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Viewpoint

Artificial Intelligence in Cardiology: Insights From a Multidisciplinary Perspective

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Introduction

On the evening of July 18, 2024, I began my shift in the cardiac intensive care unit, preparing for 12 hours as the unit charge nurse. I logged into our electronic medical record (EMR), printed my report sheets, and assumed my role in the secure messaging system. My responsibilities for the night revolved heavily around integrated health care technologies. The EMR displayed vital signs, laboratory results, and task completion statuses for every patient. Central monitors delivered constant alarms for minor condition changes, and provider notifications kept me informed of nursing concerns and progress notes. Technology seemed to promise a smooth shift.

Shortly after midnight, however, every computer on the unit shut down. Our medication dispensing system failed to update, labs could not be processed, and central monitors stopped saving patient data. The cardiac catheterization lab equipment also malfunctioned, jeopardizing our ability to respond to emergencies. Panic quickly spread across the hospital. With 5 years of nursing experience—surpassing my colleagues by at least 3—I found myself leading a team untrained to function effectively without technology.

This incident highlights a critical question: to what extent should health care integrate technology? Artificial intelligence (AI) has emerged as a groundbreaking tool capable of simulating human thought processes. Although its potential benefits in high-reliability organizations like hospitals are undeniable, its unchecked implementation risks exacerbating the overreliance on technology. This article examines AI's role in cardiology through the perspectives of physicians, nurses, respiratory therapists, pharmacists, and social workers, alongside technical insights.

Physician perspective

Artificial intelligence is transforming cardiology by enhancing diagnostic precision and improving patient outcomes. AI algorithms excel in detecting subtle abnormalities in imaging studies, such as echocardiograms and MRI, often with accuracy comparable to expert cardiologists. Predictive tools can flag early signs of conditions like heart failure or arrhythmias, enabling timely interventions, and reducing adverse outcomes. Decision-support systems further aid by recommending evidence-based treatment plans tailored to individual patients.[1]

However, physicians face challenges when incorporating AI into practice. "Black box" algorithms that provide recommendations without clear reasoning can undermine trust and clinical adoption. Furthermore, AI systems trained on biased data sets risk perpetuating disparities in care. Physicians must balance AI-generated insights with clinical judgment and advocate for inclusivity in algorithm development.

Although AI can optimize workflows and reduce administrative burdens, it cannot replace the nuanced understanding required in sensitive areas such as end-of-life care. Physicians remain central to ensuring AI is used responsibly, fostering collaboration with technologists to align tools with clinical needs (Table 1). Ultimately, AI should complement, not replace, the expertise, and compassion that define medical practice.[1]

Nursing perspective

Nurses play a multifaceted role in patient care, particularly in acute care settings. The charge nurse role, burdened with administrative tasks

Abbreviations: AI, artificial intelligence; ECG, electrocardiogram; EMR, electronic medical record; MRI, magnetic resonance imaging.
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such as bed flow, acuity logs, and staffing requests, often leaves limited time for direct patient care. AI can alleviate these burdens by streamlining time-intensive regulatory duties, enabling charge nurses to be more available to support bedside care.

For bedside nurses, AI holds promise in improving the efficiency and accuracy of change-of-shift reports. Historically, shift reports resemble a prolonged game of "telephone," where critical details risk being lost or miscommunicated. Although institutions attempt to standardize this process, such efforts often fail to account for the unpredictability of critically ill patients. AI could consolidate nursing documentation into a cohesive report, highlighting changes in patient status over the previous 72 hours. This tool would allow nurses to focus on evaluating the significance of these changes, reducing the likelihood of missed details and enhancing patient safety.

However, AI's utility in nursing is not without limitations. Nursing is deeply rooted in compassion and human connection, as Florence Nightingale exemplified in her emphasis on holistic care. Nurses are often the primary source of emotional support for patients, holding their hands in moments of fear and sharing their joy during recovery—qualities that no AI system can replicate.

Additionally, nurses rely on continuous subjective assessments of patients, which often precede measurable clinical changes. These observations, difficult to quantify or document in EMR, are critical in identifying early signs of deterioration (Table 1). Although AI excels at analyzing objective data, it cannot capture the nuanced, intuitive judgments nurses make in real-time. Overreliance on AI risks overlooking these critical subjective assessments, reinforcing the necessity of maintaining human expertise at the core of nursing care.

