 2013 IEEE International Conference on Bioinformatics and Biomedicine, 35-40 (2013).
[36] Melas, P. A., et al. "Patient opinions and attitudes towards electronic patient information in a well-defined area in Sweden." Informatics for Health and Social Care, 43(1), 63-76 (2018).
[37] Weber, G. M., et al. "The shared health research information network (SHRINE): A prototype federated query tool for clinical data repositories." Journal of the American Medical Informatics Association, 16(5), 624-630 (2009).
[38] Sorani, M. D., et al. "Prognostic value of multimodal evoked potentials in moderate and severe traumatic brain injury." Brain Injury, 24(8), 975-980 (2010).
[39] Loukides, G., Denny, J. C., & Malin, B. "The disclosure of diagnosis codes can breach research participants' privacy." Journal of the American Medical Informatics Association, 20(4), 687-692 (2013).
[40] Karim, A., et al. "A comparison of data preprocessing techniques for prediction models." Journal of Information & Knowledge Management, 15(04), 1-15 (2016).
[41] Zhang, X., et al. "The potential for big data to improve health outcomes and systems." Journal of the American Medical Informatics Association, 20(2), 277-280 (2013).

[42] Bragazzi, N. L., &Mahroum, N. "The value of global health information and surveillance systems: What are the implications for the United Nations post-2015 sustainable development goals?". Health Policy and Technology, 5(3), 223-227 (2016).
[43] Wachter, R. M., & Cassel, C. K. "The good doctor: A new, old role." Annals of Internal Medicine, 172(9), 614-615 (2020).
[44] Hauskrecht, M., et al. "Outlier detection for patient monitoring and alerting." Journal of Biomedical Informatics, 55, 30-40 (2015).
[45] Sahama, T., et al. "Proposing a framework for using mHealth for healthcare purposes." Health Informatics Journal, 19(3), 198-215 (2013).
[46] Bates, D. W., & Sheikh, A. "Asking the right questions about electronic health record safety." Journal of the American Medical Informatics Association, 20(4), 472-474 (2013).
[47] Khorasanee, R. "Implementing electronic health record-based quality measures for developmental screening." Pediatrics, 135(4), e1081-e1087 (2015).
[48] Reshef, D. N., et al. "Detecting novel associations in large data sets." Science, 334(6062), 1518-1524 (2011).
[49] Plasek, J. M., et al. "Analytics for infection control: Visualization of hospital-acquired infections." Journal of the American Medical Informatics Association, 20(2), 257-262 (2013).
[50] Tavares, J., & Oliveira, T. "Electronic health record patient portal adoption by health care consumers: An acceptance model and survey." Journal of Medical Internet Research, 18(3), e49 (2016).