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Yapay zekanın birinci basamak sağlık hizmetlerindeki rolü ve geleceği

The role and future of artificial intelligence in primary care

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Özet

Teknolojinin hızla evrim geçirmesi, Yapay zekayı (YZ) çeşitli sektörlerde, özellikle sağlık alanında yeniliklerin öncüsü konumuna getirmiştir. Bu derleme, YZ'nin birinci basamak sağlık hizmetindeki mevcut ve gelecekteki rollerini araştırarak, dönüştürücü etkisini ve entegrasyonunu beraberinde getiren zorlukları vurgulamaktadır.

YZ şu anda sağlık profesyonellerine birçok şekilde yardımcı olmaktadır. Tanı prosedürleri, tıbbi görüntüleri hassasiyetle analiz edebilen YZ algoritmaları sayesinde devrim geçirmiştir. Hastaların randevu planlaması ve kayıt tutma gibi idari görevler, YZ'nin işlemleri hızlandırma yetenekleri sayesinde daha verimli hale gelmiştir. Öngörüsel analitik, kritik bir YZ özelliği olarak, geniş çaplı hasta verilerini analiz ederek sağlık sorunlarını önceden tahmin etmede önemli bir rol oynamaktadır. Ayrıca, YZ tele-tıbbı önemli ölçüde ilerletmiş ve küresel sağlık acil durumları sırasında sağlık hizmetlerine daha geniş erişim sağlamıştır.

Bunun yanı sıra, YZ kişiselleştirilmiş tıp alanına önemli katkılarda bulunmakta, genetik bilgi gibi büyük ölçekli verileri analiz ederek tedavi planlarını özelleştirmektedir. Elektronik Sağlık Kayıtları (ESK) sistemlerine entegrasyonu, veri işleme süreçlerini iyileştirerek tedavi sonuçlarını ve operasyonel verimliliği artırmaktadır. Bu gelişmelere rağmen, bazı zorluklar devam etmektedir. Veri gizliliği endişeleri, hasta bakımında insan faktörünün erozyonu, mevcut sistemlere YZ'nin entegrasyonuyla ilgili zorluklar ve teknolojiye aşırı bağımlılık riski, dikkatli bir yönetim gerektiren acil konulardır. Algoritmik şeffaflık ve sorumluluk gibi etik konular da önemli zorluklar oluşturmaktadır.

Geleceğe baktığımızda, birinci basamak sağlık hizmetinde YZ'nin seyri, etik etkiler ve teknoloji ile insan merkezli bakım arasında bir denge sağlama üzerine daha ileri gelişmelere odaklanmış durumdadır. YZ'nin kronik hastalık yönetimi ve ruh sağlığı gibi alanlarda geliştirilmesi potansiyeli büyüktür. Birinci basamak sağlık hizmetinde YZ odaklı bir döneme yaklaşırken, bu derleme, teknolojik yenilikleri empatik hasta bakımıyla birleştirmenin önemini vurgulamaktadır.

Anahtar kelimeler: Yapay zeka, aile hekimliği, birinci basamak

Summary

The rapid evolution of technology has positioned Artificial intelligence (AI) at the forefront of innovation in various sectors, notably in healthcare. This review explores AI's current and future roles in primary healthcare, highlighting its transformative impact and the challenges that accompany its integration.

AI currently aids healthcare practitioners in a myriad of ways. Diagnostic procedures have been revolutionized by AI algorithms capable of analysing medical images with precision. Administrative tasks, such as patient scheduling and record-keeping, have become more efficient due to AI's streamlining capabilities. Predictive analytics, a critical AI feature, plays a pivotal role in pre-empting health complications by analysing extensive patient data. Additionally, AI has significantly advanced telemedicine, offering wider access to healthcare, a crucial development amidst global health emergencies.

Moreover, AI contributes substantially to personalized medicine, analysing large-scale data, including genetic information, to tailor treatment plans. Its integration into Electronic Health Records (EHR) systems enhances data processing, improving treatment outcomes and operational efficiency.

Despite these advancements, challenges persist. Data privacy concerns, potential erosion of the human element in patient care, difficulties integrating AI with existing systems, and the risk of over-reliance on technology are pressing issues that require careful management. Ethical considerations, including algorithmic transparency and accountability, also pose significant challenges.

Looking ahead, AI's trajectory in primary healthcare is geared towards further advancements, with an emphasis on ethical implications and maintaining a balance between technology and human-centred care. The potential of AI to enhance areas like chronic disease management and mental health care is vast. As we approach an AI-driven era in primary healthcare, this review underscores the importance of merging technological innovation with empathetic patient care.

