European Medical Students' Association

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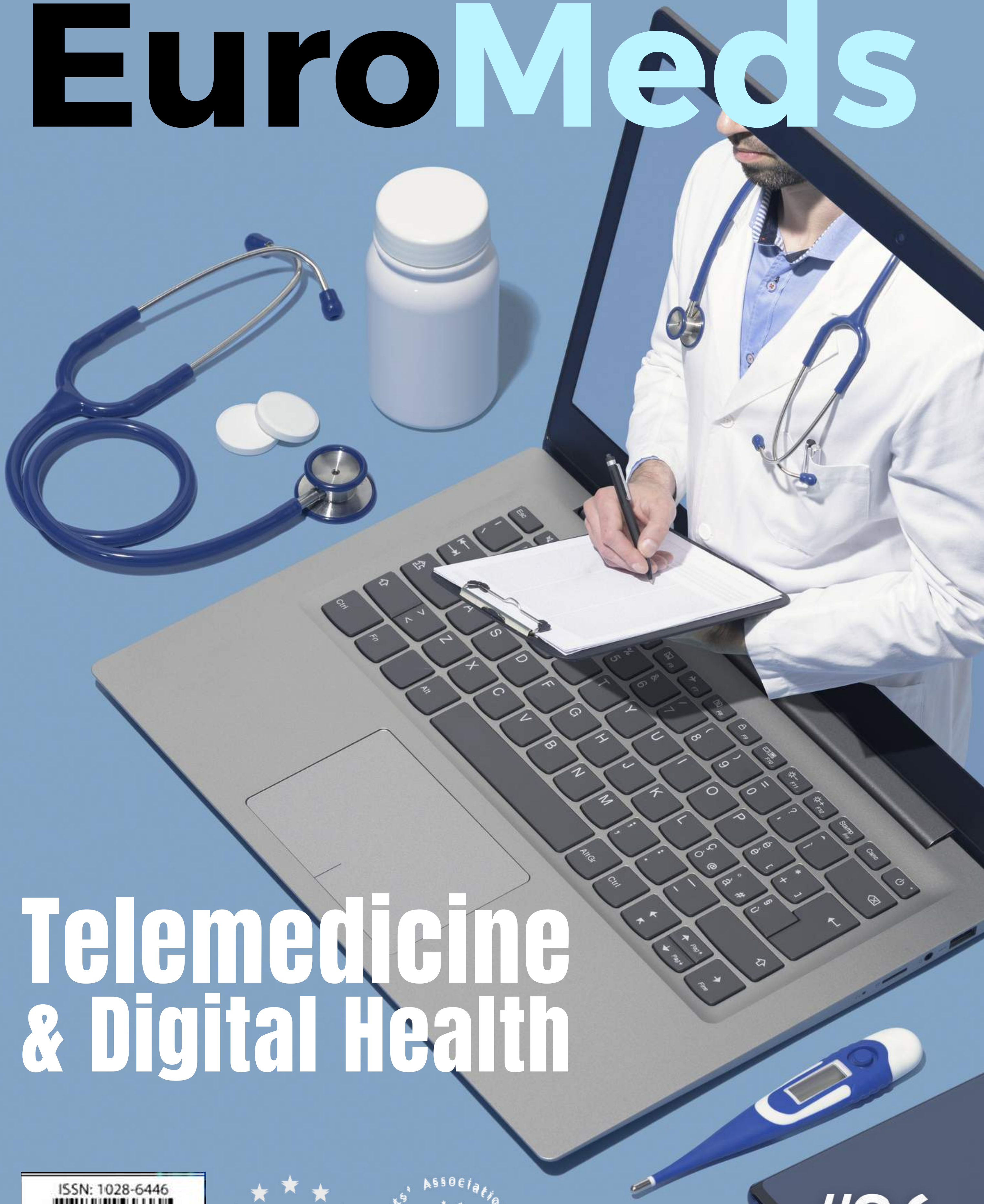

Telemedicine & Digital Health

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European Medical Students' Association

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European Medical Students' Association -
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(EMSA) is a non-profit, non-governmental organisation representing more than 150.000 medical students from over 90 faculties across Europe. Founded in 1990, in Brussels, it is the voice of students within the European Commission, the Council of Europe and the United Nations. The association provides a platform for high-level advocacy, projects, trainings workshops and international meetings. Its activities gather around Medical Education, Medical Ethics and Human Rights, Health Policy, Public Health, Medical Science and European Integration and Culture.

OUR VISION

Shaping a solidary and united Europe, where medical students actively promote health.

OUR MISSION

EMSA empowers medical students to advocate health in all policies, excellence in medical research, interprofessional healthcare education and the protection of human rights across Europe.

EDITOR'S NOTE

Zeynep Eylül Erol
EuroMeds Chief Editor
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Dear EuroMeds Enthusiasts,

We are beyond excited to share with you the 26th issue of EuroMeds, the Autumn Assembly'23 Issue in which we delved into the blooming field of "Telemedicine and Digital Health."

We are living in an age where digital technologies are developing exponentially and becoming more and more integral to all aspects of our lives. Naturally, healthcare is no exception. Thanks to the advancements in technology, patients can now consult their healthcare providers in the comfort of their own houses, many diseases can be monitored remotely, and innovations such as artificial intelligence and virtual reality are being applied to medicine to develop novel treatment modalities. Hence, in this issue, we wanted to explore the exciting future of digitalized healthcare and the multitudinous benefits of incorporating technology into medical practices.

The issue you are about to read is the product of weeks of hard work and effort. I am deeply grateful to all of our contributors for sharing their marvelous work with us and my excellent editorial team for putting their all into creating this beautiful magazine. I am very lucky to have the sweetest team ever and had it not been for my editors' everlasting enthusiasm and motivation since the very first day, we could not have achieved any of this. I would also like to thank our dear Vice President of Capacity Ezgi Ceren Kutlu from the bottom of my heart for her ceaseless support and encouragement throughout this entire process. Finally, I would like to express my gratitude to Prof. Maciej Banach and Prof. Karin Fijnvandraat for honoring our magazine with two wonderful interviews.

On behalf of the EuroMeds Editorial Team, I sincerely hope that you enjoy reading this issue as much as we enjoyed preparing it.

Warm regards,
Zeynep Eylül Erol | EuroMeds Chief Editor

Ezgi Ceren Kutlu
Vice President of Capacity
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VICE PRESIDENT OF CAPACITY'S NOTE

Dear EuroMeds Enthusiast,

For the last time, it is a pleasure for me to express my gratitude for this beautiful magazine. This year, we have published SA'23, Online Summer and AA'23 issues with great contributions, interviews with our valuable professors and the great efforts of my Editorial Team. I would like to thank everyone who contributed, our valuable professors who informed us with their interviews, and most of all my valuable Editorial team for leaving such a wonderful 3 issues to EMSA. It was a great honor for me to accompany Editorial Team as VPC.

I wish you'll enjoy reading this issue as well!

Best regards,
Ezgi Ceren Kutlu | Vice President of Capacity

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Adapting to the 5th Industrial Revolution: Futureproofing Ourselves in Medicine

Natasha Barbour-Murray

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Introduction

As the world gears up for what is popularly referred to as the 5th Industrial Revolution, the healthcare sector and medical professionals find themselves at a unique, transformational juncture. [1] This revolution promises an amalgamation of artificial intelligence, biotechnology, data analytics, and, even more fundamentally, a change in human thought and ethical paradigms. Just as the Lumière brothers could not foresee the extensive societal impacts of their film projector, we, too, find it challenging to fully grasp how these rapid advancements will redefine the fabric of medicine. Furthermore, consider how the invention of cameras revolutionized art, giving rise to various new artistic movements that evolved in response to these changes. Therefore, the urgent questions that we should ask are: How do we prepare for this uncertain yet inevitable future? What questions should medical students, professionals, and educators be asking now to future-proof themselves for the challenges and opportunities ahead?

The Dilemma of Unforeseen Impacts

Historically, people have often underestimated the far-reaching impact of technological revolutions. When the Lumière brothers first invented the film projector, many saw it as a mere novelty, just a "moving picture" that brought delight but was not considered revolutionary. Several decades later, film had not only become a new form of art but also a powerful tool for communication, education, and social change.

Similarly, the 5th Industrial Revolution has already started showing early signs of unprecedented impact on various sectors, including healthcare. Yet, a form of cognitive dissonance exists. On one hand, we are captivated by the possibilities—imagine AI-powered diagnostics, remote surgeries, and personalized medicine based on genetic profiling. On the other hand, these innovations bring forth complex ethical dilemmas and questions about societal norms and the nature of medical practice itself.

The Change Drivers: AI, Biotechnology, and More

At the core of the 5th Industrial Revolution are several key technological advancements. Artificial Intelligence (AI) promises to revolutionize diagnostics and data analytics, enhancing the precision of predictive healthcare.[2] Biotechnology holds the promise of personalized medicine, where treatments are customized based on an individual's genetic makeup. Meanwhile, advances in robotics and automation could make surgical procedures more accurate and less invasive.[3]

However, with these promising developments come intricate ethical and societal questions. If AI algorithms make diagnostic decisions, who bears the responsibility for any errors? How do we ensure that biotechnological advancements do not deepen societal inequities, given that they may be accessible only to those who can afford them?[4]

Interdisciplinary Challenges and Opportunities

As the boundaries between medical science, data analytics, psychology, and even philosophy continue to blur, the need for an interdisciplinary approach has never been greater. As medical students and professionals, we may need to expand our skill set to include an understanding of algorithms, data privacy laws, and even the ethical implications of human-machine interactions.

How equipped are our current educational infrastructures to prepare us for this multifaceted role? Are we creating an environment that empowers medical students to delve into the realms of AI ethics, data science, and behavioral psychology? Or are we still sticking to traditional silos that may soon become obsolete? [5,6,7]

Questions We Must Ask and Discuss

Given this landscape of rapid technological growth and ethical complexity, we come back to the essence of our inquiry: What are the questions that should guide our intellectual and practical discussions?[8]

- **What does the 5th Industrial Revolution mean for healthcare, both conceptually and practically?**
- **Are we looking at a paradigm shift in the very way we define healthcare?**
- **How will technological advancements in AI, biotechnology, and data analytics transform diagnostics, treatment planning, and patient care?**
- **What will be the impact on traditional roles within the healthcare sector?**
- **What are the ethical considerations when integrating these advancements into our healthcare system?**
- **How do we address the issues of accessibility, fairness, and accountability?**
- **How should medical curricula be adapted to prepare students for these interdisciplinary roles?**
- **What new subjects or training modules need to be introduced?**
- **How can we foster a culture that encourages adaptability and a proactive approach to embracing technological and ethical challenges?**
- **What frameworks could be developed to guide this cultural transformation?**

Delving Deeper: Expanding the Questions

What does the 5th Industrial Revolution mean for healthcare, both conceptually and practically?

The impacts of the 5th Industrial Revolution on healthcare are complex and multifaceted. From a conceptual standpoint, we might be looking at a shift in how we understand healthcare itself. Are we transitioning from a reactive healthcare system focused on treatment to a proactive one driven by predictive analytics? Are we shifting from general medicine to more personalized, genetic-based treatments? Understanding these shifts is crucial for medical professionals to adapt their skill sets and expectations accordingly.

How will technological advancements in AI, biotechnology, and data analytics transform diagnostics, treatment planning, and patient care?

AI promises to make diagnostics more precise and quicker, potentially saving lives through earlier identification of critical illnesses. Biotechnology, particularly genomics, could revolutionize treatment plans, allowing them to be tailored to individual genetic profiles for maximum efficacy. Wearable technology could elevate patient care to a new level by providing real-time data that can be analyzed for ongoing treatment adjustments. However, each of these advancements comes with its own challenges, including data security, ethical dilemmas, and the potential for technology to widen healthcare disparities across various socio-economic groups.

What are the ethical considerations when integrating these advancements into our healthcare system?

Ethical considerations will be at the forefront as we enter this new era. Issues of data privacy and security, potential biases in AI algorithms, and the ethics of gene editing and other biotechnologies are just a few of the complex questions we will need to answer. Medical ethics courses may need to be updated or expanded to cover these emerging topics, ensuring that the next generation of doctors is well-equipped to make ethically sound decisions.

How should medical curricula be adapted to prepare students for these interdisciplinary roles?

Traditional medical training has been primarily focused on medicine as an isolated discipline. However, as technology merges with healthcare, an interdisciplinary approach becomes essential. Curricula might need to include courses on data science, AI ethics, and even some engineering for robotics-assisted surgical treatments.[9]

How can we foster a culture that encourages adaptability and a proactive approach to embracing technological and ethical challenges?

