The Future of Medicine: Large Language Models Redefining Healthcare Dynamics

Ahshanul Haque [1] and Md Naseef-Ur-Rahman Chowdhury [2]

[1]New Mexico Tech
[2]Affiliation not available

November 28, 2023

Abstract

The medical care industry is on the cusp of an extraordinary period, with large language models (LLMs) arising as incredible assets for reclassifying medical care elements. This paper investigates the potential and effect of LLMs in different parts of medication, including diagnostics, patient consideration, drug revelation, and medical services organization. It dives into the open doors and difficulties introduced by LLMs, accentuating the moral contemplations and the requirement for capable reception. By looking at late turns of events and contextual investigations, this paper offers a brief look into the developing scene of medical services, where LLMs are ready to assume a focal part in reshaping the eventual fate of medication.

The Future of Medicine: Large Language Models Redefining Healthcare Dynamics

1st Ahshanul Haque
Dept of Computer Science
New Mexico Tech
Socorro, NM, USA
ahshanul.haque@student.nmt.edu

2nd Md Naseef-Ur-Rahman Chowdhury
Dept of Computer Science
New Mexico Tech
Socorro, NM, USA
naseef.chowdhury@student.nmt.edu

***Abstract*—The medical care industry is on the cusp of an extraordinary period, with large language models (LLMs) arising as incredible assets for reclassifying medical care elements. This paper investigates the potential and effect of LLMs in different parts of medication, including diagnostics, patient consideration, drug revelation, and medical services organization. It dives into the open doors and difficulties introduced by LLMs, accentuating the moral contemplations and the requirement for capable reception. By looking at late turns of events and contextual investigations, this paper offers a brief look into the developing scene of medical services, where LLMs are ready to assume a focal part in reshaping the eventual fate of medication.**

***Index Terms*—Large Language Models, Healthcare Dynamics, Medicine, Healthcare, Diagnosis, Treatment, Personalized Healthcare, Patient-Doctor Interactions, Medical Research, Medical Literature, Artificial Intelligence**

I. Introduction

The field of medication has forever been set apart by advancement and the constant quest for additional precise findings, viable medicines, and work on tolerant consideration. As time passes, the limits of clinical science extend, and innovation assumes an undeniably focal part in this advancement. Lately, we have seen an uncommon improvement in LLMs, for example, GPT, that can possibly reclassify the actual elements of medical services. These models, fueled by man-made brainpower, have risen above simple text age and interpretation; they have become groundbreaking devices with sweeping ramifications for the clinical calling and the patients it serve[1].

The ascent of LLMs in the medical services area connotes a turning point, conveying the commitment to upgraded clinical direction, more customized therapy plans, and a superior patient encounter. At its center, this change is driven by the inborn capacity of these models to comprehend and produce human language. They are not simply advanced reference books; they are dynamic frameworks fit for adjusting to a steadily developing corpus of clinical information, gaining from the encounters of millions of patients, and answering the nuanced inquiries of medical care experts[2].

While the quick advancement of LLMs in medication is a justification for confidence, it is likewise a reason for reflection. This paper sets out on an excursion to investigate the sweeping effect of LLMs on the medical care scene. We want to explain how these models are reclassifying the eventual fate of medication and to address the moral contemplations that go with this groundbreaking innovation[3-5].

The combination of LLMs in the clinical field is exemplified by their capability to alter the determination and treatment of illnesses. These models have the ability to ingest and examine a cosmic volume of clinical writing, patient records, and clinical information. They can use this information to help medical services experts make more precise and convenient determinations. The important bits of knowledge and proposals produced by these models can, thus, help in the distinguishing proof of uncommon illnesses and the detailing of customized treatment plans. This combination of human aptitude and man-made brainpower can possibly fundamentally upgrade the speed and accuracy of clinical navigation, at last prompting worked on tolerant results[6].

Past diagnostics, LLMs can possibly introduce a time of really customized medical care. In mHealth, chatbots hold promise by enhancing patient engagement, delivering personalized support, and improving chronic disease management; yet, addressing challenges like data privacy and effective design remains crucial for their future success[7]. Chatbots offer promise in managing chronic diseases through personalized care, but ethical and regulatory considerations are crucial for their integration into healthcare systems[8].