Keywords: Artificial Intelligence, family physician, primary care

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Introduction

Artificial intelligence (AI) embodies the quest to instil machines with capabilities that mimic human intelligence. Historically rooted in the ground-breaking Dartmouth summer research project of 1955, where luminaries like McCarthy, Minsky, Rochester, and Shannon postulated foundational ideas of AI, the field has aimed to create machines capable of human-like thought processes.[1]

Core facets of AI include learning—where systems accumulate information and the guiding rules for its utilization; reasoning—the act of leveraging these rules to derive either general or precise conclusions; or the ability for self-refinement. Over the decades, the propulsion of AI can be attributed to technologies such as machine learning (which allows computers to glean insights from data and enhance their performance), neural networks, and natural language processing (NLP).[2]

Artificial intelligence (AI) has a broad range of applications, transforming various sectors with its advanced capabilities. Voice and speech recognition technologies, as exemplified by Siri from Apple and Alexa from Amazon, allow users to interact with devices using natural language commands, assisting in everyday tasks like communication, entertainment, and home automation. In the realm of image recognition, tools such as Google Lens, Amazon Rekognition, and Microsoft Azure Cognitive Services harness AI to identify and interpret elements within images and videos, offering functionalities crucial for security, content moderation, and user interaction. The field of autonomous vehicles, particularly Tesla's self-driving cars, showcases AI's role in navigation and road safety, employing a combination of sensors and algorithms to analyse and respond to real-time road conditions.[3,4]

Predictive analytics, another significant AI application, utilizes machine learning and statistical methods to forecast future events from historical data, proving invaluable in sectors like finance, marketing, and healthcare for risk assessment, consumer behaviour prediction, and disease management. Furthermore, AI-driven chatbots and virtual assistants are revolutionizing customer service and information dissemination, using natural language processing to deliver efficient and responsive assistance.

Lastly, AI in platforms like Netflix and Amazon personalizes user experiences by curating content recommendations based on individual preferences, thereby enhancing user engagement and satisfaction. This diverse array of applications highlights AI's transformative impact across various domains, continually evolving to meet an expanding range of human needs and challenges.[5]

Revolutionizing Primary Care with AI

In an era where technology intersects with healthcare, Artificial intelligence (AI) emerges as a linchpin in redefining the landscape of primary care. Through its myriad applications, AI offers avenues to bolster patient care, streamline administrative processes, and create a more proactive healthcare model.

Central to this transformation is the role of AI in Clinical Decision Support. General practitioners, of-

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ten the first point of contact for patients, grapple with a deluge of diverse cases daily. AI-driven support systems can be invaluable allies in this scenario. By meticulously analysing patient data, these systems can proffer potential diagnoses or suggest treatment avenues.[6] The implications of this are profound, especially when one considers the pervasive issue of diagnostic errors in primary care.

Furthermore, the promise of predictive analytics reshapes the traditional reactive model of primary care. By gleaning insights from patient records, AI stands poised to flag patients at heightened risk of chronic ailments or potential complications. Such early identification paves the way for timely interventions, potentially staving off hospital admissions, and ensuring better patient outcomes.[7]

On the administrative front, AI promises reprieve from the often-tedious tasks that dominate a significant chunk of a physician's workday. From patient scheduling to intricate billing processes and meticulous records management, AI-driven automation can ensure efficiency and accuracy, freeing physicians to channel their focus where it truly matters: their patients.[8]

In a world forever changed by the COVID-19 pandemic, the pertinence of telemedicine and virtual health assistants has skyrocketed. AI-powered virtual health platforms have emerged as frontline responders, providing initial medical consultations based on robust medical datasets. While they adeptly manage minor medical queries, their true prowess lies in discerning when to escalate more intricate cases to human doctors.[9]

Beyond virtual consultations, the scope of AI in primary care stretches into the realm of remote patient monitoring. The ubiquity of wearable tech, armed with AI capabilities, has opened avenues for continuous health monitoring. These devices vigilantly track vital statistics, flagging any aberrations and ensuring that primary care providers can intervene promptly.[10]

Lastly, AI serves not just as a clinical tool but also as a medium for patient engagement and education. Through chatbots and specialized applications, AI can demystify medical jargon, offer timely medication reminders, and even extend motivational support, particularly crucial for patients navigating the challenges of chronic conditions.[11]

In essence, AI, with its multifaceted applications, stands poised to redefine primary care, blending technological prowess with the core tenets of patient-centric care.