The medical field has often faced criticism for its resistance to change. However, as we stand on the brink of a revolution, adaptability becomes not only a virtue but a necessity. Creating a culture that encourages continuous learning, openness to change, and a proactive approach to ethical and technological challenges is crucial. This could include setting up interdisciplinary committees within medical institutions to discuss and prepare for upcoming changes, offering ongoing learning opportunities for current medical professionals, and developing frameworks for ethical decision-making that can be adapted as new challenges emerge.

Conclusion: Preparing for the Inevitable

It is clear that the 5th Industrial Revolution is not a question of "if" but "when." Integration of various technologies into the healthcare ecosystem is imminent and will bring about transformative changes that we cannot afford to ignore. Preparation, therefore, becomes the cornerstone of futureproofing ourselves in the medical field.

The Need for Open Dialogue and Institutional Support

No single person or even a group of experts can foresee all the intricacies of the upcoming revolution. What is crucial is the establishment of channels for open dialogue among medical students, healthcare professionals, technologists, ethicists, and policymakers. Only through a multidisciplinary approach can we hope to navigate the complexities that lie ahead.

Moreover, this dialogue must not be confined to academic journals or professional conferences. It must penetrate the walls of our educational institutions, prompting them to adapt curricula and teaching methodologies. It is imperative for faculties to take an active role in fostering a culture of adaptability, inquiry, and ethical integrity. Without institutional support, individual efforts may amount to little.

Sustainability and the Finite Nature of Resources

As we enthusiastically discuss the prospects of a technologically driven healthcare system, it is crucial to also address the elephant in the room: the sustainability of these advancements. Our dependence on technology inherently ties us to the availability of energy resources that power these technologies. In an era when concerns about climate change and depleting natural resources are escalating, how sustainable is a healthcare system deeply entrenched in technology?

The Risks of Technological Dependence

Relying heavily on technology for medical procedures, diagnostics, and even record-keeping assumes a continuous energy supply. In a world with finite resources, this reliance could create a system vulnerable to fluctuations in energy availability. A power outage or a shortage of essential materials, like rare earth metals used in many electronic components, could severely disrupt healthcare services.

Ethical and Social Implications

The implications extend beyond logistical concerns. There are ethical considerations as well. Who gets priority if access to essential healthcare technology becomes limited due to resource constraints? How do we ensure an equitable distribution of technological benefits in such a scenario?

Proactive Planning for a Sustainable Future

To mitigate these risks, proactive planning is essential. Investing in renewable energy sources, developing low-energy-consuming technologies, and creating contingency plans for resource shortages are steps that cannot be delayed. This introduces another dimension to the multidisciplinary approach required to future-proof our healthcare system: the integration of sustainability and environmental science into medical education and practice.

The Road Ahead: A Framework for Adaptive Learning and Ethical Preparedness

As we gear up for this transformation, establishing some form of structural framework for adaptive learning and ethical decision-making is essential. Steps must be taken now to prepare for the future - whether it is through developing new courses, establishing interdisciplinary committees, or creating ethical guidelines tailored to emerging technologies.

Final Thoughts: Embracing Uncertainty as an Opportunity

While the future is filled with uncertainty, this uncertainty itself holds limitless opportunities for innovation, improvement, and impact. By asking the right questions now, engaging in meaningful dialogue, and preparing ourselves both technically and ethically, we not only future-proof ourselves but also help shape a healthcare landscape that is equitable, effective, and truly revolutionary.

Technological and Engineering Innovations in Cardiac Modelling: A Collaborative Approach

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REFERENCES

Introduction:
The model aims to provide a comprehensive understanding of cardiac electromechanics, offering insights into the complex interplay between the heart's electrical and mechanical functions. Through a combination of computational simulations and physical representations, this innovation has the potential to revolutionize various aspects of cardiac research, medical education, and clinical practice.

This paper delves into the following key aspects of the electromechanical model's development and innovation:

Simulation Technology:
The electromechanical model employs advanced simulation technology, which precisely replicates cardiac electromechanical processes. This facilitates the examination of a wide range of scenarios, allowing researchers and medical professionals to study the heart's behavior under diverse conditions. Such versatility is invaluable for identifying abnormalities, optimizing treatment plans, and enhancing diagnostic accuracy.

Medical Education Enhancement:
By integration of the electromechanical model into medical education curricula, students can achieve a deeper understanding of cardiac function. The tactile nature of this model offers a hands-on learning experience, fostering a profound appreciation of the heart's complex interplay between electrical impulses and mechanical contractions. This innovative approach to medical education holds the potential to produce highly skilled healthcare professionals who are better prepared to diagnose and treat cardiac conditions.

Cardiac Research Advancements:
Researchers have a powerful tool at their disposal with this electromechanical model. It enables them to investigate novel therapies, assess interventions, and refine treatment approaches for various cardiac conditions. Whether examining the effectiveness of new medications or simulating the outcomes of different surgical procedures, the model accelerates the pace of cardiac research, potentially leading to life-saving breakthroughs.

Ethical Considerations:
While the advantages of advanced simulation models in healthcare research and education are significant, ethical considerations are paramount. This paper addresses the ethical implications associated with the use of such models. It highlights the importance of obtaining informed consent from patients whose data used in these simulations, ensuring privacy and confidentiality, and being vigilant about potential biases in the data used to create and validate the model.

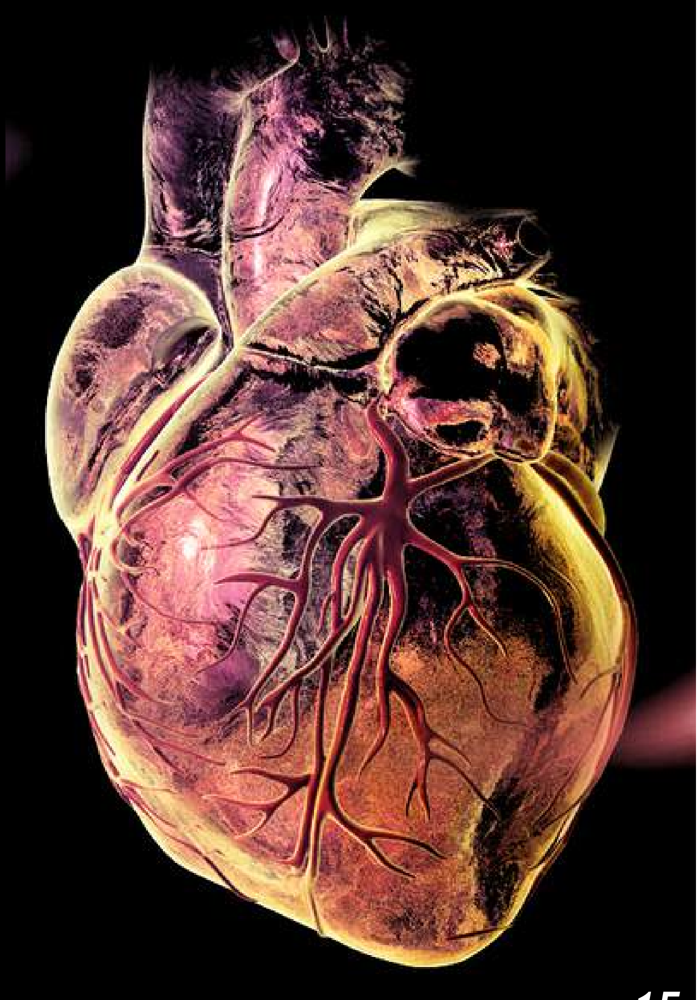
Digital Health Ecosystems:
Integration: This innovation can be integrated into digital health ecosystems, facilitating real-time monitoring and data analytics to enhance cardiac care management.

Inspiration for Cardiac Device Development :
The electromechanical model may inspire the development of novel cardiac medical devices, such as innovative monitoring tools or assistive devices, by offering a platform for testing and refinement.

Clinical Applications:
Beyond its utility in research and education, the electromechanical model can find applications in clinical settings. It may assist in diagnosing cardiac conditions, optimizing treatment strategies, and monitoring patient's progress in real time.

Model Validation and Accuracy:
Ongoing efforts are directed towards enhancing the accuracy and validation of the model. By continually refining the model's parameters and inputs, it evolves into more reliable tool for medical and research purposes.

Global Collaboration:
following its presentation at the "Engineering - Science of 21st Century" conference, the model has the potential for broader global recognition and collaboration, fostering international progress in cardiac research and technology.
As the electromechanical model of the heart continues to evolve through ongoing collaboration and innovation, it holds the promise of contributing significantly to the field of cardiac medicine and engineering.



Interview with

Prof. Karin Fijnvandraat

What is telemedicine, and how does it differ from traditional healthcare delivery?

The difference between telemedicine and traditional healthcare delivery is that in traditional healthcare, patients are in physical contact with their healthcare providers or sometimes by telephone. There's a whole new transition in healthcare and telemedicine encompasses all modern ICT technologies to deliver healthcare. This was very much influenced by the COVID pandemic because this prompted us to do video consultations with patients which can be regarded as telemedicine. There are more advanced forms of telemedicine wherein there's only screen-to-screen contact that also uses patient data collected at home like vital signs which can be collected from wearables. There are even developments to do PC ultrasounds by the patients.

I'm a pediatric hematologist. So I'm also in hemophilia and sickle cell care. In hemophilia care, you want to know if the patient has joint bleeding. I'm aware of some projects I'm not yet involved in myself, where the patient uses a probe attached to the mobile phone to make a radio ultrasound of a joint and then it is sent to the doctor, who judges whether there's joint bleeding. I'm involved in a project using wearables to measure vital signs in sickle cell patients. We hope to be able to use these vital signs to predict complications or exacerbations of the disease. Also, I think all the apps that exist to help patients manage their disease by reminding them to take their pills or to do their breathing exercises or whatever is required are telemedicine.

Tarannom Mansouri Nasrabad

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What are the main challenges or barriers to the widespread adoption of telemedicine and e-health technologies?

Of course, there's the cost and the infrastructure that is needed. To add to that professionals are not used to these new forms of medicine. Depending on the age of the healthcare professional, it's easier or more difficult to adapt. For my generation, it's sort of challenging. I think we also have to be very careful with telemedicine to make sure that there is equity so that disprivileged groups can also have the same access. In disprivileged groups, there's also a lack of health literacy, which can also jeopardize access to these forms, so it's important to pay a lot of attention.

Can you explain the key benefits of telemedicine for patients, healthcare providers, and healthcare systems?

Patients don't have to travel so much to the hospital and have more autonomy and grip on their care and self-management. For instance, I'm a pediatric hematologist so I treat patients below the age of 18. For the families, especially for the mother, it's usually quite a hassle to come with the patient to the hospital because they have other children and they have to be picked up from school or things like that. So for patients, it's very convenient if we can fulfill their consultation or monitor them remotely.
For healthcare providers and systems, it can be a more efficient way to organize care because you usually spend 80% of the time on 20% of the patients. The other 80 percent are doing quite well, but they come to the hospital for checkups and everything. Now with remote monitoring, you can reduce the number of visits and you can pay really good attention to the patients that need it. So it helps to balance the resources where it's needed most. You can have all kinds of remote monitoring and warning systems so that if something is going the wrong way you can step in and this also means that patients can be more independent.

Can you provide examples of successful telemedicine implementations that have improved healthcare access or outcomes?

I think there are a lot of advantages and examples of successful telemedicine implementations. An example of a very broad, successful implementation is video consultation in the COVID period. Other successful implementations are perhaps portals where we use a portal in our hospital where patients fill in quality of life questionnaires before they visit us, and then we can read them before they come to the clinic. This way, when we have the consultation, we are already informed about how their quality of life isn't fulfilling and if there are any problems compared to previous measurements. We already have some kind of screening tool before they come and we can really dive into the things that are important. So it has allowed us to work with the patient-reported outcomes. Also, I think many other remote monitoring devices - for instance, remote monitoring of pacemakers in cardiology - have been very successfully implemented.

How does telemedicine impact the doctor-patient relationship, and what strategies can healthcare providers use to maintain effective communication?

I think this is a very important aspect because as you start organizing care farther away from the patients, you no longer have much physical contact with them. It's very important that when you see the patient they should have enough time and attention for all the things that they have on their minds. Also, the patients should have a telephone number where they can easily contact the health care provider and really feel at ease to contact in case they want to speak about something. So telemedicine should not draw up a wall between the patients and providers in communication.

What is the role of artificial intelligence (AI) in telemedicine and e-health, and how can it improve healthcare delivery?

AI can be very useful in building prediction models. I know of successful prediction models in our hospital, Amsterdam UMC, used in neonatal intensive care to predict if a baby will have bradycardia from the vital signs. They also use it in the adult intensive care unit to predict when the patient is suitable to be discharged from intensive care based on their vital signs. AI is also used in radiography for image analysis and lots of other applications.

Can you discuss the challenges of ensuring equitable access to telemedicine services, especially for underserved populations?