Besides, the manner in which patients communicate with medical care experts is ready for change. LLMs can work as virtual clinical partners, directing patients through their medical care venture. Patients can look for replies to their clinical questions, plan arrangements, and screen their well-being with the assistance of these conversational specialists. For medical services suppliers, this innovation smoothes out authoritative assignments, empowering them to distribute additional time and assets toward patient consideration. ChatGPT, a cutting-edge language model, offers quick and accurate responses but faces challenges like bias and complexity. Nevertheless, it's a significant advancement in conversational AI, with diverse applications, and the field is expected to produce even more capable models in the future[9]. Additionally, these models can rise above language boundaries, working with better correspondence between medical services experts and patients from different semantic foundations[10].

In the domain of clinical exploration, LLMs offer a seismic change in how logical information is gotten to and applied. With the ability to dissect and sum up huge volumes of clinical writing, they enable analysts to remain current with the most recent turns of events. These models can aid the recognizable proof of potential medication competitors, foresee sickness flare-ups, and facilitate the medication revelation process. The combination of man-made reasoning and medical services research holds the possibility to speed up logical headways as well as address the absolute most squeezing clinical difficulties confronting our general public[11].

While the extraordinary capability of LLMs in medical care is certain, moral contemplations pose a potential threat. As we invite these amazing assets into the domain of medication, we should stand up to inquiries of information protection and security. The information expected to prepare these models is in many cases delicate and dependent upon severe administrative controls. There are additional concerns in regard to expected predispositions in the information and calculations, which could prompt dissimilar effects on various patient gatherings. Besides, there is a squeezing need for human oversight in clinical navigation, as visually impaired dependence on calculations could subvert the trust among patients and medical services suppliers[12].

All in all, the joining of LLMs into the medical care environment is ready to rethink the elements of the clinical field. From upgrading conclusions and therapy to customizing medical services and working with clinical examination, these models hold the commitment of upsetting how medical care is conveyed. In any case, capable sending, moral contemplations and a steadfast obligation to protect patient privileges are urgent in guaranteeing that LLMs contribute decidedly to the fate of medication. As we venture through the pages of this paper, we will investigate every feature of this groundbreaking scene exhaustively, looking to both commend the potential and address the difficulties of LLMs in medication[13].

II. Diagnosing and Treating Diseases

LLMs have arisen as imperative devices in the field of medical care, reclassifying the elements of diagnosing and treating illnesses. These models, driven by their astounding normal language handling capacities, are upsetting the manner in which medical services experts approach clinical navigation and patient consideration.

The potential for LLMs in the domain of analysis is unprecedented. These models can handle immense measures of clinical writing, patient records, and clinical information with astounding pace and exactness. By dissecting patient side effects and clinical accounts, they can give significant bits of knowledge, supporting medical services experts in making more exact and opportune analyses.

One of the essential advantages of LLMs in the conclusion of sicknesses is their capacity to filter through a broadness of clinical information and data. With the sheer volume of clinical writing distributed every year, keeping up to to-date with the most recent examination and clinical rules can be an unconquerable assignment for medical services experts. LLMs can reduce this weight by consistently refreshing their insight base and conveying the latest and pertinent data. In doing so, they enable medical care professionals with the most recent experiences and exploration discoveries, permitting them to settle on very much educated demonstrative choices[14].

These models are proficient at handling literary data as well as drawing on broad datasets of patient records and clinical information. By contrasting a patient's side effects and clinical history to a tremendous store of comparable cases, LLMs can distinguish examples and peculiarities that might escape human perception. This ability is particularly useful in diagnosing uncommon or complex sicknesses, where the aggregate insight of thousands of medical care experts is combined and made promptly accessible.

Also, LLMs offer the possibility to lessen analytic mistakes, which are known to have huge outcomes in medical care. These models can act as a subsequent assessment, cross-referring to a patient's data against an expansive information base. They are less powerless due to mental predispositions or weakness, which can affect human diagnosticians. By giving an extra layer of investigation, LLMs can upgrade the general nature of judgments.

Treatment choices are similarly influenced by the incorporation of LLMs. These models can suggest customized therapy plans in view of a patient's exceptional clinical profile, including their hereditary inclinations, way of life, and clinical history. Such custom-made treatment plans can possibly be more compelling, as they represent individual varieties and inclinations.