Pharmacy perspective

The integration of AI into pharmacy practice holds significant potential to improve the safety and efficacy of pharmacotherapy in cardiac care. AI-driven clinical support systems can assist pharmacists in selecting optimal medications and dosages, reducing the risk of adverse effects and drug interactions. For example, high-risk medications, such as commonly prescribed anticoagulants, pose significant risks, including bleeding complications that contribute to morbidity, mortality, and hospitalizations. AI systems can proactively identify patients at risk for these adverse effects, such as those arising from drug-drug interactions, and suggest strategies to mitigate them. Additionally, many cardiac medications are associated with QTc prolongation, which can lead to severe arrhythmias. AI systems can flag such risks, enabling tailored medication regimens that improve patient outcomes. Furthermore, given the complexity of guideline-directed medical therapy, AI can enhance patient education and medication adherence, particularly as cardiac patients are often discharged on multiple medications.

However, challenges remain in fully leveraging AI in pharmacotherapy. Frequently used medications with narrow therapeutic indices, such as digoxin and warfarin, highlight the limitations of AI systems. The variability in dosing requirements due to factors like pharmacogenomics may not always be accounted for, leading to suboptimal recommendations. These limitations underscore the importance of clinical judgment when interpreting AI-generated insights. Pharmacokinetics and pharmacodynamics, which vary widely among patients, present additional hurdles for AI to effectively model interpatient variability. Overreliance on AI without incorporating a pharmacist's expertise may lead to suboptimal therapeutic outcomes (Table 1).

As AI continues to evolve, its potential to revolutionize pharmacotherapy is undeniable, but its role must complement, rather than replace, the critical decision-making capabilities of clinical pharmacists. By addressing the current limitations, AI can become an invaluable tool in optimizing cardiac patient care while preserving the human oversight necessary for nuanced clinical scenarios.

Respiratory perspective

The COVID-19 pandemic and a recent information technology (IT) outage at my facility underscored the critical role of continuous data recording in delivering quality care. Although the outage lasted less than 24 hours, it highlighted the challenges of caring for critically ill patients without access to EMR. During the pandemic, this difficulty was further magnified as we were forced to manage patients in areas without continuous monitoring—a particularly significant challenge in cardiac ICU.

Looking forward, I am optimistic about the potential of AI to improve respiratory care. AI could aid in evaluating risk-benefit ratios for interventions, optimizing ventilation strategies, and enhancing system-wide quality control at minimal cost. By analyzing real-time patient data, AI has the potential to support clinicians in managing complex respiratory conditions. However, limitations remain. Troubleshooting equipment issues, such as distinguishing between condensation in a flow sensor and a mucus plug, or differentiating between acute

Table 1. Multidisciplinary perspectives on AI in cardiology: Advantages and disadvantages across disciplines

Discipline	Advantages	Disadvantages	Essential needs
Physicians	- Enhanced diagnostic accuracy (eg, ECG interpretation). - Predictive modeling for adverse cardiac events.	- Risk of overreliance on AI, weakening clinical judgment. - Bias in algorithms affecting diverse populations.	- Training programs focused on understanding AI algorithms and their implications. - Implement standardized protocols for integrating AI decision-support tools.
Nursing	- Streamlined shift reports with reduced human error. - Assistance with administrative tasks (eg, bed flow).	- AI lacks compassion and emotional intelligence. - Challenges in documenting subjective assessments.	- Continuous education on AI applications in nursing. - AI systems that alert nurses to critical patient needs based on data.
Respiratory	- Improved evaluation of risk-benefit ratios for interventions. - Enhanced quality control across systems.	- Inability to address equipment-specific issues (eg, ventilator troubleshooting). - Dependence on objective data only.	- AI-driven platforms suggesting personalized ventilation strategies based on patient history. - Real-time data monitoring systems integrated with AI for alerts.
Pharmacy	- Optimized medication dosages. - Detection of drug-drug interactions and adverse effects.	- Narrow therapeutic index medications (eg, warfarin) pose challenges for AI. - Variability in pharmacogenomics not fully captured.	- Collaborative framework between pharmacists, AI developers, and clinicians.
Social work	- Retrieval of historical documents for end-of-life planning. - Assists with logistical challenges in care coordination.	- Cannot replicate empathy during sensitive discussions. - Lacks adaptability to complex human emotions.	- AI platforms that identify at risk patients based on psychosocial data trends.