It's very important that patients with health literacy get the required support to participate in telemedicine in order for them not to be detached and lose the connection with the healthcare provider. When we implement telemedicine, we should really put effort into keeping these people aboard.

How do telemedicine platforms handle emergencies or situations requiring immediate in-person care?

I think for emergencies there's more of a role for traditional healthcare, the contact of the team with the patients. The role of telemedicine could perhaps be in combination with AI or remote monitoring to identify if the patient is deteriorating and if there is a risk that an emergency is going to develop. If so, the doctor or the healthcare team should be alerted and see the patient in the emergency room to see what the problem is and how to intervene.

What trends do you see emerging in the telemedicine and e-health industry in the next few years?

I think telemedicine will take over more of the care and decision support will also be developed.

How can healthcare providers effectively integrate telemedicine into their existing healthcare delivery models?

We are in a sort of transition right now. We are used to screen-to-screen contact now and some teams are using remote monitoring. I think the proportion of telemedicine will gradually increase, whereas traditional physical contact will gradually decrease until it's at a good balance. I think where it is balanced the best depends on the population, the severity of the disease, the distribution of severity within the population, and whether there is a hospital nearby. All kinds of factors will determine what is optimal for a certain patient group in a certain geographical region with a certain number of resources. So that's very different from situation to situation.

What skills and qualifications are important for healthcare professionals who want to work in telemedicine or e-health?

I think future healthcare professionals will always learn about telemedicine because it will be an integral part of medicine. Communication skills are always key for a healthcare professional as well as attention for the population under your care and people with lower health literacy. Of course, you also need to have some technical and digital skills to work with the application, but usually, since you work in a team as a doctor, you don't have to be an ICT expert.

Decoding the Science Behind Intelligent Imaging as AI Revolutionizes Radiology

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The AI Renaissance in Radiology:Introduction
The seamless fusion of human knowledge and artificial intelligence (AI) is driving a major shift in the field of clinical radiology. The saying "AI won't replace radiologists, but radiologists who skillfully wield AI will surpass those who do not" sums it up perfectly. In this investigation, we set out on a quest to unravel the complex workings of the AI-radiology nexus, demystifying its processes and illuminating its enormous potential.

Computer-based intelligence in Radiology: Lifting Precision and Productivity
Envision a time where the meticulous analysis of intricate clinical images becomes more than just routine practice. This is the commitment of artificial intelligence - a tool that automates image analysis with sophistication. " With accuracy comes automation." The role of artificial intelligence isn't about overshadowing radiologists, but rather acting as a partner, liberating them from routine tasks and empowering them to channel their mental acuity to intricate cases that require human insight.

AI Mastery Revealed: The Art of Training and Recognition
AI's strength comes from its capacity for deep learning, which is akin to nurturing an expert sleuth. Imagine teaching an AI system to differentiate between a normal and abnormal lung scan. AI is immersed in a vast visual database, absorbing the subtleties that denote health or illness. This data bank enables AI to detect small variations, much like a skilled detective revealing hidden secrets.
Apply this analogy to brain scans, where AI acts as a careful observer. It develops into a sentinel during the diagnostic procedure as it learns the complicated patterns of normal and abnormal brains. When given patient scans, AI's system accurately detects anomalies, acting like a smart investigator by raising possible red flags.

REFERENCES

Exploring The Art of AI Training

AI's education is comparable to a rigorous boot camp for a new investigator. Many tagged medical images are provided to AI, similar to how textbooks are filled with visual cues. The algorithm learns to recognize patterns, textures, and properties that distinguish different circumstances through numerous repetitions.

The parameters that control the AI's decision-making are adjusted when new data is ingested, and "weights" are added. The system becomes better at identifying minute variations between photos with each adjustment. The learning process is iterative because the AI constantly improves its capacity to identify disorders by learning from its mistakes.

Unraveling the Decision-Making Process: An Algorithm in Action

The way AI makes decisions is akin to how Sherlock Holmes would conduct an inquiry. The program thoroughly analyzes each image it receives, comparing its attributes to the vast array of patterns it learned during training. AI compares the image to its mental database of typical and unusual circumstances, much like a detective putting together a puzzle.

After the evaluation is complete, AI delivers a judgment, classifying the likelihood of pathology. This choice, drawn from an extensive repository of learning experiences, empowers AI to provide radiologists with crucial insights, enabling quicker and more precise diagnoses.

Conclusion: Radiology's Future Is Revealed

As the landscape of AI and radiology unfolds, ponder these crucial questions: Does AI enhance patient care? Does it alleviate the strains caused by medical burnout? These inquiries delve into the core of a broader narrative about the fusion of technology and compassion. “I believe—and some studies have shown this—that human-machine assistive hybrid teams are better for specific findings than just machines,” says Dr. Falgun Chokshi, an expert in neuroradiology and imaging sciences.

The resonating truth "AI won't replace radiologists, but radiologists who master AI's potential will lead the evolution of medical imaging" captures the essence at this pivotal juncture. Let's harness the collaborative opportunity to expand diagnostic horizons as we navigate this unknown territory, propelled by the confluence of human understanding and AI innovation. The journey of science and intelligence is etched as the odyssey unfolds.

ABHA: Pioneering a New Era in Stroke Recovery

Siddhant Shukla

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Stroke stands as a prevalent cause of disability and the second leading contributor to global mortality. It arises from the blockage of cerebral blood supply or the rupture of brain blood vessels. Survivors often grapple with life-altering symptoms, including significant motor and sensory impairments, disrupting their daily functioning. The aftermath of a stroke's effects is heavily influenced by the site and origin of the injury. Amidst the multitude of stroke treatment approaches, physical therapy assumes a critical role in the recovery journey. At present, motor rehabilitation techniques for hemiplegic stroke patients predominantly encompass physical therapy and constraint-induced movement therapy (CIMT), which necessitate residual movement in the affected limb. Regrettably, around 20-30% of stroke survivors are ineligible for CIMT or similar rehabilitation strategies.

The realm of bio-robotics has found extensive utility in assistive technology and rehabilitation. This encompasses the manipulation or control of various neuro-prosthetic devices, wheelchairs, and therapeutic exoskeletons.

REFERENCES

Some of these rehabilitation modalities are contingent upon brain signals like electroencephalograms (EEGs) or magnetoencephalograms (MEGs), while others hinge on bio-signals such as electromyograms (EMGs). Relying solely on brain or muscle signals for actuation and control of external devices presents its own challenges. Brain signal-based controls often grapple with issues like reduced accuracy and the need for personalized adaptation to ensure reliability.

In the arena of stroke rehabilitation using Brain-Computer Interface (BCI), notable progress has emerged from a company called BRAINALIVE RESEARCH PRIVATE LIMITED. They have pioneered a solution named ABHA, which operates on BCI principles. BCI represents a computer-based system that translates cerebral signals into commands for output devices, facilitating desired actions. BCI technology, more specifically focused on signals from the central nervous system (CNS), holds immense promise in aiding individuals afflicted by neurological disorders such as amyotrophic lateral sclerosis, stroke, and traumatic brain injuries. Mohammad Abbas Mehdi, Co-founder and Director at Brainalive, elucidates, "BCI (Brain-Computer Interface) holds significant potential in assisting stroke survivors through targeted, activity-dependent brain plasticity. This innovative approach capitalizes on the stroke's impact on specific cerebral regions while retaining relatively intact affected limbs. By directing motor tasks that require the initiation or suppression of distinct neural signals, BCI can effectively induce and guide the process of brain plasticity among stroke survivors."

“Doctor” is ONLINE

İlayda Kılıç

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What are the potential risks concerning the breach of confidentiality in telemedicine? Are there any concerns regarding the reliability of patient data in the context of telemedicine? How can patient trust be maintained in the field of telemedicine? We have numerous questions, right?

Telemedicine is rapidly replacing the traditional treatment methods in mental health care and chronic disease management in clinical settings that require frequent post-treatment follow-ups but not necessarily regular in-person physical examinations. The fast growth of the telemedicine sector raises questions about the reliability of patient data, the risks of confidentiality breaches, and how patients can feel assured of the treatment they are receiving. The prevalence of telehealth among mental health clinicians and addiction medicine physicians is much higher than in other specialties; the COVID era serves as the primary evidence for this claim. On the other hand, not every specialty is ready to transition to an online platform due to the fact that in some settings, telehealth can create communication barriers and result in inadequate information exchange between the clinician and the patient. At this point, we start to question some aspects of telemedicine. Does it obscure the professional competency of the remote clinicians?

REFERENCES

Are we sacrificing essential elements of human relationships for the sake of seemingly efficient digital communication? To resolve this so-called paradox, we shall first examine the context of patient-clinician communication within telemedicine. Continuing with a clinician already known to the patient may be well-suited for telemedicine, as evidenced by the successful follow-up sessions conducted for patients with mental health issues. In this case, continuing the sessions online can be time-efficient for both parties by reducing waiting times, and can also be useful in areas with physician shortages, such as rural and underserved communities. However, there are situations involving initial encounters with no previous patient-clinician interaction or cases where an assisting nurse performs basic assessment tests in the examination room while the physician participates online. The last example is how things work in a small village in France, where a telemedicine startup conducts examinations to alleviate the medical burden resulting from an insufficient number of doctors per capita. In this setup, nurses assist patients, while an ENT physician can review imaging tests real-time and provide a diagnosis.

Have you considered the potential risks of confidentiality breaches and how these might affect the trust between patients and clinicians? How can telemedicine guarantee that patients feel assured about the quality of care they receive despite not being physically present with their clinician?

In both in-person and telemedicine interactions, patients should have the right to privacy and trust their clinicians without fearing deception or betrayal. [1]

In both cases, trust should never be compromised to pursue fame or financial gain. This is because trust is scarce and difficult to gain; once broken, it is difficult to rebuild, whether in-person or via telemedicine. We emphasize 'trust' because remote health data transactions are not under the protection of HIPAA (Health Insurance Portability and Accountability Act) rules, raising questions about the security of personal health information. In telemedicine, patients transmitting health data via video, e-documents, or smart health apps cannot always be sure that the person online is the "DOCTOR".

Interview with Prof. Maciej Banach

Tarannom Mansouri Nasrabad

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How has telemedicine evolved over the years, and what are some of the significant milestones in its development?

I've been involved in this area for the last 20 years. The history is quite long, but on the other hand, it is not an easy history, because we know very well that in many cultures despite the many developments in this area, we still do not use telemedicine devices for telemedicine solutions. When I was undersecretary of the state of the Polish government in the Ministry of Science and Higher Education, we had a conference that was a summary of the project about the use of telemedicine in emergency cars in patients with myocardial infarction (MI), to make the telemedicine evaluation of the ECG and to send the information on it to the Interventional Cardiology Center ahead of arriving to the center in order to prepare the physicians about whether the patient has MI or not. It was amazing because for the first time we were able to see that we can be very preventive and we can in fact be well prepared for the patients that are approaching the center with the MI in this situation. It was not a surprise that telemedicine started in cardiovascular diseases considering they are still a leading cause of death worldwide with approximately 20 million deaths per year. From there, the development was very fast because we have noticed that we can use telemedicine not only for MI but also in patients with different arrhythmias especially in case of implantable cardiac devices such as pacemakers. In the upcoming years these devices will become smaller and smaller and telemedicine allows us to monitor the efficacy of them.

Telemedicine can also be used in laryngology. I have met great colleagues who use telemedicine solutions to monitor cochlear implants, especially in children, to see whether they are working properly, which reduces the number of hospital visits. When I was the president of the second largest hospital in Poland, Polish Mother's Memorial Hospital Research Institute, between 2014-2021, we also introduced the use of telemedicine in monitoring pregnant women with tele-cardiotocography (teleCTG). This allowed us to continuously monitor the mother's and the child's health as well as reducing the number of visits. It is amazing to see such solutions. We started with cardiovascular diseases but now we can use telemedicine in all medical areas.

Could you please provide an overview of the key concepts and technologies that underpin telemedicine and digital health?

The main aim we started with is that if we can monitor patients with telemedicine solutions and devices, we can diagnose the patients easier, reduce the number of complications and unfavorable events such as mortality. But life is much more complicated because for most of the telemedicine solutions, we do not have such great results. For example, I was a steering committee member in a trial of telerehabilitation for severe heart failure patients. We randomized them to standard care and hybrid comprehensive tele rehabilitation. At the end of this trial we were able to see a reduction in death, hospitalization, and future cardiovascular events however the reduction wasn't significant.

So probably we should focus on the other outcomes and key secondary endpoints that might be reduced with telerehabilitation and telemedicine. For instance, in our study, we have noticed that we were able to reduce and diagnose the predictors of pro-arrhythmias such as in ischemic etiology of heart failure, poor physical capacity and many others. We should also take into account that we were able to increase the quality of life of these patients as they were not forced to be at the doctor every 2-4 weeks and they felt much safer knowing that they were monitored by physicians 24 hours per day. We were also able to show that telerehabilitation was cost effective. Of course there are challenges that need to be overcome but we should focus on these critically important secondary endpoints.

