Daiichi-Sankyo | DSPACE

Heartbeats & Algorithms

Decoding the Future of Cardiology with AI

February 2025

Contents

Executive Summary

This white paper explores the transformative potential of artificial intelligence (AI) in cardiology. Drawing from a think tank event with cardiologists in Belgium, it highlights how AI can revolutionise cardiovascular disease prevention, diagnosis, treatment, and control by leveraging new technology and vast data sources. The integration of AI in cardiology is seen as a means to:

- Alleviate administrative burdens
- Optimise workflows
- Enhance diagnostics and personalised treatment
- Improve patient empowerment
- Support professional training

Challenges such as financial, ethical, and regulatory considerations, especially in Europe, are acknowledged, alongside international legislative efforts for safe AI use. Trust among clinicians and patients is seen as an essential success factor, highlighting the importance of making AI intuitive and explainable. For AI's successful integration into cardiology, collaborative efforts among stakeholders are vital while ensuring human-led care remains central.

1. Introduction: Harnessing the power of data in cardiology

Cardiovascular diseases are the leading cause of death and disability in Europe and are responsible for approximately 10,000 deaths in the region every day.[1] Decades of innovation have led to significant improvements in cardiovascular disease management and yet the burden they inflict on patients, health systems, and society continues to rise.

On the other hand, digital technology – particularly artificial intelligence (AI) – is advancing at record speed. AI encompasses technologies that enable machines to mimic human intelligence, performing complex tasks once considered exclusive to humans.