Artificial Intelligence in Primary Care: Paving the Way for Enhanced Patient Care

The infusion of Artificial intelligence into primary care heralds a paradigm shift, redefining healthcare delivery through its numerous advantages.[12]

a) Enhanced diagnostics:

The prowess of AI algorithms lies in their ability to sift through voluminous datasets at a pace unparalleled by human capacity. By discerning intricate disease markers or patterns, these algorithms offer a level of diagnostic precision that could prove elusive to even the most seasoned clinicians.[13]

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By suggesting potential diagnoses or treatments rooted in data-centric analyses, AI emerges as a valuable adjunct, complementing a doctor's clinical acumen.[14, 15]

b) Proactive patient management & predictive analysis:

Beyond diagnostics, AI stands out in its capability for foresight. Predictive analytics, a cornerstone of AI, arms primary care providers with the insights needed to pinpoint patients at an augmented risk of complications or readmissions.[16] Such pre-emptive identification facilitates timely interventions, tailor-made care plans, and, crucially, improved patient outcomes. Moreover, AI's capability to forecast those on the brink of specific ailments offers a more proactive stance in patient care.[17]

Artificial intelligence systems used in the first step for provider and patient acceptance can assist in various ways. These systems can support processes such as appointment scheduling, triage, and patient routing.[18]

Appointment scheduling: Artificial intelligence can analyse providers' current appointment calendars and communicate with patients to determine suitable appointment times. This can enable more efficient appointment scheduling and reduce waiting times.

Triage process: Artificial intelligence can evaluate patients' symptoms and health conditions and prioritize them based on urgency. This ensures the rapid detection of urgent cases and intervention when needed.

Patient routing: Artificial intelligence can answer questions related to patients' health issues and direct them to the appropriate healthcare provider or specialist. This can ensure that patients receive the right treatment and care.[19]

Artificial intelligence systems can save time for healthcare providers, optimize appointment scheduling, and help patients be directed more quickly and effectively. However, the use of these systems should be carefully managed, taking into account ethical and privacy considerations.[20,21]

c) Optimized operations & administrative efficiency:

The operational landscape of primary care clinics, often mired in complexities, stands to gain immensely from AI. By analyzing patient inflow trends, AI can finetune appointment schedules, ensuring minimized wait times and maximized clinic throughput. Additionally, the automation of administrative chores, such as the intricate management of patient records, translates to valuable time savings for physicians, allowing them to redirect their focus on patient care.[8]

d) Telemedicine and enhanced patient engagement:

The digital age has ushered in the era of telemedicine, further catalyzed by AI innovations. AI-powered chatbots, virtual health assistants, and advanced telemedical platforms can adeptly manage rudimentary patient concerns, orchestrate appointments, and even provide rudimentary care guidelines.[22]

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More than just a conduit for remote consultations, these platforms foster a heightened level of patient engagement, delivering timely reminders, demystifying medical complexities through educational content, and offering sustained support.[23]

e) Continuous monitoring:

The ubiquity of wearables, especially those imbued with AI capabilities, brings forth the prospect of uninterrupted patient monitoring. These devices vigilantly track vital metrics, providing both patients and their caregivers real-time notifications about any health deviations, ensuring that timely interventions aren't just possible but a norm.[9] In its totality, AI in primary care represents more than just technological innovation; it encapsulates the essence of enhanced, data-driven, patient-centric care.

Artificial Intelligence in Primary Care: Unravelling the Complexities

The proliferation of Artificial Intelligence (AI) in primary care has undeniably unlocked new horizons of patient care. However, this nascent integration is not without its challenges and disadvantages, warranting an in-depth scrutiny.[24]

a) Reliability, trust, and data privacy

The foundational bedrock of AI is its data. The accuracy of AI recommendations hinges critically on the calibre of this training data. Flawed, biased, or piecemeal data can skew AI outputs, leading to potentially detrimental recommendations.[1] Concomitantly, the magnified data collection and analysis open the Pandora's box of heightened cybersecurity threats, accentuating the risk of breaches or misuse.[25]

b) Loss of human touch and over-reliance on technology

The sanctity of the doctor-patient relationship, underscored by human touch and empathy, might be compromised with an overriding dependency on AI.[26] The seductive allure of technology runs the risk of clinicians leaning excessively on AI, potentially sidelining patient-specific subtleties that may not be evident in cold, hard data.[27]