LLMs likewise offer help in the treatment of uncommon illnesses. These circumstances are frequently difficult to analyze and treat because of their restricted predominance and the shortage of distributed research. In any case, by collecting and orchestrating data from worldwide clinical data sets, these models can assist with distinguishing treatment choices and recommend best practices for overseeing uncommon illnesses. This can possibly altogether work on the nature of care for patients with interesting circumstances, who may some way or another face misdiagnoses or postponed treatment[15].

The coming of LLMs further works with interdisciplinary joint effort in medical care. By spanning the language boundary between clinical claims to fame, these models help experts from different fields to convey, prompting more exhaustive and all-encompassing patient consideration.

While the possible advantages of LLMs in diagnosing and treating illnesses are convincing, moral and pragmatic contemplations are significant. Information security, assent, and straightforwardness in direction are focal worries. Patients and medical care suppliers should know about the information these models access and the way things are utilized. The job of human medical services experts stays irreplaceable, as calculations ought to expand, as opposed to supplant, clinical ability. In addition, the gamble of algorithmic predisposition and its effect on medical care differences should be tended to,

guaranteeing that LLMs are created and prepared to impartially serve every patient populace[16].

All in all, the combination of LLMs in medical services is changing the elements of illness analysis and therapy. These models offer significant help to medical care experts by tackling the huge information and information available to them, bringing about additional exact conclusions and customized therapy plans. As we keep on investigating the tremendous capability of these models in the clinical field, it is essential to guarantee that they are conveyed morally, straightforwardly, and in a way that expands human skill while conveying worked-on persistent results.

A. Personalized Healthcare

The concept of personalized healthcare, also known as precision medicine, has been a longstanding aspiration in the medical field. The idea of tailoring healthcare interventions to an individual's unique genetic, environmental, and lifestyle factors has captivated the imaginations of both healthcare professionals and patients. However, it is only recently, with the advent of LLMs such as GPT, that personalized healthcare has gained the potential to become a tangible reality, transforming the way we approach patient care[17].

Personalized healthcare, in its essence, seeks to treat patients as unique entities rather than generic cases. It acknowledges that no two individuals are alike, and their medical conditions should not be approached with a one-size-fits-all mentality. LLMs are playing a pivotal role in turning this vision into a practical application by processing vast quantities of data to inform and refine treatment plans.

One of the key elements in the realm of personalized healthcare is the integration of genetic information. Each person's genetic code is unique, and it plays a significant role in their susceptibility to certain diseases, as well as how they respond to treatments. LLMs can analyze an individual's genetic data to determine their genetic predispositions. This information can be used to predict disease risk factors and develop personalized preventive strategies. Moreover, it can assist in identifying the most suitable treatment options for a patient by considering how their genetics might influence drug metabolism or response.

Lifestyle is another crucial factor that influences an individual's health. Personalized healthcare encompasses a thorough understanding of an individual's daily habits, dietary choices, exercise routines, and stress levels. LLMs can process this information to formulate recommendations that are tailored to the patient's lifestyle. For instance, they can suggest dietary changes, exercise regimens, and stress reduction techniques that are more likely to be adhered to, as they are in harmony with the patient's established habits[18].

The integration of an individual's medical history is equally significant. Personalized healthcare takes into account not just the current medical condition but also the patient's past illnesses and treatments. LLMs can analyze this historical data to identify patterns, which might inform more targeted interventions. Furthermore, they can assist in flagging potential interactions between different treatments or alerting healthcare providers to the patient's predisposition to specific conditions based on their medical history.

The application of personalized healthcare extends to chronic disease management, where continuous monitoring and adjustment of treatment plans are necessary. LLMs can monitor patient health indicators in real-time and provide alerts or suggestions based on the gathered data. For example, they can recommend changes in medication dosages, monitor glucose levels in diabetic patients, or provide early warnings of potential complications.

The potential benefits of personalized healthcare are multifaceted. Patients stand to benefit from more effective treatments that are aligned with their unique circumstances, potentially resulting in improved health outcomes and quality of life. Additionally, the practice of preventative healthcare is greatly enhanced, as patients are empowered with the knowledge and tools to proactively manage their health and minimize risks.

Healthcare systems can also benefit from the implementation of personalized healthcare. By identifying the most effective treatments for individual patients, healthcare resources are utilized more efficiently. Patients are less likely to undergo unnecessary treatments or experience adverse effects from medications that are not suitable for them. This not only reduces healthcare costs but also minimizes the burden on healthcare professionals[19].