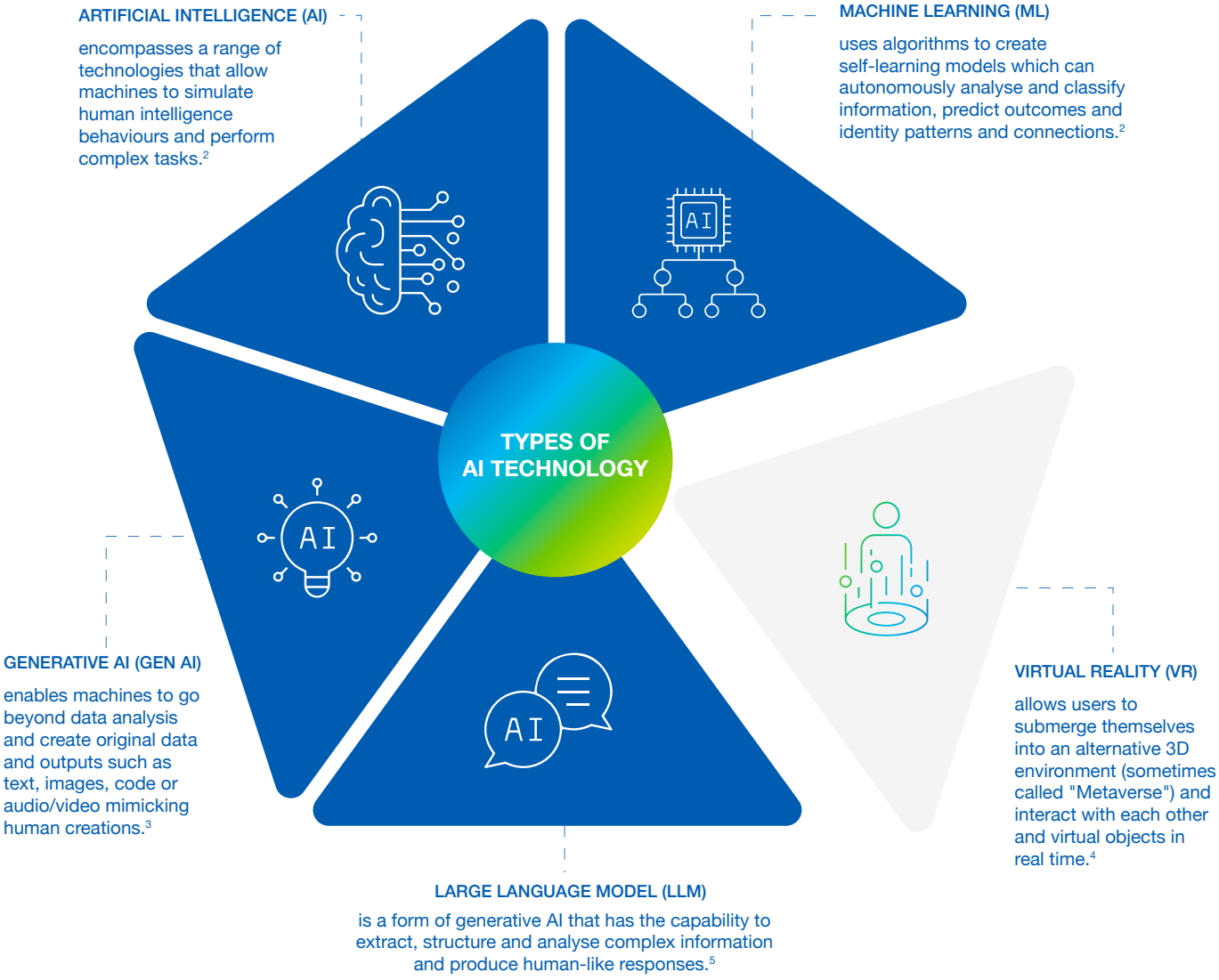


Figure developed by Daiichi Sankyo.

A significant capability of AI is its capacity to analyse and interpret vast datasets. In healthcare, datasets are continuously generated from diverse sources, such as electronic medical records, laboratory results, epidemiological surveys, wearables, smart devices, clinical registries, and online platforms.

The integration of AI with this extensive data pool can transform medicine, paving the way for innovative approaches in preventing, diagnosing, treating, and managing cardiovascular diseases.[2]

While the potential benefits of AI in clinical care could be substantial, it is essential to address the associated risks through a careful and controlled integration process.

The adoption of this technology should be backed by strong evidence demonstrating its capability, cost-effectiveness, superiority over existing technologies, and its impact on enhancing patient outcomes.

This approach will ensure that AI technology is fit for purpose and this evidence will be crucial in earning the trust and support of healthcare and regulatory stakeholders, as well as patients.

To navigate the road ahead, cardiology stakeholders would benefit from a collaborative approach to make this vision a reality for patients. This white paper provides a starting point, capturing discussions amongst cardiologists and highlighting key considerations as they explored how to make this future a reality for patients.

2. Capturing the cardiologist perspective

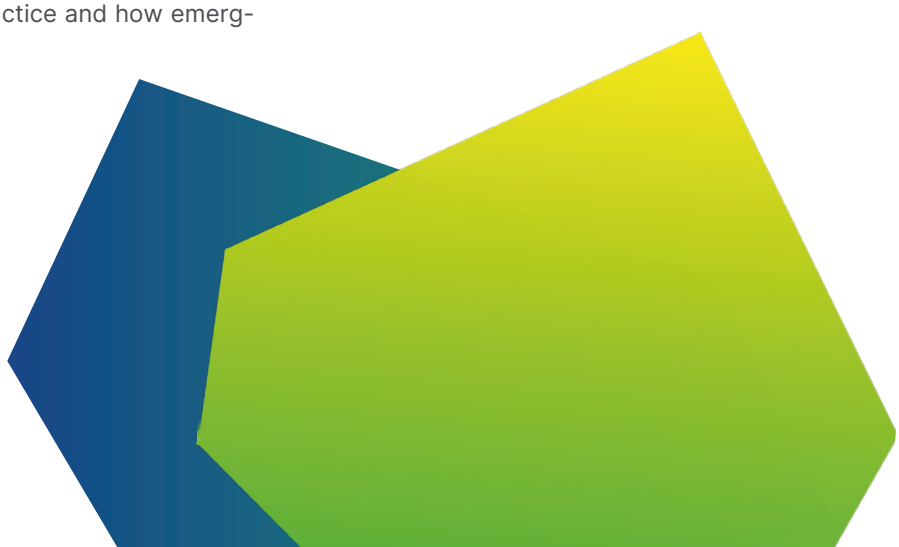
To explore the role of AI in shaping the future of cardiology in Europe, Daiichi Sankyo Belgium and IZIDOK (production house for medical congresses & education in Belgium) brought together a group of 20 leading cardiologists from across Belgium.