c) Interoperability and integration issues

The marriage between AI systems and incumbent Electronic Health Record (EHR) systems is fraught with challenges. These teething issues arise from compatibility concerns and the quagmire of data standardization. Moreover, the maiden voyage into AI's integration within primary care infrastructures can bleed finances, given the steep initial costs.[28]

d) Potential misdiagnosis and over-reliance

The infallibility myth surrounding AI can lead to unwarranted complacency. Excessive trust, devoid of critical human oversight, can culminate in misdiagnoses. This is especially pertinent if the AI lacks training on specific, especially rare, pathologies.[29]

e) Provider and patient acceptance

The challenges of provider and patient acceptance of Artificial intelligence in primary care are notable, with several experts highlighting key aspects:

Provider Acceptance: Healthcare providers often have reservations about AI, including concerns about the reliability of AI systems and potential loss of professional autonomy.[30] Providers may worry about an

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over-reliance on technology, potentially overshadowing clinical judgment and experience. Adapting to AI-integrated workflows also poses a challenge, requiring not only technical training but a shift in approach to patient care.

Patient Acceptance: Patients also express concerns regarding the use of AI in primary care. These include worries about privacy, the impersonal nature of AI interactions, and a potential reduction in the quality of human aspects of care. The security of personal health data managed by AI systems and the lack of personal interaction are significant points of apprehension for patients.[31]

Trust in AI Systems: Building trust in AI systems is a central issue for both provider and patient acceptance.[32] Ensuring that AI systems are accurate, reliable, and safe is crucial. Providers and patients need confidence that AI can enhance healthcare outcomes without compromising care quality.

Cultural and Societal Perceptions: Societal and cultural attitudes towards technology and AI significantly influence acceptance levels.[33] These perceptions can either facilitate or hinder AI adoption in primary care, depending on how technology and its role in healthcare are viewed culturally.

f) Training and education

Healthcare providers need adequate training to use AI tools effectively. Understanding how to interpret AI recommendations and when to rely on human judgment is critical. This requires ongoing education and adaptation. The metamorphosis into an AI-infused primary care ecosystem necessitates rigorous training for physicians and auxiliary staff, demanding significant investments in both time and resources.[34]

Additionally, there's a need for practical training in AI applications within primary healthcare settings.[34] This includes learning how AI can assist in diagnosis, treatment guidance, disease screening, hospital management, and patient monitoring, requiring hands-on experience with these tools.

Addressing ethical and privacy concerns in AI usage is also a key challenge.[35] It's essential for healthcare professionals to be educated on maintaining patient confidentiality, addressing biases in AI algorithms, and ensuring fair and unbiased AI usage.

Another significant challenge lies in equipping healthcare staff with the skills to interpret and critically evaluate the large volumes of data processed by AI systems.[36] This skill set is vital for making accurate diagnostics and treatment decisions.

Finally, the rapid evolution of AI technology presents a challenge in ensuring continuous education and adaptation for healthcare professionals.[35] Staying updated with the latest AI developments and undergoing regular training is imperative for effective and up-to-date patient care. Addressing these challenges is key to the successful integration of AI in primary healthcare, ensuring that healthcare professionals are equipped with the necessary AI skills and are prepared to navigate its ethical and security aspects.

h) Cost and resource allocation

Implementing AI solutions in primary care can be expensive. The cost includes not just the technology

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itself but also the infrastructure to support it, training for staff, and ongoing maintenance.

The cost and resource allocation of AI in primary healthcare depend on the complexity of the technology and applications used, the scale of the organization, and the available resources. Each healthcare organization should assess the costs and resource requirements of AI usage based on their specific circumstances.[37] The cost and resource allocation of artificial intelligence in primary healthcare can vary depending on several factors.

Investment Costs: The implementation and application of AI systems typically incur initial costs. These costs may include the procurement of hardware and software infrastructure, the creation of databases, the collection of training data, and the employment of experts for model development. These investment costs can vary depending on the scale of the healthcare organization, the complexity of AI technologies, and the scope of the applications to be used.

Data Sources and Data Management: AI systems require a substantial amount of data to function effectively. Therefore, it is important to establish sufficient and reliable data sources for the use of AI in primary healthcare. The processes of data collection, storage, and updates may require additional resources and costs.

Expert Employment and Training: Having personnel with the necessary skills is crucial for the effective use of AI. This may require the employment of AI experts and the training of existing personnel in AI. Expert employment and training may incur additional costs and resource allocation.