ECG, electrocardiogram.

respiratory distress syndrome and eosinophilic pneumonia, often requires sensory input that AI cannot replicate. However, I do see potential in the utilization of AI to produce troubleshooting algorithms based on potential differential diagnoses for the obtained data. This will allow AI to guide ventilation decision-making, while relying on human expertise.

To ensure the safe and effective integration of AI into respiratory care, cross-disciplinary collaboration is essential.[2] Experts in medical ethics, regulatory affairs, and health care delivery must work alongside AI developers to ensure compliance with ethical standards and regulations. Addressing AI bias is particularly important, as algorithms trained on incomplete or skewed data sets risk perpetuating disparities in care. Rigorous validation across diverse demographic groups is necessary to ensure fairness and equitable outcomes.[3,4]

Education will also play a vital role in advancing AI adoption. Training health care professionals in AI fundamentals, data management, and continuous evaluation is crucial to bridging knowledge gaps and enabling the effective use of these tools. AI must ultimately function as a supplement to, rather than a replacement for, the clinical judgment, and hands-on expertise that define respiratory care.

Social work perspective

Social workers, as licensed mental health professionals, are trained to communicate effectively, read emotions, and guide individuals through complex decisions about their health and well-being. Although computers can be programmed for many tasks, they cannot adapt to the dynamic and multifaceted emotions that humans experience daily. This unpredictability is especially evident in end-of-life care, where no blueprint can account for the unique circumstances of each patient.

Artificial intelligence offers some benefits in cardiac care, particularly in facilitating advance directives and end-of-life planning. For example, retrieving older documents or generating templates tailored to conditions like heart failure can streamline care coordination. By accessing historical information beyond human reach, AI can fill knowledge gaps, making it a valuable tool in certain respects.

However, there are clear limitations to the role of AI in social work. A case in point involves a female patient in her late 50s who had been on dobutamine. After repeated hospital admissions and failed tolerance of home infusions, it was decided that transitioning to comfort care was the best option. Although AI might predict her prognosis, it cannot prepare us for the specific needs of the patient during her final days. This is where social workers excel—offering emotional support and facilitating difficult conversations with empathy and understanding.

Social work is inherently subjective, requiring an ability to perceive the unshed tears in a patient's eyes or the hesitation in their voice. Although AI can enhance efficiency by organizing and presenting data, it must be interpreted by a professional well-versed in human connection, which stands at the core of the social work profession (Table 1). Social workers remain essential in bridging the gap between clinical care and the emotional and psychological needs of patients and their families.

Family and patient perspective

From the perspective of patients and their families, the integration of AI in health care can evoke mixed feelings. Although many are hopeful about the potential for improved diagnostic accuracy and personalized care, there are concerns about the impersonal nature of AI systems. Patients often seek not only technical expertise but also empathy and compassion in their interactions with health care providers.

Families may worry that reliance on AI could diminish the human touch in care, particularly during critical moments such as end-of-life discussions. Technology may facilitate the efficient gathering and analysis of medical data, but it cannot replace the comfort found in a health care professional's presence or the invaluable emotional support provided by nurses and social workers.

Moreover, there is a fear of misunderstanding or miscommunication when AI systems provide recommendations without transparency. Patients and families may feel sidelined if they perceive that decisions are being made by algorithms rather than through discussions with their health care team. Therefore, incorporating the patient and family perspective in AI development and implementation is crucial. Engaging them in conversations about how these technologies will be used can alleviate concerns and foster trust.

Overall, the patient and family perspective underscores the necessity of balancing technological advancements with the enduring need for human relationships and emotional intelligence in health care. To ensure that AI enhances rather than detracts from patient experience, it must be integrated thoughtfully and transparently into clinical practices.

Technical perspective on AI in cardiology

Over the past decade, AI has emerged as a transformative tool across industries, including health care. In cardiology, AI's ability to analyze vast data sets and identify complex patterns offers significant potential to improve patient outcomes. Successful applications include the automated interpretation of electrocardiograms, detection of heart murmurs, and predictive modeling for adverse cardiac events.[5–8] Despite these achievements, growing reliance on AI exposes critical vulnerabilities in the underlying infrastructure.