How can we measure the success and effectiveness of telemedicine programs or applications?

Obviously there are many points we should focus on. First of all, there is an ongoing discussion in many countries about the additional costs of telemedicine solutions. When we offer these solutions to the patients we should take into account these costs. For example, in Poland and many central Eastern European countries, we have a problem with the reimbursement of telemedicine, because on one hand we have a data showing that we are able to improve different key secondary endpoints such as the quality of life but on the other hand there is some lack of understanding as to why it should be reimbursed. As I've mentioned, we've made a great step in pacemakers, other implantable cardiac devices, and cochlear implants but still many telemedicine applications such as the teleCTG and telerehabilitation are not reimbursed in many countries. So now we should focus on presenting to the payers how these solutions can reduce costs by reducing the number of complications, improving the quality of life, and help with early diagnosis. Also when we discuss the measure of success and effectiveness of telemedicine, we should take its accessibility into account. For instance, in Poland, telemedicine solutions are available in a commercial way, so patients can pay for them. However, some are quite expensive thus not many patients can access these solutions. In order to assess the real impact of telemedicine in healthcare, we should make these solutions available to everyone by reimbursement.

Then how can we measure success and effectiveness? For one, we can diagnose early, in the emergency department or even in the emergency car, especially in case of MI. Then when we have the diagnosis, more effective, personalized treatment can be given to patients based on the continuous monitoring of different variables. We may have up to 100% less complications, which obviously makes these solutions much more cost effective. Also, we should always remember that the quality of life significantly improves. For example, after MI, patients are able to return to their normal lives much more easily compared to those who aren't monitored in such an effective way.

How can we handle patient education and engagement within telemedicine platforms to ensure a positive patient experience?

If you would like any kind of virtual medicine to be effective, the patients need to be well educated. They need to be well informed about the disease or any possible risk factors. They need to have a complete understanding of why we are offering telemedicine in their case and how it would be better for them compared to the standard care. They also need to be well trained on how to use the equipment and to react in different situations. We should always have time to answer all of the questions of the patients, even if they are very unusual. Also since there is no reimbursement in most cases, we should try to convince patients that having continuous monitoring would be better for their health, such as in case of pregnant women with concomitant diseases or the elderly.

I would also like to emphasize that all stakeholders should be involved in educating patients. Not only physicians or scientific societies but also patient organizations and the Ministry of Health National Health Plans and Payers. All parts of the system need to be involved in order for this education to be effective.

What ethical and legal considerations should healthcare providers and policymakers take into account when implementing telemedicine programs?

This is probably one of the most important questions we get from patients. They are afraid of continuous telemonitoring because of the fake news and theories they have heard during the pandemic regarding how these solutions may track all of their activities. So we need to explain and ensure that the data that is used in telemonitoring is only associated with their health condition and no other personal data is used. We should inform the patients about the general data protection regulation (GDPR) and that we always follow it.
Next, we should always follow something called “patients physician shared decision making” which needs to be a part of the legal approach. Both the physician and the patient must agree for telemonitoring solutions to be used as part of the treatment and obviously it should be based on the patient’s preferences. Finally since most telemedicine solutions aren’t reimbursed, patients need to be informed about the payments that may be required.

How do you ensure scalability and adaptability of telemedicine solutions to accommodate changes in healthcare needs and technologies?

One cause that led us towards the development of digital health was the Covid-19 pandemic. I wish such a terrifying situation hadn't happened but it caused significant developments in telemedicine not only in Central European countries, but also Western Europe and the US. As I mentioned, education is critically important, especially when all the important stakeholders for healthcare are involved. We as specialists, scientists and scientific societies need to give the payers much more independent data to be used in order to help them and to support them with the reimbursement process because if we have more and more telemedicine solutions which are reimbursed and available for everyone, then it will be much easier to increase the number of patients that are using these innovative and effective solutions that might help us to prevent diseases and complications. So probably these are the most important things. Looking at the pandemic from the bright side, digital healthcare developed very fast due to the lack of accessibility to healthcare during the lockdown.

How can telemedicine and digital health technologies be integrated into medical education and training for healthcare professionals?

This is one of the most important issues. I graduated in 2002, so about 21 years ago, and during my study, there was no information about IT or digital solutions which we might use. I don't know how the situation looks now but I know very well that a medical students are being taught very little about IT or digital solutions such as artificial intelligence, machine learning, deep learning and many other things that are being used in healthcare today. We use such IT solutions for mammograms, NMR, something called a “medi-planner” which supports physicians with the diagnosis and treatment of cardiovascular diseases and many other thing. So if medical students are not prepared, even about the general information about the digital healthcare IT solutions, AI machine learning and deep learning, it will be very difficult for them to be introduced and to start using those methods during their professional life efficiently. This needs to be a permanent part of any training during the medical studies as well as specializations because only then will we know how to use it effectively and be well prepared to suggest the most effective and optimal telemonitoring solutions for the given patients.

How has the COVID-19 pandemic impacted the adoption and utilization of telemedicine, and what lessons can be learned from this experience?

I can give you the best example from Poland. For many years, we weren't able to introduce teleadvice, e-prescription, e-registration, e-referral on the Polish market. There was an ongoing discussion about the GDPR, about how to do it effectively and so on. For the last ten years before the pandemic, we had been discussing something called "Platform P1", a platform where all government recorded patient data were gathered. However, it did not work for various reasons despite receiving a lot of funding from the European Unions. Half a year after when Covid-19 started in Poland, we were able to introduce all those solutions that couldn't be introduced in the previous ten years. The pandemic was a terrifying experience for all physicians but the one beneficial aspect of it was that we were able to implement digital solutions that stayed with us and now we are able to improve them based on our experiences. Hopefully, the next improvements and developments will not be due to another pandemic, but due to the use of the experience we have had so far based on those sources that were introduced during the pandemic.

What research opportunities exist in the field of telemedicine and digital health, and how can academia contribute to advancing these technologies?

I don't know a specialization in which telemedicine solutions aren't used currently. We are using it in all areas of medicine for many different issues. Obviously, the main problem we usually have is how to evaluate the results of randomized controlled trials dedicated to using telemedicine solutions in a given patient population. Of course we are very happy that the final results are successful but we also need to show the payer that these solutions are worth being reimbursed and made commonly available for many patients in order to reduce complications and to have an early diagnosis. Over the last 20 years, we have learned how to do this effectively based on the learning curve we have had from previous trials. I strongly believe that we are in a beautiful moment when in the next few years telemedicine will be quite a common part of medicine because it is already one, in many aspects like in cardiovascular diseases and rehabilitation. For example, there are three centers in Poland that use tele-echo through which we are able to see the echocardiography examination performed 400-600 kilometers away from our center. Based on this tele-echo, we can decide when is the best time to hospitalize these patients because we should neither be too late nor too early. Although telemedicine is not so common in other specializations, I strongly believe that it should be. This is a truly beautiful time for telemedicine.

Role of Artificial Intelligence in Transforming Modern Healthcare

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Introduction

Over the past few years, the healthcare sector has undergone rapid transformations, and Artificial Intelligence (AI) has emerged as one of the key drivers of this change. AI has immense potential to revolutionize various aspects of healthcare, from diagnostics and treatment recommendations to administrative tasks and patient management. In this article, we will delve into the significant contributions of AI to healthcare.

Diagnostics and Predictions

One of the most profound applications of AI is in the field of diagnostics. Machine learning algorithms, a subset of AI, have been trained to recognize patterns and anomalies in various types of medical data such as X-rays, MRIs, and even genomic sequences [1]. For instance, these algorithms can identify indicators of diseases like diabetic retinopathy in eye images [2] or predict the risk of cardiac arrest based on patient data [3].

Treatment Recommendations

Treatment protocols can sometimes be complex, especially in fields like oncology. AI systems can analyze vast amounts of research data, patient histories, and clinical trial results to suggest the most appropriate treatments for specific patient profiles [4].

IDrug Discovery and Development

Traditionally, drug discovery and development can take years and considerable investments. AI can accelerate this process by predicting how different compounds can interact with biological systems, thus shortening the development timeline and reducing costs [5].

Managing Medical Records

Electronic Health Records (EHR) have become standard in healthcare facilities. However, these records often exist in vast numbers and can be challenging to manage and analyze. AI can automate the data extraction process, ensuring that physicians have all relevant information at their fingertips [6].

Predictive Analytics for Patient Management

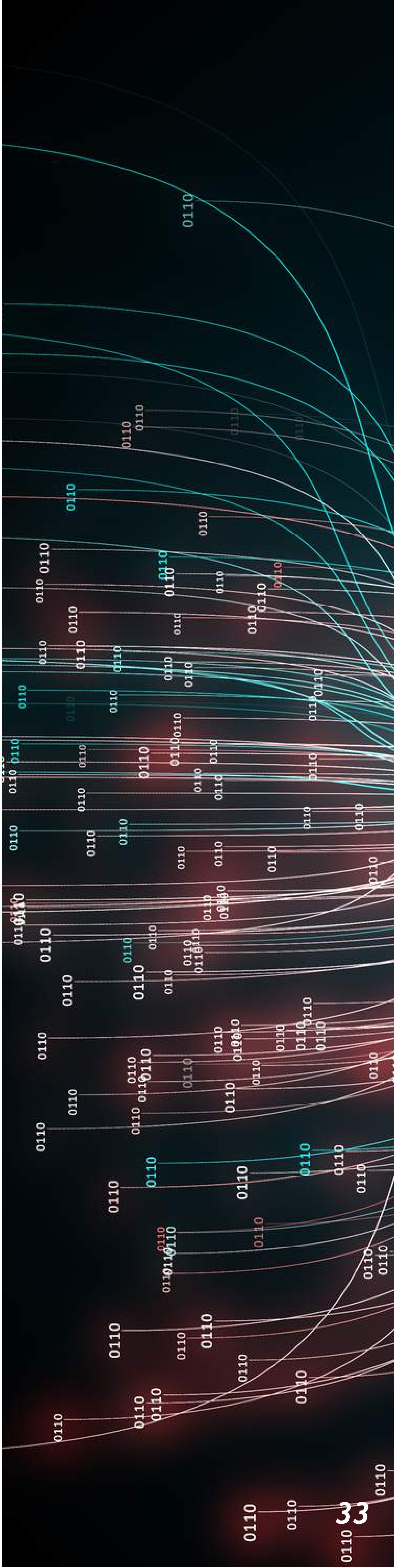
Healthcare facilities are utilizing AI to predict patient admissions, thereby optimizing staff allocations and bed management. By analyzing data trends, AI can also predict potential outbreaks or the spread of diseases in specific geographical regions [7].

Virtual Health Assistants

Virtual health assistants, often facilitated by AI, can offer patients reminders for medication, provide information about diseases, or even guide patients through post-operative care, reducing the burden on healthcare professionals [8].

Conclusion

While AI's role in healthcare is promising, it is essential to proceed cautiously. The integration of AI tools should be approached with consideration for data privacy, ethics, and prevention of inadvertent biases in healthcare delivery [9]. With the right checks and balances, AI can undoubtedly reshape the future of healthcare, making it more efficient, accurate, and personalized.



TELESURGERY/REMOTE SURGERY:
AN IMPROVED AND EFFICIENT ERA

How does remote surgery impact the delivery of healthcare?

"It is better to open and see than to wait and see." Sidney Cuthbert Wallace

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INTRODUCTION

Remote surgery (telesurgery) allows doctors to operate on patients without being physically present at the exact location. This approach is a form of telepresence. A robotic surgical system mainly consists of multiple tools controlled by the surgeon, a central control system, and a sensory system providing feedback to the surgeon. Remote surgery integrates robotics, telecommunications, and elements of management information systems. Although robotic surgery is well-established, most of these robots are still operated by surgeons at the procedure site. Telesurgery offers surgeons the opportunity for remote work, thereby reducing the importance of the distance between the surgeon and the patient. It promises to make specialized surgeons' expertise accessible worldwide without requiring patients to travel beyond their local hospital. Remote surgery is a new surgical management technique using robotic technology and wireless systems to connect patients and surgeons far from each other. Telesurgery uses a form of network-mediated computerized control system. The word comes from the Ancient Greek "tele" (which means "far"), "cheir" (which means "hand"), and "ergein" (which means "to work"). The main advantage of telesurgery is that it overcomes the limitations of traditional surgery, namely the geographical inaccessibility to fast and high-quality surgical care, shortages of surgeons, and logistical constraints related to surgeons' schedules, financial costs, and distances. This technology benefits both patients and surgeons by increasing the technical accuracy and safety of procedures.