> "We are extremely honoured to partner with Daiichi Sankyo to organise a first-of-its-kind Digital Health Think Tank with a focus on artificial intelligence. This format served as a platform for insightful dialogue and connections that could accelerate learning and adoption of new technologies."
>
> Tom Rossenbacker MD PhD,
> Cardiologist and Founder of IZIDOK, Belgium.

Their sessions discussed what actions need to be taken to harness the full potential of AI. The group explored some of the key challenges that cardiologists face in delivering their day-to-day clinical practice and how emerging AI technologies could overcome these. The group also debated the most effective ways to integrate these new technologies and any barriers that could prevent this integration.

> "The question is not whether AI will be implemented, but rather when it will be implemented. [...] The efficiency of AI tools will be driven by their adoption and usage by doctors and patients."
>
> Think Tank Participant

This white paper captures the discussions and provides a broader perspective on the potential for AI in cardiology across Europe. It also highlights key considerations for important stakeholders on the path to making this future a reality for European patients.



3. Opportunities for AI in cardiology

3.1 Support for clinicians

As the European population ages, the number of people living with cardiovascular diseases is increasing. This growing patient demand on cardiology services, workforce challenges, and the increasing complexity of care begs innovative solutions that AI might be able to provide.

The following examples for smart AI integration have the potential to alleviate the administrative burden and deliver efficiencies that may allow cardiologists to see more patients, while improving the accuracy of patient records and the efficiency of follow-up care.[6]

> "We as clinicians are increasingly overwhelmed by the demands of data management, spending significant time encoding and analysing data, leaving minimal time for patient interaction. [...] We are still working for the machines, instead of the AI working for us."
>
> Think Tank Participant