One illustrative incident was a recent IT outage caused by a cybersecurity company, Crowdstrike, which rendered EMR inaccessible and disrupted essential biomedical systems. This event highlighted the fragility of AI-dependent health care systems, raising questions about preparedness during large-scale technological failures. Overreliance on AI could leave providers ill-equipped to manage such disruptions, posing risks to patient safety.

Another concern is the potential erosion of clinical judgment. Although AI excels at processing data and making recommendations, it is not infallible. Overdependence risks diminishing health care professionals' decision-making skills. Clinicians must be encouraged to remain the ultimate decision-makers, ensuring AI complements their expertise rather than undermines it.

Bias and limitations in AI systems

Artificial intelligence models often rely on historical data for training, which can often harbor biases and inadequately represent the diversity of patient populations. These data biases can significantly affect AI outcomes, leading to disparities in health care delivery where marginalized groups may receive less accurate diagnoses or treatment recommendations.[9] To mitigate these issues, developers must rigorously evaluate data quality and emphasize the use of diverse and representative data sets. Ensuring that algorithms aretrained on varied data sources is crucial in promoting equitable care and reducing the risk of algorithmic bias.

In addition to data biases, the "black box" nature of many AI algorithms poses a significant challenge regarding their interpretability. The lack of transparency in how AI models make decisions can hinder clinicians' trust and adoption of these technologies. Ongoing efforts to improve algorithm interpretability are essential, including the development of tools that clarify AI decision-making processes. Enhancing transparency will enable health care professionals to better understand and integrate AI recommendations into their clinical practices.

Furthermore, the reliance on AI systems exposes health care to risks during technological outages, which can disrupt critical care processes. The consequences of such failures may include delays in diagnosis or treatment and compromised patient safety. To address these vulnerabilities, health care organizations should develop contingency plans that maintain care quality during technological disruptions. This may include implementing manual backup systems, ensuring continuous training for staff on emergency procedures, and establishing interdisciplinary teams dedicated to assessing and managing these risks.

The implementation of AI technology in health care often entails significant costs, including expenses for software, hardware, and ongoing maintenance. Smaller or underfunded health care facilities may struggle to afford these technologies, which could exacerbate existing disparities in care quality between more affluent and resource-limited environments. The financial burden of integrating AI systems can also divert crucial resources away from other essential areas of patient care.

Additionally, inadequate infrastructure can hinder the effective deployment and utilization of AI solutions. Health care organizations need robust IT systems and support to manage and analyze the large volumes of data that AI requires. Facilities lacking such infrastructure may not fully benefit from AI advancements or may face increased operational challenges.

By focusing on these challenges—data biases, algorithm interpretability, technological outage risks, and limitations regarding cost and infrastructure—along with proposing actionable strategies to mitigate them, the health care sector can better harness AI's potential while ensuring that its limitations are effectively managed.

Ethical and accountability challenges

Artificial intelligence in health care raises important ethical questions. If an AI-driven recommendation results in harm, should accountability rest with the clinician, the institution, or the developers? Establishing clear frameworks to address these dilemmas is critical. Health care professionals must understand AI's limitations and exercise oversight, particularly in sensitive contexts like end-of-life care. Although AI can provide prognostic insights, it cannot replicate the emotional intelligence needed to guide these discussions effectively.[10]

Opportunities and future directions

Despite legitimate concerns, halting AI development is not the solution. Instead, health care systems must invest in robust education, infrastructure, and regulatory frameworks to support AI integration. Training health care professionals to understand AI's capabilities and limitations is crucial to bridging knowledge gaps and ensuring informed use.

Institutions should consider establishing dedicated divisions to monitor and manage AI systems, akin to clinical engineering or medical physics departments. These teams would address issues such as data shifts, model recalibration, and system failures to maintain performance and reliability.

Regulatory frameworks, such as those established by the European Union and the Food and Drug Administration, already classify AI systems as medical devices subject to risk-based evaluation. These guidelines can ensure safe implementation, particularly for low-risk, repetitive tasks like transcription or drug administration annotations. By alleviating workloads for health care professionals, AI can free them to focus on complex, intellectually demanding tasks that require human judgment and compassion.

Conclusion

Artificial intelligence holds immense potential to revolutionize cardiology, optimizing workflows and improving patient outcomes. However, its successful integration depends on addressing ethical, technical, and infrastructural challenges. By prioritizing education, robust oversight, and multidisciplinary collaboration, AI can enhance care delivery while preserving the central role of health care professionals in decision-making.

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