SOME TECHNICAL (BORING :D) DETAILS FOR THE ENTHUSIASTS

Surgical robotic systems have evolved from the first functional remote surgery system, ZEUS, to the da Vinci Surgical System, which is currently the only available surgical robotic system. In Israel, a company was founded by Prof. Moshe Schoham of the Mechanical Engineering Faculty at the Technion. The Da Vinci Surgical System has also been integrated into a Dual Da Vinci System, allowing multiple surgeons to work on the same patient simultaneously. The system enables surgeons to control different arms, switch commands among associates at any time, and communicate via headsets during surgery.

BACKGROUND

The concept of distance between a surgeon and a patient was recently introduced. It was developed in the 1970s by the U.S. National Aeronautics and Space Administration (NASA), which had a specific interest in remote surgery for treating astronauts. At the same time, the advancement of robotic surgery gives surgeons the opportunity to operate with greater agility, higher accuracy, and wider accessibility to difficult sites of the body, such as the minor pelvis. Crucial innovations in telecommunications and robotic surgery in the 1980s and 1990s made telerobotic surgery a practical option. On July 9, 2001, Professor Jacques Marescaux successfully performed the first telerobotic surgery on a patient in Strasbourg, France, known as the 'Lindbergh Operation'. The procedure was a telesurgery-assisted cholecystectomy that took 54 minutes and was completed without difficulties. It was a richly symbolic landmark in surgery that laid the groundwork for the globalization of surgical techniques.

We are witnessing the fourth industrial reform transforming all aspects of our lives, including surgery. The combination of new technologies like 5th-generation (5G) internet, artificial intelligence (AI), haptic feedback technology, three-dimensional (3D) printing, and nanotechnology is revolutionizing the future of surgery. Some clinical series in the literature have also investigated a new "one-to-many" model of remote surgery, in which a surgeon in the control room simultaneously performs surgical treatment on physically separated patients. These cases demonstrate that it is possible to provide medical services with low latency, high bandwidth, and reliable communication, all without telecommunication errors or network delays. Due to substantial network system limitations, the development of remote surgery has been challenging since the first telerobotic operation in 2001.

HOW DOES REMOTE SURGERY IMPACT THE DELIVERY OF HEALTHCARE?

Remote surgery has grown in popularity due to rapid advances in computer technology, telecommunications, and robotic tools. As a result of these advancements in medical training and the expansion of technological resources available to clinicians, modern methods of telesurgery offer the following benefits: They enable high-quality surgery in medically challenging environments such as the rural areas, war zones, and massive mission vehicles for space and sea, like submarines, outposts, and spacecraft, where crew members stay for extended periods. Telesurgical tools integrate numerous display technologies, enabling high-definition video feeds to be broadcast simultaneously to remotely stationed surgeons, thereby eliminating the need for costly and potentially dangerous long-distance trips. Due to scheduling constraints, these surgeons would typically be unable to collaborate on in-person surgeries. However, this technology facilitates real-time collaboration among surgeons, who may be geographically distant. Accelerometer technology eliminates the risk of error associated with surgical precision, linked to the natural physiological tremors of human hands, and considerably reduces damage to adjacent healthy tissue in real time. Patient healing is accelerated due to reduced collateral damage to surrounding healthy tissues. Because surgeons and patients are geographically separated, remote surgery eliminates the potential for virus transmission.

BENEFITS OF TELESURGERY

Telesurgery has numerous advantages over traditional surgical approaches. Telesurgery is a promising and viable option for patients, allowing them to get treated without traveling long distances, thanks to developments in telecommunication and robotic surgery (R.S.). The following are some advantages of remote surgery:

THERE IS NO NEED FOR DISTANCE TRAVEL

Traveling for medical treatment is not feasible for many people due to financial constraints, travel-related health hazards, travel restrictions, or time delays, which might be counterproductive in some cases. Telesurgery is a fantastic way for patients to receive medical attention without leaving their local hospitals, as surgical experts can provide care to patients from anywhere in the world.

PROVIDING HEALTHCARE TO MEDICALLY UNDERSERVED AREAS

Telesurgery can offer surgical treatment to individuals worldwide, particularly in remote regions such as rural areas or battlefields, as well as inaccessible areas such as spaceships.

SURGICAL COLLABORATIONS

Real-time collaborations between surgical professionals from diverse healthcare facilities are possible. A patient can benefit from the expertise of multiple healthcare specialists simultaneously. These real-time surgical collaborations can assist with complex microsurgical techniques.

IMPROVING SURGICAL ACCURACY

High-resolution (3D) cameras enable surgeons to obtain close-up images of surgical sites that would otherwise be inaccessible. Robotic arms provide access to body parts that are otherwise difficult to reach, such as the pelvis, making them particularly useful for urologists, colorectal surgeons, and abdominal surgeons. Accelerometer technology can neutralize a surgeon's physiological tremors and alleviate anxiety, thereby increasing surgical precision and overcoming limitations associated with surgeon dexterity. Improved surgical precision minimizes the risk of damaging adjacent structures and significantly reduces the likelihood of blood loss, transfusions, and infections. In summary, a patient can heal sooner and with fewer complications, as in the case of the da Vinci Surgical System).

ELIMINATE POTENTIAL SHORTAGE OF SURGEONS

There is a worldwide shortage of qualified healthcare providers, and remote surgery could be a potential solution.

MINIMIZING THE RISK OF INFECTION

The World Health Organization declared the COVID-19 disease, caused by Sars-CoV-2, a pandemic on March 11, 2020. Due to the risk of viral transmission, surgical interventions are reserved for only the most severe cases. Telesurgery is a realistic solution for ensuring both the surgeon's and the patient's safety.

LIMITATIONS OF TELESURGERY

However, telesurgery is not without limitations. There are concerns about patient safety and privacy, the significant expenses of initial deployment and upkeep, and legal and ethical issues. Privacy is of the highest importance, especially when exchanging sensitive photos or patient data over the internet; nonetheless, the risk of cyber-attacks and unreliable connections could compromise the capacity to perform telesurgery safely and ethically. Signal latency arising from unstable networks can increase the likelihood of errors during surgical treatment and lengthen the operation duration. In standardized surgical procedures, patients may need clarification regarding the identity of the healthcare providers, which is one of the disadvantages of remote surgery further complicating obtaining informed consent for telesurgical treatments. The COVID-19 pandemic has highlighted an emerging issue in telesurgery: health inequity, which disproportionately affects individuals of lower socioeconomic status and older age groups. This is because many people in these categories cannot access qualified technological resources. According to National Health Service digital statistics, roughly 40% of individuals had not yet engaged in online consultations in 2019. The advancement of telemedical technology is expected to worsen the disparities between people who can and cannot access sufficient care. Even despite the encouraging progress in both surgery and telecommunications, some downsides still exist, for instance:

WORLDWIDE NETWORK DEVELOPMENT

To make telesurgery a viable option for anyone in the world, an excellent worldwide network that allows patients in any region to receive treatment without traveling great distances is required.

LEGAL ISSUES

The idea of receiving medical care from a surgeon without genuine interaction might raise some concerns. On one hand, the development of telesurgery has allowed political and geographical limits to be circumvented. On the other hand, it has led to various legal and ethical challenges, as regulations differ across states and national borders.

BILLING ISSUES

In telesurgery, multiple medical facilities interact. The challenge of dividing the operational costs among participating medical centers could pose a hurdle.

HARD TO FIND EQUIPMENT: ACQUISITION AND MAINTENANCE OF THE EQUIPMENT IS ANOTHER OBSTACLE

The cost of robotic systems and the affordability of high-speed communications pose challenges, particularly in economically disadvantaged countries. The prices of the new automated systems are expected to decrease as more companies obtain production licenses.

CYBER SECURITY THREATS

The fast expansion of telesurgery applications has led to an increase in cyber-attacks against teleoperated surgical robots. These robotic computer systems have the potential to be taken over and turned into potentially dangerous weapons.

LATENCY

The main disadvantage in the field of telerobotic surgery is time latency. It refers to the delay in transmitting sensory and motor signals between two distant locations. Increased latency and prolonged procedures might increase the likelihood of errors.

APPROACH

Some approaches integrate various emerging technologies that can result in an immense improvement in telesurgery.

HIGH SPEED 5G NETWORK

5G has a potential maximum speed of up to 10 Gbps, a hundred times faster than 4G's theoretical maximum speed of 100 Mbps. Integrating high-speed 5G internet with telesurgery could reduce the current lag time from 0.27 seconds to 0.01 seconds. This reduction in latency could alleviate the time-delay issues associated with telesurgery. Furthermore, a fifth-generation (5G) network allows haptic applications to come to life. These indicate that it is a significant technology for remote surgery.

HAPTIC FEEDBACK AND TACTILE ROBOTICS

A remote surgery operating room requires an HD 3D 360° view camera and a robotic system. The surgeon examines the patient on a screen and utilizes his haptic arm to correctly position the robotic arm in the operation theater. The tactile robot technology perfectly translates the surgeon's hand gestures on the console into mechanical arm movements. This allows robotic arms to mimic the surgeon's natural hand motions in the control center, providing surgical specialists with greater control over the tools and superior skill compared to traditional operating rooms with conventional surgical equipment. Haptic technology allows tactile information to be transmitted to the teleoperator. With the development of artificial intelligence, new augmented and virtual reality surgical education programs could incorporate these technologies to further improve and enhance the accuracy of the robotic arm through the inclusion of better touch sensors.

ONE-TO-MANY REMOTE SURGERY

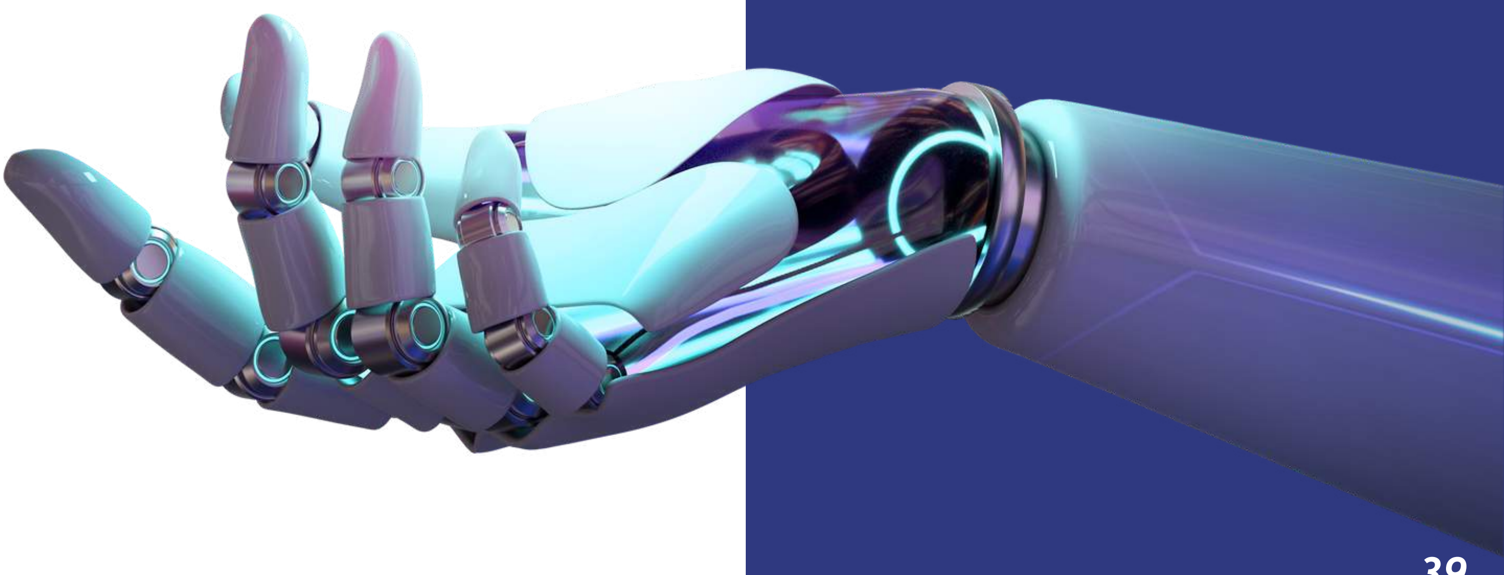
The concept of 'one-to-many' telesurgery is based on a surgeon simultaneously performing procedures on multiple patients. It is a way to treat more patients. Previously, the idea of one-to-many remote operations faced challenges due to time lag constraints. The time lag is no longer an obstacle thanks to high-speed 5G internet, which has decreased latency and improved capacity. In 2019, this concept proved effective in a telerobotic surgical series.

INTERNET OF THINGS (IOT)

The Internet of Things (IoT) represents a technological revolution that aims to connect all standard physical objects to the Internet, creating a massive global network of unique items that can exchange information and execute planned tasks. It is a game-changing technology that allows visualization of tool usage in specific processes. The routine use of IoT in surgery will enable the visualization of surgical procedures. It will result in various medical advancements, including improvements in surgical techniques.