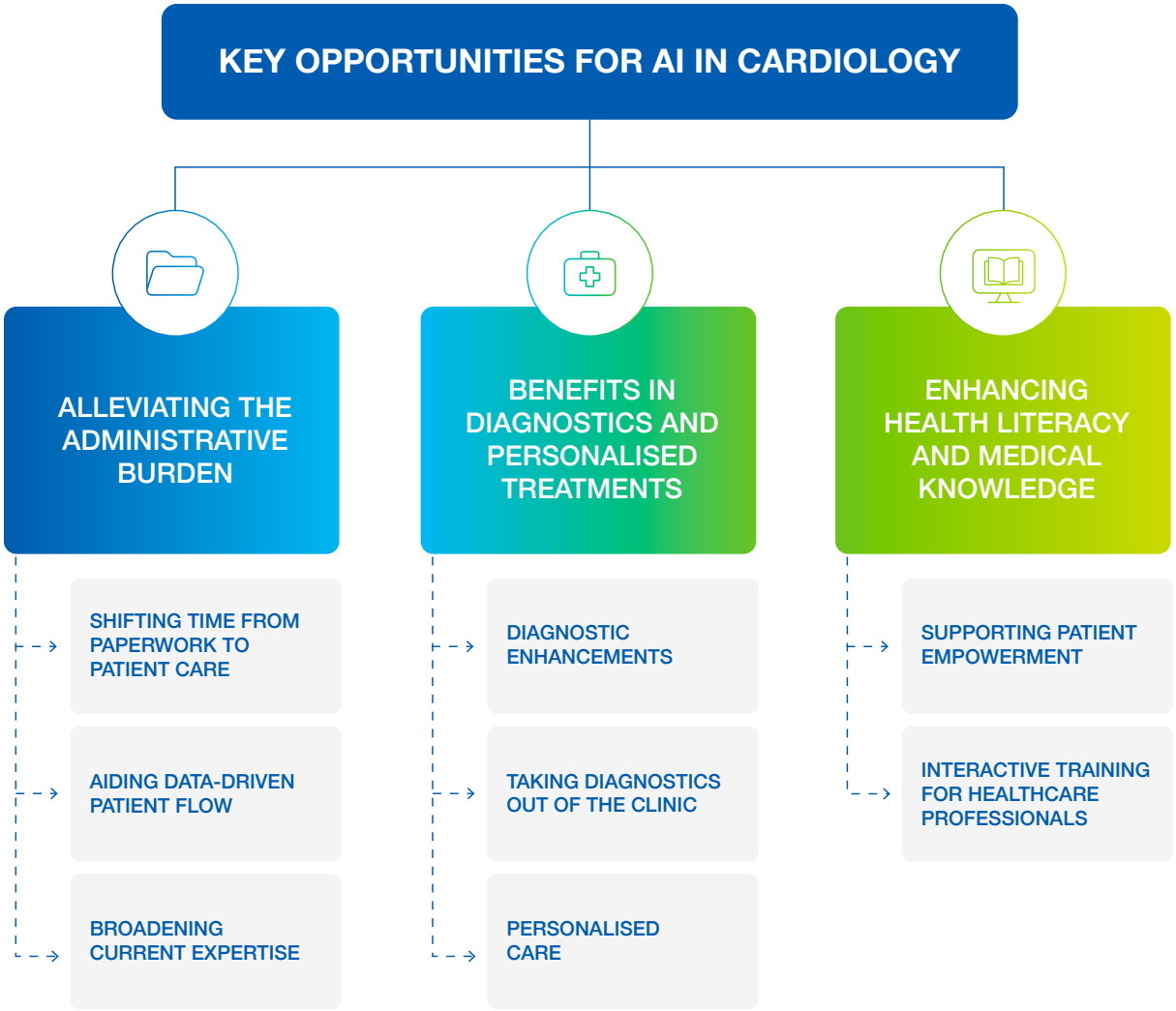


Figure developed by Daiichi Sankyo.

Shifting time from paperwork to patient care

Automation of patient data collection and analysis

AI-driven systems could automate the collection and summarisation of required patient information ahead of their consultation. By analysing their medical history, condition, current treatments, and other clinical information, use of AI could reduce administrative burden and unlock operational efficiency while supporting decision-making about treatment and care.[6]

Automation of administrative tasks

AI tools could be used to perform a range of repetitive and time-consuming tasks that take clinicians' time away from patients. Fully integrated AI tools could capture summaries of the patient consultation in real time, generate follow-up reports, order prescriptions and tests, and update members of the multidisciplinary team to ensure continuity of care.

Automation of electronic health record maintenance

Electronic health record (EHR) entries could be encoded automatically during consultations, driven by AI-powered speech recognition applications that could ensure completeness and accuracy of EHRs and organise them according to necessary ontologies, like ICD or SNOWMED codes.[7] This standardised structure would enable EHRs to be more integrable across health systems, allowing better coordination between stakeholders including health care providers, payers, and patients. And at the same time, standardisation will unlock the potential of population health management tools. As a result, EHRs could be utilised to guide clinical decisions and potentially delay or prevent disease onset.[8]

AI-support for optimising workflow and knowledge management

Aiding data-driven patient flow

AI systems could effectively support triage decisions by flagging patients who need more urgent care. This would increase the efficiency of care, utilise resources more effectively, and improve patient outcomes through timely intervention reducing risk and emergence of complications.

Broadening current expertise

Ongoing innovation is making the cardiology landscape more complex, presenting challenges for clinicians in keeping up with the latest advances. Upskilling clinical management software with AI tools that can deliver educational content to clinicians in a convenient and accessible way could help practitioners keep abreast of the latest developments in the field.

3.2 Benefits in diagnostics and personalised care

Diagnostic enhancements

AI is already driving transformation in the diagnostic imaging landscape. AI models that are trained to analyse echocardiograms, angiograms, electrocardiograms (ECGs)[9] and magnetic resonance images (MRIs)[10] can analyse medical imaging significantly faster than humans and with greater accuracy and depth. The ability of AI to recognise patterns or features that a human would find challenging to see could drive improved detection of rare conditions.[2]

In cardiology, AI-driven ECG analyses has proven its cost-effectiveness while improving clinical outcomes for patients. It can reduce the rate of misdiagnoses in computerised ECG interpretations, improve clinical efficiency, patient characterisation, risk stratification, as well as treatment selection,[11] optimisation, and personalisation.[12,13]

The future potential for AI could be even greater. The diagnostic ability of AI algorithms, such as deep neural networks trained on large datasets of single- and 12-lead ECG results, has dramatically increased. Mounting evidence demonstrates that AI can go beyond current diagnostic capabilities:[14] for example, by detecting acute conditions such as coronary occlusion myocardial infarction,[15] or predicting 'future' episodes of atrial fibrillation.[16]

Taking diagnostics out of the clinic

The new generation of diagnostic tools provides solutions that are closer to the patient, outside of clinical settings. This includes point-of-care testing, wearable devices, and medical diagnostic software integrated into smartphones. These tools enable the collection of real-time physiological data from patients' daily lives, indicating health status and informing easier and faster disease detection.[17]

In the past, such devices have been useful to a certain extent but lacked the capability to match in-clinic diagnostic equipment when it comes to accuracy and reliability. Through improvements in wearable technology and the incorporation of AI-enabled capabilities, these devices will continue to grow as powerful tools that enable patients to take control of their health on a day-to-day basis.