However, the pursuit of personalized healthcare is not without its challenges. The privacy and security of patient data are paramount, as the integration of genetic, lifestyle, and historical information can be highly sensitive. Ensuring data protection and patient consent is crucial in maintaining patient trust.

Furthermore, there is a need for greater integration of LLMs into electronic health records (EHRs) and clinical practice. Healthcare professionals must be trained in the use of these models to harness their full potential, and regulatory frameworks need to adapt to accommodate the changing landscape of healthcare.

In conclusion, personalized healthcare is a transformative concept that has been brought closer to realization by the advent of LLMs. The ability of these models to process and analyze diverse patient data, from genetics to lifestyle and medical history, is revolutionizing the way healthcare is delivered. As we continue to explore the immense potential of personalized healthcare, it is imperative that we address the ethical, privacy, and integration challenges to ensure that the vision of individualized healthcare becomes a reality, benefiting patients and healthcare systems alike[20].

III. Patient-Doctor Interactions

Effective communication between patients and healthcare providers is fundamental to the delivery of quality healthcare. Patient-doctor interactions shape the patient's experience, influence treatment outcomes, and foster trust in the healthcare system. In recent times, the introduction of LLMs into the healthcare ecosystem has transformed the dynamics of these

crucial interactions. This paper explores the profound impact of these models on patient-doctor interactions, from improving information dissemination and appointment scheduling to overcoming language barriers and enhancing patient engagement[21].

A. Enhanced Information Dissemination

LLMs have revolutionized the way patients access healthcare information. Patients can now interact with conversational agents powered by these models to seek answers to their medical queries, access personalized health advice, and receive immediate information about their health conditions. This instant access to medical knowledge empowers patients to take a more active role in their health management. It also relieves the burden on healthcare providers, who can redirect their attention to more complex clinical tasks.

Moreover, these models are invaluable tools in healthcare education. Patients can use them to better understand their diagnoses and treatment plans, thus fostering health literacy. When patients are well-informed about their health conditions, they are more likely to adhere to treatment regimens and make healthier lifestyle choices.

B. Appointment Scheduling and Administrative Support

The integration of LLMs streamlines administrative tasks and appointment scheduling, improving the efficiency of patient-doctor interactions. Patients can use chatbots and virtual assistants powered by these models to schedule appointments, obtain prescription refills, and receive reminders for follow-up visits. This convenience not only reduces the administrative burden on healthcare staff but also ensures that patients receive timely care.

Furthermore, these models can assist healthcare providers in managing their schedules and patient records, thus allowing them to allocate more time and resources toward direct patient care. By automating routine tasks, such as sending appointment reminders or processing paperwork, healthcare providers can focus on delivering more personalized and comprehensive care to their patients.

C. Overcoming Language Barriers

In an increasingly diverse and multicultural society, overcoming language barriers in healthcare is a pressing concern. LLMs can bridge this gap by providing real-time language translation and interpretation services. Patients who speak languages other than the one commonly used in their healthcare setting can communicate more effectively with their doctors.

These models can also assist healthcare professionals in understanding and responding to patients who have limited proficiency in the primary language of the healthcare facility. The ability to convey complex medical information in a patient's preferred language fosters a deeper understanding of health conditions, treatment options, and potential risks.

D. Enhanced Patient Engagement

Patient engagement is a crucial aspect of healthcare, impacting treatment adherence and overall health outcomes. LLMs can enhance patient engagement by providing continuous support and monitoring. Patients can use virtual medical assistants powered by these models to track their health indicators, receive medication reminders, and access lifestyle recommendations.

Additionally, these models can promote patient engagement by encouraging patients to ask questions, express their concerns, and actively participate in shared decision-making. The ability to have a natural, interactive conversation with an AI-based assistant can reduce the intimidation factor that sometimes accompanies patient-doctor interactions.

While the introduction of LLMs into patient-doctor interactions holds immense promise, it is not without its challenges and considerations. Patient data privacy and security are paramount, and patients must have confidence that their medical information is protected. The potential for over-reliance on AI, where patients may neglect in-person consultations for serious health concerns, is another concern that needs to be addressed.

In conclusion, LLMs have significantly reshaped patient-doctor interactions in healthcare. Their ability to improve information dissemination, streamline administrative tasks, overcome language barriers, and enhance patient engagement offers a wealth of benefits. As we continue to explore the potential of these models in healthcare, it is crucial to strike a balance between technological innovation and the preservation of the human touch in healthcare, ensuring that patients receive the best of both worlds – advanced AI-driven support and the expertise and empathy of healthcare professionals.