CONCLUSIONS

Telesurgery, also known as remote surgery, is a promising surgical innovation but faces several challenges. For accurate and well-done procedures, zero-latency time and advancements in haptic feedback technology are essential. Technologies such as 5G, IoT, and haptic robots should be incorporated into remote surgery to overcome these limitations. The expenses associated with addressing legal and ethical concerns should be considered. Robotic surgery can play a critical role in the current pandemic conditions by reducing the number of surgical personnel in operating rooms, thereby lowering the risk of COVID-19 infection and the associated morbidity and mortality.



Wired for Wellness: An Insight into

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We live in the era of the Internet, where information is just a click away. However, not all of it is accurate, and it requires a specialist's interpretation to be truly useful. One cannot become a doctor merely by reading an article from a website,contrary to the belief of some individuals worldwide.

Telemedicine is a valuable resource for both medical and non-medical individuals, experiencing a peak in its utilization over the past few years. During the recent pandemic, people fell ill with ailments other than COVID-19,needing treatment despite numerous restrictions. As a means to contain the disease, telemedicine gained increasing traction among health professionally globally. This enabled them to provide distinct diagnoses for patients, conduct follow-ups, determine if a patient's health required urgent hospital treatment rather than home-based medication, or simply refer patients to appropriate medical specialties. Telemedicine also served as an educational platform and for counseling and psychotherapy sessions. [1]

Even with the pandemic's wane, telemedicine continues to be widely employed. Many medical websites offer "online consultations" with doctors, requiring payment for the service. In our fast-paced world, many individuals choose to share their symptoms or laboratory results with doctors through platforms. This allows for quicker diagnosis, bypassing hospital queues or length appointment waits. Additionally, for those distant from medical facilities, seeking a doctor's opinion via online formats becomes essential. However, caution is crucial, as these websites or platforms should be verified to prevent potential scams and protect patients.

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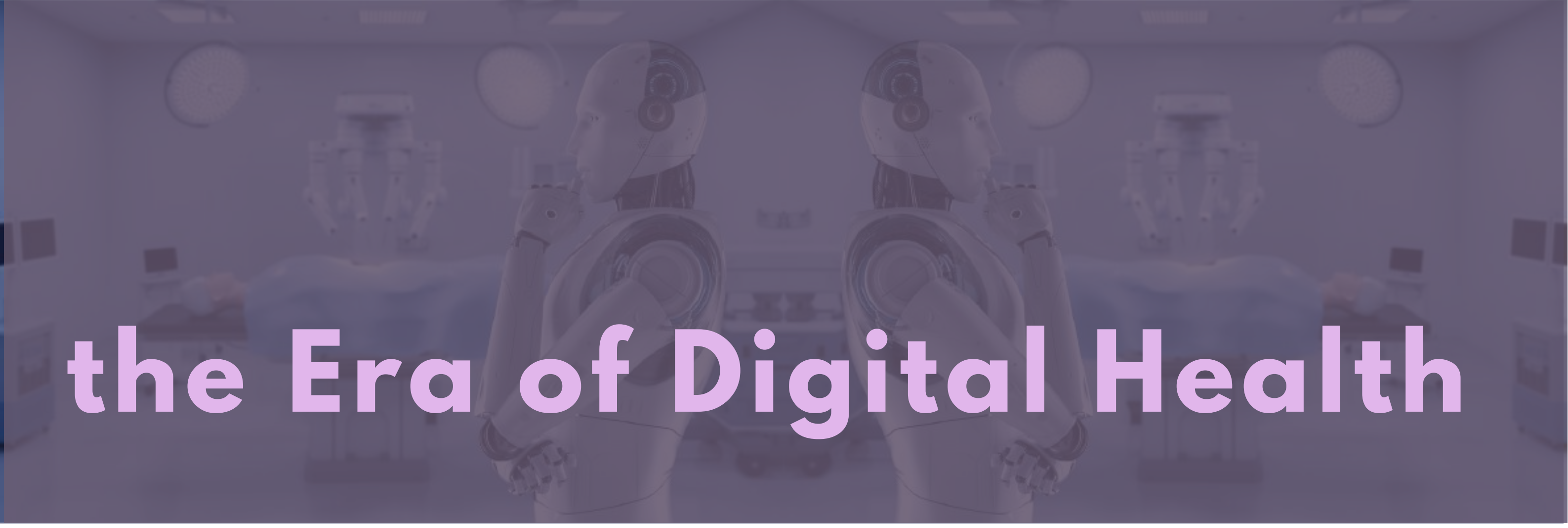

the Era of Digital Health

In Dermatology, for example, there are video programs that help patients get in touch with their doctors more conveniently from the comfort of their homes, reducing unnecessary travel time. By using these apps, patients take charge of monitoring and treating their illnesses themselves. Furthermore, post the COVID-19 pandemic, these apps have evolved becoming more precise and enhancing the diagnostic process. However, their potential hasn’t been fully realized. Moreover, according to a study conducted by Hampton et al., it appears that some of the apps are highly user-friendly, offering significant health benefits to patients. [2]

However, the phrase “la vie en rose” doesn’t always apply seamlessly to digital health, as it doesn’t consistently go smoothly. Some individuals, including both doctors and patients, lack technical skills or reside in remote areas with no signal, computers, or smartphones.This lack of access makes it challenging for them to avail digital health services. Other challenges encompass internet glitches on both communication ends, high power consumption, steep platform and software costs, people’s mistrust and fear of technology, security concerns regarding patients’ confidential data, socioeconomic limitations, absence of privacy at patients’ residences, debilitating illnesses hindering telemedicine usage, absence of advertising for this form of medical care, and ultimately, the fact that online consultations could never fully replace physical ones. All these issues may contribute to stress and frustration for both doctors and patients, making medical communication more complex and impeding doctors’ responsibilities. [1, 3]

In conclusion, the world is evolving rapidly, and adaptation is imperative. By integrating the digital elements of medicine into our daily routines, we will stay aligned with the changing landscape, fostering our evolution and enhancing the care we provide to future patients.

THE CONVERGENCE OF ARTIFICIAL INTELLIGENCE AND BIOMEDICINE TRANSFORMING GENOMICS AND PROTEOMICS

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The intersection of artificial intelligence (AI) and biomedicine has led to revolutionary changes in the field, with AI's prowess in processing vast and complex datasets revolutionizing genomics and proteomics research. Genomics, the study of an organism's entire DNA sequence, and proteomics, the study of an organism's entire complement of proteins, have been significantly impacted by AI-driven methodologies. Machine learning, a subset of AI, has emerged as a pivotal tool in handling and deciphering the intricate biological data inherent to genomics and proteomics research [1].

Machine learning in genomics and genetics operates on the principle of creating and refining computer algorithms through experience. This methodology is particularly useful for identifying patterns within DNA sequences, such as transcription start sites (TSSs). The process entails algorithm development, algorithm training using labelled sequences, and subsequently using the trained model to predict labels for new sequences. This supervised learning approach is analogous to the scientific method, where algorithm design mirrors hypothesis testing [1]. Machine learning's diverse applications span from identifying splice sites, promoters, and enhancers to processing various genomic assay data, including gene expression, chromatin accessibility, and histone modification. This approach enables the differentiation of disease phenotypes and functional elements [1].

In machine learning, it is important to select appropriate features for accurate classification and analysis. Feature selection involves identifying relevant characteristics while discarding irrelevant ones, catering to specific scientific goals. The motivation for feature selection varies optimizing classification efficiency, enhancing biological insight, and constructing the most accurate classifier.

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This selection process becomes particularly vital in genomics due to high-dimensional data analysis, where the challenge of overfitting arises [1]. Techniques such as feature selection and dimensionality reduction, such as principal components analysis, mitigate this challenge by projecting data onto lower dimensions [1].

Missing data is a common obstacle in machine learning analyses. In the context of genomics and genetics, missing data can arise from defective cells in gene expression microarrays or unreliable measurements. The solution lies in either imputing missing values or incorporating missingness information into the model. Imputation methods range from basic techniques like replacing missing values with zero to advanced approaches that leverage correlations between data points for imputation. However, the challenge lies in ensuring downstream analyses' unawareness of the imputed values [1]. Alternatively, missingness information can be embedded in the model. For instance, in predicting mutation deleteriousness, Boolean indicators signal the presence or absence of a feature, adaptable regardless of the absence's significance [1].

Certain biological domains, such as gene regulation networks, entail complex interdependencies among entities. Building networks based on inferred relationships provides a meaningful framework for integrating multiple examples. Bayesian networks, which model gene regulation and distinguish direct effects from indirect correlations, offer biologically interpretable solutions. These methods enable insights into complex relationships, enriching biological understanding [1].

Artificial intelligence (AI) is leading a revolution in clinical diagnostics and genomics by seamlessly integrating data-driven approaches into medical decision-making processes [2]. AI involves training computer systems to accurately interpret health data, enabling disease identification and prognosis. Within AI, deep learning, a subset of the technology, employs neural networks to directly learn intricate features from data, reshaping tasks such as image classification, speech recognition, and disease diagnosis [2]. Clinical AI encompasses computer vision, time series analysis, speech recognition, and natural language processing, each tailored to specific diagnostic objectives [2]. When applied to clinical genomics, AI addresses challenges beyond human capabilities and traditional statistical methods. It enhances precision in tasks like variant calling, annotation, prediction, and phenotype-genotype mapping. AI-powered algorithms like DeepVariant and CADD excel in identifying genetic variants and predicting their effects. Furthermore, AI contributes to the mapping of phenotypes to genotypes by extracting diagnostic concepts from medical images and electronic health records (EHRs) [2]. Deep learning models like DeepGestalt utilize facial images for diagnosing genetic syndromes, while AI's analysis of tumour histology images predicts genomic aberrations. The fusion of AI with genomics enhances the accuracy of polygenic risk prediction and disease risk assessment [2].

The convergence of AI and biomedicine is significantly reshaping the landscape of genomics and proteomics, fundamentally transforming data analysis and interpretation within these fields [3]. This shift is propelling biomedicine from being a "soft science" to a data-driven domain, with AI's remarkable capability to process massive datasets revolutionizing genomics and proteomics research [3]. Particularly in the realm of mass spectrometry (MS)-based proteomics, AI's integration is proving highly advantageous, efficiently managing the intricate complexity of proteomic data. Its incorporation into the analytical pipeline of MS-based proteomics is enhancing several critical aspects, including peptide identification, protein quantification, data integration, and biological interpretation [3]

AI in clinical diagnostics comprises "narrow" or "weak" AI, designed for specific tasks rather than general intelligence. Transfer learning, adapting AI algorithms to related tasks, allows the application of diagnostic AI to different domains. Computer vision, a crucial component, processes images and videos, playing a vital role in medical scans and pathology images. It aids in blood flow quantification, lung nodule detection, and dermatological classification. In genomics, AI analyses histopathological images to identify cancer cells and guide molecular diagnoses [2]. The integration of computer vision with genomics facilitates phenotypic feature extraction from medical images, enhancing molecular testing recommendations and potentially surpassing human expertise [2].
AI is also catalysing biomarker discovery through the utilization of advanced techniques in genomics and proteomics research. The advent of mass spectrometry has enabled the measurement of a multitude of proteins with high specificity, offering the potential for enhanced biomarker identification. Through bioinformatics analysis and the integration of machine learning techniques, potential biomarker candidates are identified, trajectories are established, and enrichment analyses uncover biological themes [3]. AI's potential lies in creating actionable biomarkers through the amalgamation of outlier proteins, thereby transforming diagnostic laboratory tests for improved disease detection and risk assessment [3]