Real-world example:
Fighting atrial fibrillation via smartphone

While there are therapies in place to manage this serious cardiac arrhythmia once diagnosed, catching it in the clinic is often tricky as it can be intermittent, leading to delayed diagnosis that exposes patients to the ongoing risks of stroke.

Enhanced detection options that are clinically validated, accurate, and convenient could provide valuable data to inform healthcare professionals and support further investigation and diagnosis.

To this end, Daiichi Sankyo fosters collaboration with Software as a Medical Device (SaMD) firms – most notably with FibriCheck that developed the world's first medicallycertified mobile application capable of timely detection of heart rhythm disorders.

The application uses smartphone camera technology and is simple to use. It generates a clear and accessible report and advice for the patient's care team.

Since its launch, the application has been incorporated into official cardiology care pathways in multiple countries as a clinically-validated tool for improving the detection and monitoring of atrial fibrillation.

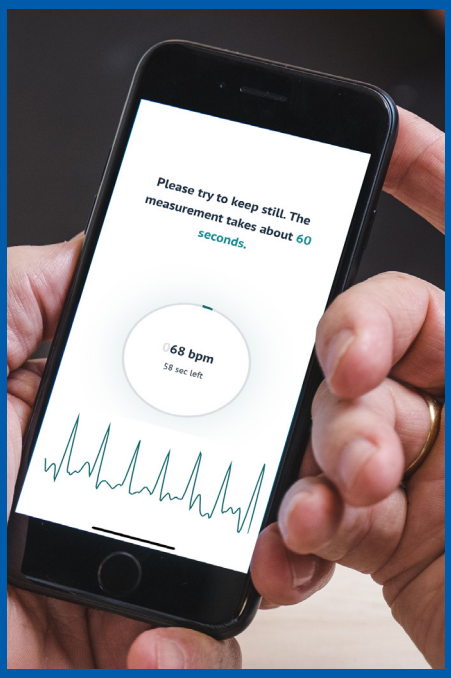


Image provided by FibriCheck

Personalised care

Personalised care involves customising medical care to the individual characteristics, needs, and preferences of each patient to improve treatment effectiveness and outcomes.

This new way of delivering care can be unlocked with the power of AI algorithms fed with vast amount of patient data from a wide variety of sources. Indeed, integrating demographic data with patient-generated behavioural data and physiological data, imaging, and laboratory results, could truly lead to personalised treatment and care.[2]

In this process, AI algorithms can support the challenging collection of data from various sources and afterwards identify relevant patterns within this heterogenous data ecosystem.

For example, with patient consent, AI tools within smartphones or watches could gather and analyse physiological data and behavioural patterns such as physical activity, providing personalised preventative advice based on these that supports treatment adherence and the improvement of health-related behaviour in real time.

3.3 Enhancing health literacy and medical knowledge

Supporting patient empowerment

To ensure patients play their part in the management of their condition, it is critical that they understand their diagnosis and its implications. The better patients are equipped with knowledge, the more empowered they are. AI-powered virtual assistants or chatbots could offer patients clear, convenient, and accessible information about their condition and enable them to easily find health-related answers.[18] This could include guidance on diet and lifestyle, medication information, adherence support, or practical help in managing the impact of symptoms on quality of life.[7]

AI-generated life-like avatars can further improve the experience by simulating human interactions more closely than text-based chatbots. The visual and auditory elements of a life-like avatar can capture and hold the attention of patients more effectively and the sense of personal connection might enhance trust and empathy.[19]

While there are some limitations with current AI-powered chatbots such as struggles with complexity or incomplete answers, their ongoing sophistication holds potential.[20]

Real-world example:
HiDoc educates patients

Launched by Daiichi Sankyo, HiDoc supplies an effective way to communicate in an easy and accessible way about diseases and prescribed medications by providing a life-like avatar of a physician with whom patients can interact. The avatar was created using advanced machine learning algorithms and computer vision techniques with the aim of promoting therapy adherence and proper medication intake. Videos provide simplified explanations for complex medical topics and can easily be translated into different languages.