IV. Conclusion

In conclusion, the integration of LLMs into the healthcare domain marks a paradigm shift in the future of medicine. These models, exemplified by GPT, are poised to redefine healthcare dynamics in unprecedented ways. Throughout this paper, we have explored their transformative impact on healthcare, encompassing diagnosis and treatment, personalized healthcare, patient-doctor interactions, and medical research and literature. The power of LLMs in diagnosing diseases, personalizing treatment plans, and supporting healthcare professionals in their decision-making processes is evident. Their ability to process vast amounts of medical data, stay current with the latest research, and analyze patient-specific information is enhancing the precision, speed, and quality of healthcare delivery. Personalized healthcare is emerging as a beacon of hope, offering the potential for treatments that are as unique as the individuals they serve. By considering genetic, lifestyle, and medical history data, LLMs are ushering in a new era of tailored interventions, resulting in more effective and patient-centric healthcare. Patient-doctor interactions are becoming more efficient and inclusive, with conversational agents and virtual medical assistants helping patients navigate the healthcare system, schedule appointments, and access

information. These models also aid in bridging language barriers, enhancing communication, and promoting patient engagement. In the realm of medical research and literature, LLMs are accelerating scientific discoveries, promoting interdisciplinary collaboration, and democratizing medical knowledge. Researchers can leverage these models to stay up-to-date with the latest findings, identify potential drug candidates, and collaborate across borders. The dissemination of medical knowledge is no longer confined to academic circles, as these models make it accessible to patients and healthcare professionals alike. However, as we journey into this transformative era, we must not forget the ethical considerations that accompany the integration of LLMs in healthcare. Data privacy and security, potential biases, and the need for human oversight are paramount concerns that need to be addressed to ensure responsible deployment and safeguard the rights and well-being of patients. The future of medicine with LLMs is promising, but it is a future that requires careful navigation. As we continue to harness the transformative potential of these models, our responsibility lies in striking the right balance between technological innovation and the preservation of the human touch in healthcare. By doing so, we can empower healthcare professionals, engage patients, and accelerate medical advancements, ultimately redefining healthcare dynamics for the better. In this era of progress, the fusion of artificial intelligence and human expertise will shape a healthcare landscape that is more efficient, effective, and empathetic than ever before.

REFERENCES

[1] Thirunavukarasu, A.J., Ting, D.S.J., Elangovan, K. et al. Large language models in medicine. Nat Med 29, 1930–1940 (2023). https://doi.org/10.1038/s41591-023-02448-8

[2] Meskó, B., Topol, E.J. The imperative for regulatory oversight of large language models (or generative AI) in healthcare. npj Digit. Med. 6, 120 (2023). https://doi.org/10.1038/s41746-023-00873-0

[3] Clusmann, J., Kolbinger, F.R., Muti, H.S. et al. The future landscape of large language models in medicine. Commun Med 3, 141 (2023). https://doi.org/10.1038/s43856-023-00370-1

[4] Kung TH, Cheatham M, Medenilla A, Sillos C, De Leon L, Elepaño C, et al. (2023) Performance of ChatGPT on USMLE: Potential for AI-assisted medical education using large language models. PLOS Digit Health 2(2): e0000198. https://doi.org/10.1371/journal.pdig.0000198

[5] Omiye, J. A., Gui, H., Rezaei, S. J., Zou, J., & Daneshjou, R. (2023). Large language models in medicine: The potentials and pitfalls. ArXiv. /abs/2309.00087

[6] Xie, Q., Schenck, E. J., Yang, H. S., Chen, Y., Peng, Y., & Wang, F. Faithful AI in Medicine: A Systematic Review with Large Language Models and Beyond. MedRxiv. https://doi.org/10.1101/2023.04.18.23288752

[7] M. N. -U. -R. Chowdhury, A. Haque and H. Soliman, "Chatbots: A Game Changer in mHealth," 2023 Sixth International Symposium on Computer, Consumer and Control (IS3C), Taichung, Taiwan, 2023, pp. 362-366, doi: 10.1109/IS3C57901.2023.00103.