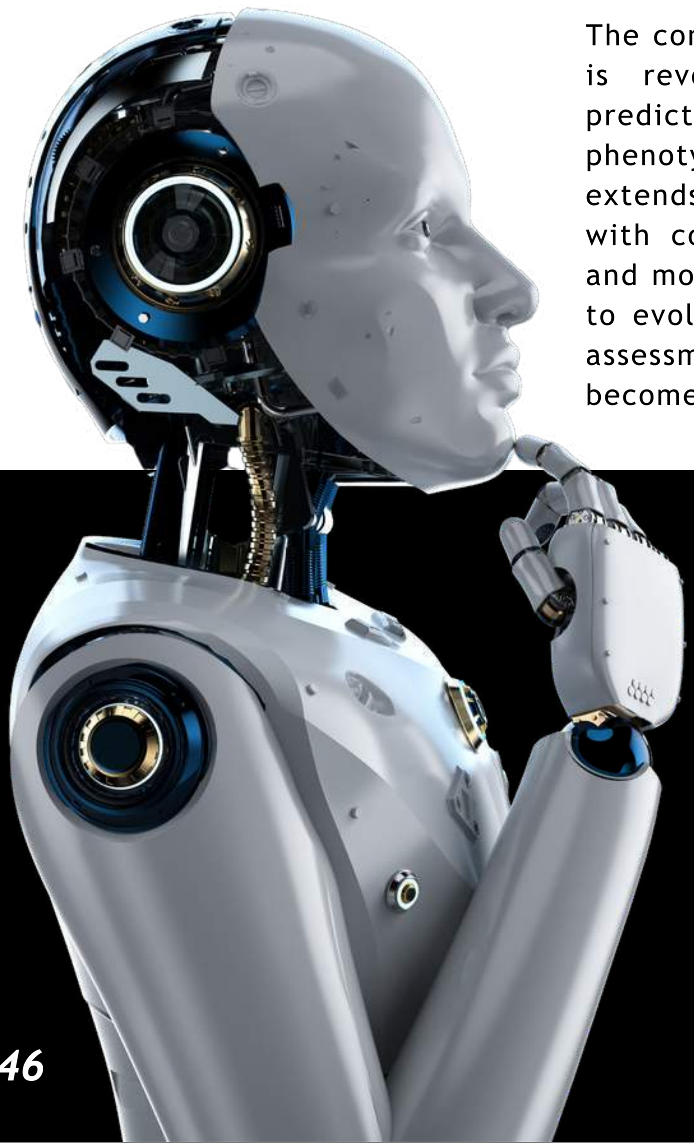
The future directions of AI in clinical diagnostics, genomics, and biomedicine are shaped by a dynamic confluence of technological advancements, expanding datasets, and AI's demonstrated superiority over existing methods [2]. Particularly prominent in imaging-based diagnostics, AI's rapid adoption is fuelled by the availability of vast datasets, continuous algorithmic enhancements, and unprecedented computational capabilities [2]. The potential applications of AI in these domains are truly transformative. Extracting deep phenotypic information from images and electronic health records (EHRs) for genetic analysis is on the horizon, promising more accurate and comprehensive diagnostic strategies [2]. Augmented precision in variant calling and annotation, coupled with meticulous phenotype-to-genotype mapping, has the potential to redefine the genomics landscape [2]. Additionally, the integration of AI-driven algorithms into predicting genotype-to-phenotype relationships holds the key to unlocking profound insights into intricate biological systems [2].

Concurrently, AI's integration into the realms of genomics and proteomics heralds a change in basic assumptions in research methodologies and clinical practice [3,4]. Empowered by machine learning and deep learning algorithms, AI's capacity to process vast and complex datasets is revolutionizing the spectrum of data analysis, interpretation, and decision-making [3,4]. From variant calling and gene expression prediction to biomarker discovery and disease risk assessment, this transformation resonates across various dimensions of genomics and proteomics research [3,4]. As AI's evolution continues, its potential to illuminate the workings of biological systems becomes increasingly conspicuous. This trajectory is positioned to reshape disease diagnosis and treatment strategies, aligning harmoniously with the tenets of data-driven precision medicine [3,4]. In this evolving landscape, AI promises to not only redefine research practices but also guide clinicians in reimagining diagnosis and personalized treatment regimens [3,4].

The growth trajectory of AI in genomics holds substantial promise, driven by technological breakthroughs and the generation of extensive genomic data [1]. Endeavours such as the 1000 Genomes Project and the 4D Nucleome initiative contribute to the wealth of available genomic information, yet effective AI application necessitates expertise and domain-specific comprehension [1]. As genomic techniques evolve and yield voluminous data through methods like mass spectrometry and high-resolution imaging, the need for innovative machine-learning approaches and skilled practitioners is set to surge [1]. Within genetics and genomics, machine learning's role is poised to yield noteworthy contributions to refined insights and discoveries [1].

While AI's potential in clinical diagnostics is immense, its journey forward is marked by navigating challenges and limitations. The approval of AI algorithms by entities like the FDA triggers concerns related to data sourcing, privacy, transparency, and accountability for prediction errors. The intrinsic "black box" nature of AI, often lacking explanations for predictions, poses a potential obstacle to critical clinical decisions [2]. Additionally, the presence of data and machine bias originating from underrepresentation or systemic disparities in training data and healthcare systems can lead to erroneous or biased predictions. Hence, the ethical implementation, transparency, equity, and ongoing enhancement of AI technology are pivotal considerations in the realm of healthcare [2].

In conclusion, the convergence of artificial intelligence (AI) and biomedicine marks a significant turning point in the fields of genomics and proteomics. Through machine learning and deep learning techniques, AI has demonstrated its prowess in processing intricate biological data, reshaping research methodologies and clinical practices alike.



The constructive collaboration between AI and genomics is revolutionizing variant calling, annotation, and prediction accuracy, along with the precise mapping of phenotypes to genotypes. This transformative potential extends to clinical diagnostics, where AI's integration with computer vision nhances image-based diagnoses and molecular testing recommendations. As AI continues to evolve, its role in biomarker discovery, disease risk assessment, and personalized treatment strategies becomes increasingly evident.

While navigating challenges surrounding transparency, bias, and ethical considerations, the future of AI in genomics and biomedicine is poised to drive data-driven precision medicine to new heights. As technology advances and data availability increases, AI's impact on these fields promises to shape a future where insights into biological systems and improved patient care intersect seamlessly.

Advancing Surgical Precision Through Augmented Reality

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Surgical accuracy and safety have seen remarkable progress with the emergence of Image-guided surgery (IGS) systems, which seamlessly merge computer technologies with medical images. In this article, I delve into the evolving landscape of IGS, focusing on the integration of augmented reality (AR) in various surgical contexts.

Introduction

Image-guided surgery (IGS) represents a transformative leap in surgical practice, bridging the gap between innovative computer science and medical imaging. Over the past three decades, the fusion of these domains has led to the emergence of IGS systems that provide real-time navigation for surgeons. Augmented reality (AR) augments this constructive interaction by overlaying digital information onto the real-world surgical field, creating a dynamic augmented view that aids in surgical navigation [1].

Navigating Surgical Complexities with AR

The integration of AR within IGS systems has the potential to revolutionize surgical navigation by providing surgeons with a comprehensive augmented perspective of the surgical field. This augmented view combines preoperative imaging data, such as MRI or CT scans, with live intraoperative visuals, including laparoscopic or ultrasound images [1]. AR not only enhances the surgeon's spatial understanding but also offers real-time guidance for instrument navigation and tissue targeting.

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Unleashing AR's Potential in Liver Resection Surgery

Within the realm of surgical procedures, Liver Laparoscopic Resection Surgery (LLRS) poses a unique set of challenges. Traditionally, surgeons have relied on their anatomical knowledge, supplemented by intraoperative imaging, to correlate patient anatomy with preoperative scans. This process, however, can introduce inaccuracies, which are further exacerbated by the complexities of laparoscopic procedures and organ deformation due to pneumoperitoneum [1].

The integration of augmented reality (AR) into Liver Laparoscopic Resection Surgery (LLRS) presents a promising avenue for addressing surgical challenges. That’s why Teatini et al. 2020 focus on investigating the impact of human-induced errors in AR overlays during LLRS through a series of three comprehensive experiments. These experiments encompass a spectrum from accuracy verification phantoms to in vivo porcine models, all meticulously designed to assess the precision of AR overlays on laparoscope images. The primary objective of these experiments is to unveil the intricate relationship between errors in position annotation and their consequential influence on AR accuracy during LLRS. The study seeks to illuminate how varying degrees of position annotation inaccuracies can affect the efficacy of AR-guided procedures in the context of liver resection. [1]

Pioneering AR in Robotic Liver Procedures

Robotic-assisted liver resections represent an amalgamation of conventional open surgery and advanced laparoscopy. While laparoscopy offers benefits like quicker recovery and fewer post-operative complications, it can pose challenges in complex cases due to constrained manoeuvrability, rigid instruments, and limited vision [2].
The integration of AR in robotic liver surgery addresses these limitations. AR overlays enable surgeons to project 3D images of preoperative scans onto the surgical field in real-time. This augmentation enhances spatial orientation, aids in tumour localization, and helps surgeons navigate complex anatomical structures [2].

The Road Ahead: Challenges and Opportunities

Despite the promise of AR, its implementation in surgical practice is not without challenges. Liver surgery presents unique hurdles due to the organ's deformable and mobile nature during procedures. Challenges range from the accuracy of registration methods to real-time tracking of anatomical structures. While AR offers potential improvements in intraoperative navigation and surgeon training, standardization, technology availability, and clinical validation must be addressed for widespread adoption [2].

Augmenting Laparoscopic Precision Through AR

Laparoscopic Anatomical Hepatectomy (LAH) for treating Primary Liver Cancer (PLC) is a complex procedure characterized by limited tactile feedback and suboptimal viewing angles. To address these limitations, Laparoscopic Augmented Reality Navigation (LARN) systems have emerged. These systems integrate 3D virtual models into the surgical field, enhancing the surgeon's understanding of anatomical structures [3].

The integration of AR in LAH, however, is not without complexities. Real-time accuracy can be influenced by factors like pneumoperitoneum, respiration, heartbeat, and surgical manipulation [3]. A 3D LARN system, coupled with preoperative 3D surgical planning, has shown promise in reducing intraoperative bleeding and enhancing surgical precision [3].

Navigating the Future: Challenges and Promise

The development of advanced technologies for liver surgery, like AR and robotic systems, holds immense promise for enhancing surgical precision and safety. However, challenges remain, including the need for real-time accuracy improvements and addressing the unique physiological responses of the liver during surgery. The future involves refining AR systems, integrating real-time ultrasound, and exploring their potential for minimally invasive training [4].

Conclusion

The fusion of augmented reality with image-guided surgery is poised to redefine the landscape of surgical procedures, particularly in complex contexts like liver resections. While challenges persist, the integration of AR holds the promise of revolutionizing surgical navigation, enhancing precision, and offering new avenues for surgeon training and education. With continued research and advancements, the intersection of AR and surgical practice is set to make a lasting impact on patient outcomes and surgical techniques.

TELEMEDICINE: Where does it stand?

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You have probably heard of the term 'Telemedicine', especially since it is currently a popular topic among healthcare professionals. But what exactly is it?

According to the internet, telemedicine refers to the provision of remote clinical services - via real-time, two-way communication between patients and healthcare providers [1]. In general terms, telemedicine, allows healthcare professionals to consult with patients through video calls rather than examining them in a traditional hospital setting.

If a patient is far away and wishes to consult with their doctor or get a health check-up, telemedicine makes it possible for them to book an appointment online and consult through a video call. In situations like the COVID-19 pandemic, telemedicine played a crucial role in examining and treating not only patients with mild symptoms, but also those who were pregnant, elderly, or too young to visit the hospital.

The pandemic was also one of the major factors in the recognition of telemedicine's true potential. This concept has always been around and was used by many healthcare professionals, but up to a limited extent. With technological advancements and the recognition of its potential, telemedicine has become a field of great interest owing to the continuous development of products and software aiming to enhance the experience of patients as well as healthcare professionals while maintaining data privacy. Apart from that, many social projects are using this approach to connect residents of underprivileged areas with medical consultations.

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Just like every light has its shadow; there are limitations to this approach. In medical schools, students are taught that a complete clinical examination consisting of inspection, percussion, and auscultation is vital. Unfortunately, it is not feasible for particular medical specialties to diagnose patients via video consultations. Moreover, some signs and symptoms may be overlooked by patients and can not be seen identified or examined during a video consultation call. Therefore, an in-person examination is generally more informative.

From a patient's point of view, the physical presence of a doctor often has a more profound effect than a virtual consultation. It helps build trust in the doctor-patient relationship and provides patients with a sense of comfort and relief regarding their health concerns. Delivering bad news or life-changing diagnoses is generally better handled in-person.

Considering all the factors, it seems clear that telemedicine has its pros and cons. While it may not replace the traditional healthcare system, it can definitely supplement it, by making it convenient for various patient groups: those with chronic diseases requiring frequent hospital visits, individuals looking to avoid catching unwanted infections during pandemics, and those constrained by time and distance. With the presence of telemedicine, patients can still consult health-care professionals and receive medical advice in these cases.

Telemedicine Unveiled: Navigating Healthcare's Virtual Frontier Amidst Global Challenges

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Navigating the intricate landscape of the pandemic era, a novel term emerged ubiquitously in our wordbook: telemedicine. Emanating from its nomenclature, telemedicine embodies the remote dispensation of healthcare services, facilitated through the telecommunications infrastructure.
Although seemingly novel to many who have traditionally engaged in person-to-person healthcare interactions, the concept of telehealth has a lineage tracing back over time. The genesis of utilizing video communication for medical purposes dates back to clinicians at the University of Nebraska. This pioneering institution, in 1959, established a groundbreaking two-way television arrangement to disseminate medical knowledge to students across their campus. Subsequently, five years later, they expanded their innovation by establishing video consultations in collaboration with a state hospital [1]

As a result of the pandemic, restrictions on physical contact were imposed, and preventative measures such as quarantines and isolation were put in place to contain the spread of the disease. [2] This caused cancellations or postponements of several in-person consultations with healthcare officials. It also led to the loosening of restrictions on telemedicine, highlighting the vital role that telemedicine plays in healthcare.
Firstly, it acts as a way to filter potential COVID-19 cases using technology.