Maintenance and Updates: AI systems require ongoing maintenance and updates. This includes software updates, data refreshes, model enhancements, and monitoring system performance. Allocating time, resources, and costs is necessary to sustain these processes.[38]

i) Limited scope and generalizability

AI models developed in one setting may not perform well in another due to differences in patient populations, healthcare practices, and data collection methods. Generalizing AI solutions across diverse healthcare settings remains a challenge.

j) Accountability and legal liability

Determining who is responsible when an AI system fails or causes harm is complex. The legal framework for AI accountability in healthcare is still evolving.

k) Regulatory, ethical concerns

The blurry lines of accountability in the wake of AI-induced misdiagnoses create a regulatory conundrum. Simultaneously, the ethical maelstrom surrounding the sanctity of patient data and AI-driven medical decisions cannot be sidestepped.[39]

In essence, while AI's promise in redefining primary care is undeniable, a balanced perspective, cognizant of its challenges, is imperative for its holistic and ethical integration.

Noteworthy AI Utilization in Primary Care

In the realm of primary care, Artificial Intelligence (AI) has made significant strides, reshaping healthcare dynamics. Here are some pioneering examples:

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Disease Identification and Diagnosis: IBM's Watson Health stands out as a flagship example. By juxtaposing patient medical data against a comprehensive database of research, clinical trial outcomes, and academic articles, it aids doctors in pinpointing diseases.[40]

Forecasting and Predictive Analytics: In the realm of medical imaging, Zebra Medical Vision has carved a niche for itself. Its state-of-the-art algorithms meticulously analyze imaging data to spot a spectrum of diseases, acting as a catalyst for timely interventions.[41]

Personal Health Surveillance: The Apple Watch, with its embedded ECG functionality and fall detection mechanism, is a testament to the power of AI in real-time health monitoring. By discerning anomalies like irregular heartbeats or detecting abrupt falls, it ensures that users and their designated emergency contacts receive prompt alerts, potentially mitigating health complications.[42]

Interactive Chatbots and Digital Health Assistants: Babylon Health's AI-driven chatbot is revolutionizing patient interaction. Capable of offering medical insights based on user-provided health data, it demystifies symptoms and guides patients towards informed decisions. [43]

Guidance on Treatment Modalities: Google's DeepMind has broken new ground with its AI model that scrutinizes 3D eye scans. With a staggering 94% accuracy rate, it provides therapeutic recommendations for a wide array of ocular conditions. [44]

Streamlining Administrative Responsibilities: Nuance Communications has spearheaded the transition towards a seamless healthcare workflow. Its AI-infused platform adeptly transcribes patient-doctor dialogues, freeing physicians from the shackles of time-consuming paperwork.[45]

Pharmaceutical Research and Drug Discovery: Venturing beyond primary care but with implications for it, Benevolent AI harnesses the prowess of AI to trailblaze drug discovery pathways. Such avant-garde approaches promise to usher in innovative treatment modalities and drugs into primary care landscapes. [46]

Conclusion

Artificial Intelligence, a term once relegated to the realm of science fiction and academic speculation, has permeated our modern reality, holding promise and potential in various sectors, primary healthcare being a notable beneficiary. AI, now a critical component of modern healthcare, brings with it a suite of advanced capabilities, thanks to breakthroughs in machine learning, neural networks, and natural language processing. Its integration into primary care is reshaping the healthcare landscape, offering improved diagnostic accuracy, operational efficiency, and patient-centric care.

Yet, as we embrace this technological marvel, it is imperative to navigate its adoption with a keen awareness of the challenges and ethical considera-

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tions it presents. The integration of AI in healthcare necessitates a delicate balance, ensuring that technological advancements augment human expertise and empathy rather than supplant them. This approach will safeguard the essential human element in healthcare, preserving the irreplaceable personal touch in patient care.

Looking forward, the potential of AI to transform healthcare is boundless. It promises not only to enhance existing medical practices but also to unlock new realms of personalized treatment and proactive health management. As we chart this course, it is vital to foster a synergy between AI and human medical professionals, ensuring that the path ahead is guided by both technological innovation and ethical responsibility.

This harmonious blend of AI and human insight is poised to redefine healthcare, making it more accessible, effective, and attuned to the unique needs of each patient. In this AI-augmented future, we envision a healthcare system that is not only more capable but also more compassionate and patient-focused.

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