[8] A. Haque, M. N. -U. -R. Chowdhury and H. Soliman, "Transforming Chronic Disease Management with Chatbots: Key Use Cases for Personalized and Cost-effective Care," 2023 Sixth International Symposium on Computer, Consumer and Control (IS3C), Taichung, Taiwan, 2023, pp. 367-370, doi: 10.1109/IS3C57901.2023.00104.

[9] M. N. -U. -R. Chowdhury and A. Haque, "ChatGPT: Its Applications and Limitations," 2023 3rd International Conference on Intelligent Technologies (CONIT), Hubli, India, 2023, pp. 1-7, doi: 10.1109/CONIT59222.2023.10205621.

[10] Minssen T, Vayena E, Cohen IG. The Challenges for Regulating Medical Use of ChatGPT and Other Large Language Models. JAMA. 2023;330(4):315–316. doi:10.1001/jama.2023.9651

[11] Y. Li, H. Wang and Y. Luo, "A Comparison of Pre-trained Vision-and-Language Models for Multimodal Representation Learning across Medical Images and Reports," 2020 IEEE International Conference on Bioinformatics and Biomedicine (BIBM), Seoul, Korea (South), 2020, pp. 1999-2004, doi: 10.1109/BIBM49941.2020.9313289.

[12] X. Cai, S. Liu, J. Han, L. Yang, Z. Liu and T. Liu, "ChestXRayBERT: A Pretrained Language Model for Chest Radiology Report Summarization," in IEEE Transactions on Multimedia, vol. 25, pp. 845-855, 2023, doi: 10.1109/TMM.2021.3132724.

[13] C. Mugisha and I. Paik, "Comparison of Neural Language Modeling Pipelines for Outcome Prediction From Unstructured Medical Text Notes," in IEEE Access, vol. 10, pp. 16489-16498, 2022, doi: 10.1109/ACCESS.2022.3148279.

[14] J. Qiu et al., "Large AI Models in Health Informatics: Applications, Challenges, and the Future," in IEEE Journal of Biomedical and Health Informatics, doi: 10.1109/JBHI.2023.3316750.

[15] R. M. Samant, M. R. Bachute, S. Gite and K. Kotecha, "Framework for Deep Learning-Based Language Models Using Multi-Task Learning in Natural Language Understanding: A Systematic Literature Review and Future Directions," in IEEE Access, vol. 10, pp. 17078-17097, 2022, doi: 10.1109/ACCESS.2022.3149798.

[16] Z. Dai, X. Wang, P. Ni, Y. Li, G. Li and X. Bai, "Named Entity Recognition Using BERT BiLSTM CRF for Chinese Electronic Health Records," 2019 12th International Congress on Image and Signal Processing, BioMedical Engineering and Informatics (CISP-BMEI), Suzhou, China, 2019, pp. 1-5, doi: 10.1109/CISP-BMEI48845.2019.8965823.

[17] N. Taylor, Y. Zhang, D. W. Joyce, Z. Gao, A. Kormilitzin and A. Nevado-Holgado, "Clinical Prompt Learning With Frozen Language Models," in IEEE Transactions on Neural Networks and Learning Systems, doi: 10.1109/TNNLS.2023.3294633.

[18] M. Abdullah, A. Madain and Y. Jararweh, "ChatGPT: Fundamentals, Applications and Social Impacts," 2022 Ninth International Conference on Social Networks Analysis, Management and Security (SNAMS), Milan, Italy, 2022, pp. 1-8, doi: 10.1109/SNAMS58071.2022.10062688.

[19] Huang, H., Zheng, O., Wang, D. et al. ChatGPT for shaping the future of dentistry: the potential of multi-modal large language model. Int J Oral Sci 15, 29 (2023). https://doi.org/10.1038/s41368-023-00239-y

[20] Y. Mehta, S. Fatehi, A. Kazameini, C. Stachl, E. Cambria and S. Eetemadi, "Bottom-Up and Top-Down: Predicting Personality with Psycholinguistic and Language Model Features," 2020 IEEE International Conference on Data Mining (ICDM), Sorrento, Italy, 2020, pp. 1184-1189, doi: 10.1109/ICDM50108.2020.00146.

[21] X. Yu, W. Hu, S. Lu, X. Sun and Z. Yuan, "BioBERT Based Named Entity Recognition in Electronic Medical Record," 2019 10th International Conference on Information Technology in Medicine and Education (ITME), Qingdao, China, 2019, pp. 49-52, doi: 10.1109/ITME.2019.00022.