Secondly, it allows for the treatment of non-COVID-19-related illnesses and chronic conditions without requiring physical visits to healthcare facilities. It also serves as a means of follow-up appointments. This comprehensive approach ranges from caring for mildly symptomatic patients who don't require hospitalization to identifying critically ill patients who need immediate medical attention.

Additionally, telemedicine permits medical professionals who have contracted the virus to continue working remotely. This technology can be applied across various medical disciplines, including internal medicine, oncology, geriatrics, cardiology, orthopedics, neurology, surgery, and dermatology, and can address the complexities of their respective chronic complications.

According to research conducted between March and August 2020, analyzing the demographics of new telemedicine users, revealed a notable similarity to the period before the pandemic. Telemedicine patients continue to be predominantly white, younger, wealthier, and residing in urban areas, in comparison to their non-telemedicine-using counterparts.[3] The observed difference is likely due to a lack of resources or even the lack of knowledge regarding the use of telemedicine.

Switzerland has registered itself as the pioneer in telemedicine, having recorded 2.5 million patient interactions every year even before the pandemic. The country's healthcare system utilizes the TelMed approach, which necessitates a teleconsultation before an in-person visit to a healthcare provider. This revolutionary approach has led to a notable reduction in emergency department visits, thereby relieving the pressure on such facilities. It is evident that the increased adoption of technology solutions that enable smooth patient-physician interactions was not solely driven by the pandemic but was rather accelerated by it.[4]

The COVID-19 pandemic has accelerated the adoption of telemedicine. It has been reported that the number of telehealth visits increased from 3.4 million in March 2020 to 88.5 million in December 2020 in the United States alone.[3]

The future of telemedicine is bright. It is expected to continue to grow in popularity hereafter the COVID-19 pandemic.

Here are some of the factors that are driving the growth of telemedicine:

Technological advancements, such as video conferencing and remote patient monitoring, are significantly enhancing the accessibility and effectiveness of telemedicine.[5]

Changing patient preferences: Patients are increasingly demanding more convenient and affordable healthcare options. Telemedicine can meet these demands.

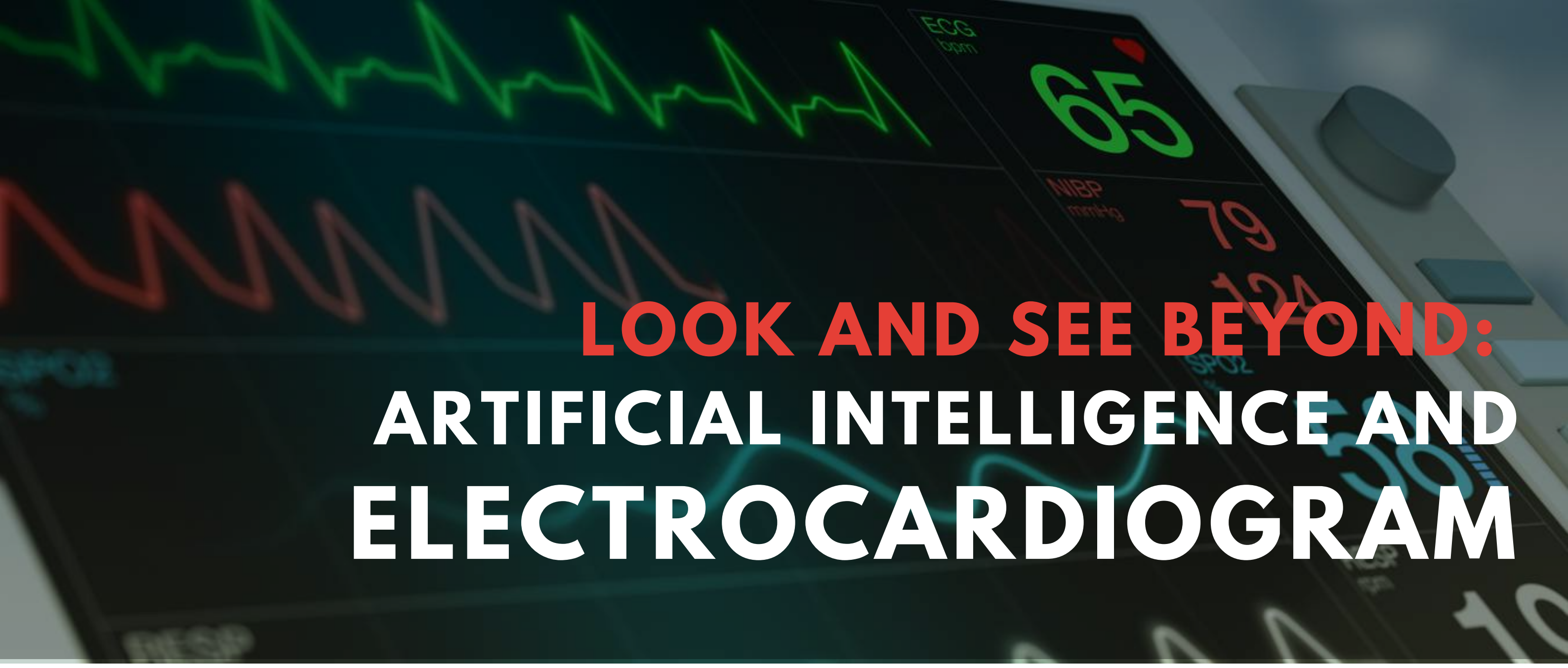
Reimbursement policies: In many countries, insurance companies are now covering telemedicine visits. This makes telemedicine more affordable for patients.

With the expanding use of telemedicine, it is crucial to ensure its safe and efficient implementation. This entails providing patients with top-notch technology and training providers in telemedicine practices. In addition, addressing any privacy concerns that patients may have is essential.

Telemedicine is a promising technology with the potential to transform healthcare delivery. By enhancing care accessibility, reducing expenses, and boosting patient satisfaction, telemedicine can facilitate making healthcare more affordable and accessible to everyone.

Where technology goes, healthcare soon follows, creating greater parity of care provision and improving the quality of care for underserved communities. Technology and healthcare go hand in hand. As Howard Stark eloquently states in the second Iron Man film,

“Technology holds infinite possibilities for mankind and will one day rid society of all its ills.”



LOOK AND SEE BEYOND: ARTIFICIAL INTELLIGENCE AND ELECTROCARDIOGRAM

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You are in the middle of reviewing a patient's chart when the ER doors swing open. A middle-aged man stumbles in, holding his chest and gasping for air, sweat dripping down his face. You rush to his side while emergency alarms start ringing in your head.
After you quickly assess him, get a history, and monitor his vital signs, your main suspect is myocardial infarction, a heart attack. What would be the first test you would order to confirm your pre-diagnosis?

The Electrocardiogram (ECG) is a valuable diagnostic tool that has been used for decades to quickly, affordably, and noninvasively evaluate both cardiac and non-cardiac conditions. It operates by recording the heart's myocytes' electrical signals using electrodes and then displaying the output as visual waveforms on paper. Any disruptions in these signals or fluctuations in blood electrolyte levels can affect ECG results and cause alterations, which may be observable to the human eye in most cases, though not always.
In our medical training, a significant challenge is learning to interpret ECG readings and identify critical situations that require diagnosis, just like the opening scenario. An ECG can give invaluable insights into an individual's health when seen by an experienced eye. Consequently, we put in diligent efforts to enhance our proficiency in recognizing these indicators and delivering precise patient care.

In addition, using computer-based interpretations for basic ECG readings allows for more reliable and objective diagnoses. Thus, our ability to interpret ECGs has reached quite an advanced level. That is why you would probably request an ECG in the opening scenario. ECGs make it possible to diagnose life-threatening conditions like myocardial infarction, arrhythmia, and structure anomalies relatively easily. Considering that ischemic heart diseases account for about 16% of global deaths and are a leading cause of mortality, the ability to quickly diagnose this condition is a significant achievement in itself.[1]

But what if this is not enough? What if there is a vast amount of information that we overlook? A patient with paroxysmal atrial fibrillation, for instance, might be diagnosed late because their ECG appeared "normal" during the initial test. Or an athlete with hypertrophic cardiomyopathy might wrongly assume that heir heart is "normal" based on non-significant ECG changes on the routine tests while it is nothing but a ticking bomb. Is it possible that we could see more, learn more, and detect these conditions much earlier with the help of technological advancements ?

It is a known fact that the use of technologies like artificial intelligence (AI) has significantly improved our patient care, especially when it comes to visual diagnostics. In the case of ECG, current computer-based interpretations cannot go further than the standard readings. Also, these interpretations are limited by preset parameters. On the other hand, artificial intelligence, especially deep learning algorithms, can recognize hidden patterns we might miss and provide more accurate and sensitive results. Therefore, we can apply AI not only for standard ECG interpretations, but also for revealing subtle abnormalities that might otherwise go unnoticed . [2]

HOW DOES DEEP LEARNING WORK?

Deep learning is a branch of machine learning that utilizes neural networks with multiple layers. Unlike traditional machine learning, which requires manual data categorization and structuring, deep learning can work with raw, unprocessed data and identify crucial elements autonomously. For instance, when teaching a machine to recognize ECG patterns associated with hyperkalemia, traditional machine learning would require us to define specific criteria for this condition and instruct the machine accordingly. In contrast, deep learning enables it to analyze raw data and identify relevant features without human intervention. While these features enable deep learning to find extensive applications in various fields, they become particularly useful when it comes to more complex data, such as those involved in image processing. Roughly, deep learning is the technology that our computer uses while distinguishing between a cat and a dog in a photo by using multiple "layers", without needing pre-defined "cat and dog characteristics" data. These layers, which give “deep learning” its name, are highly difficult to comprehend, and often, we do not know how they work.

This type of technology is commonly called a "black box" due to our limited insight into what happens within these layers. While we can confirm the accuracy of the machine's decisions, we often lack a clear understanding of the data or features it uses to make those determinations. [3] This lack of transparency raises reliability concerns, especially in medical applications. [2] Although some research aims to unveil the inner workings of this "black box" to address these questions, we still have a long way to go. (4) In addition to the challenge of the "black-box" problem, it is vital to ensure data quality, consistency, and especially accuracy of the data output. Utilizing a larger dataset for training AI yields more accurate results. Fortunately, ECGs offer a valuable resource for AI, as they are digital, follow a standardized format, and are widely used across a large population. Consequently, the more relevant and directly related data we input into AI, the more precise the outcomes become.

WHERE DO WE USE AI FOR ECG INTERPRETATION?

We have been working on automating ECG interpretation since the introduction of digital ECGs. As technology progresses, machines have become remarkably proficient at identifying basic anomalies, often rivaling the expertise of experienced cardiologists in specific cases. [5] These advancements have broadened our horizons, encouraging us to explore beyond the visible and further educate our machines.

Here are some examples of the progress made: [2,6,7]

- **Age and Sex Estimation**
- **Detection of Left Ventricular Systolic Dysfunction**
- **Detecting Paroxysmal Atrial Fibrillation:** AI helps in the early detection of silent atrial fibrillation cases that cannot be diagnosed easily.
- **Estimating Thrombosis Risk in Atrial Fibrillation:** The best result was observed when combining the CHA2DS2-VASc scoring system with AI, a typical example of a synergy between clinical findings and technological advancements.
- **Detection of Hypertrophic Cardiomyopathy (HCM):** AI can detect HCM, which is particularly significant since there are no specific ECG criteria for this condition. It can also distinguish HCM from physiological hypertrophy, which is crucial for athletes who are at risk and may exhibit both.
- **Detection of Familial Arrhythmia Syndromes**
- **Pre-Surgical Risk Assessments**

WHAT IS NEXT? LOOKING AT THE FUTURE

Looking to the future, the range of applications for these technologies will inevitably expand. The primary focus will likely remain on early detection of diseases, especially those that are fatal yet treatable if diagnosed in time. Therefore, as we continue to integrate these technologies into clinical settings, it is crucial to ensure that they meet "scanning test" criteria, like being cost-effective, applicable, and having low error rates. At present, creating such an environment appears to be of top priority.

However, there are challenges to address when using this technology. Data quality and diversity are the key concerns. Physicians need to verify data quality beforehand, and it is important to remember that studies limited to specific populations may not always yield accurate results when applied to entirely different groups. As our world becomes more interconnected, sharing data and creating a diverse, extensive database that represents a significant portion of humanity -while ensuring data security- could be the highlight of the next era of medicine.