A next step might be employing other technologies like generative AI to further improve the experience and make HiDoc more interactive and naturally conversational.

Image provided by Daiichi Sankyo.

Interactive training for healthcare professionals

The sophistication of extended reality (XR) environments and the 'metaverse' offers increased value from taking cardiology training into the virtual world. AI-assisted XR technology may provide routes for healthcare professionals to access a wide range of educational content, connect with colleagues, and access simulated content.

Integrating AI and XR technologies into training can help to overcome the financial and time limitations associated with continuing medical education (CME). With access to these technologies, healthcare professionals at every stage in their career can develop their skills and take advantage of the latest treatment and care innovations in a time- and cost-effective manner.[21]

Computational, virtual reality (VR), augmented reality (AR), and high-fidelity bench simulations allow for testing of numerous treatment strategies and the development and honing of technical expertise and surgical skills.[22] XR training can include situations such as complex cardiac surgery that are hardly accessible in the real world, thereby expanding learning opportunities for scenarios typically inaccessible to many practitioners.[23]

Moreover, XR also facilitates the efficient teaching of complex medical concepts, such as anatomy and molecular mechanisms, through advanced data visualisation techniques.[24] This approach enhances comprehension of intricate subjects beyond traditional methods.

Looking to the future, as XR technology evolves, incorporating AI, it holds the potential to offer surgeons real-time guidance and support via remote assistance in surgeries. This advancement could transform surgical collaboration in the future.[25]

Real-world example:
Doctopedia XR helps cardiologists train

Doctopedia XR is an innovative extended reality (XR) medical training platform designed to equip healthcare professionals with advanced practical skills and medical knowledge.

Through highly interactive simulations, it enables users to practice real clinical scenarios and enhance their competencies in a dynamic and immersive environment.

The platform offers not only specialised courses but also networking areas, classrooms with interactive elements, and other features that facilitate comprehensive and collaborative learning experiences.

Developed by Daiichi Sankyo in partnership with technology providers, academic institutions, and hospitals, Doctopedia XR supports asynchronous learning in a secure environment that fosters communication and teamwork through group-based training and virtual events. Additionally, the platform harnesses the vast potential of XR for designing clinical cases and holds future possibilities for enhancing image-based diagnosis.

Looking ahead, Doctopedia XR could integrate artificial intelligence to create even more realistic adaptive simulations, accurately replicating clinical scenarios and further enriching the learning experience for all healthcare professionals.

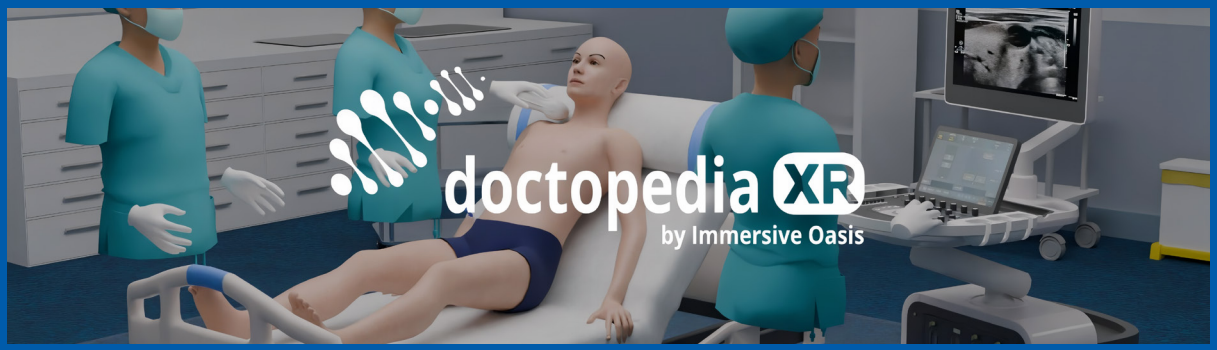


Image provided by Daiichi Sankyo.

4. Challenges for AI in cardiology

4.1 Ethical and regulatory considerations in the EU

Regulation of AI services poses challenges as AI algorithms continuously evolve with use due to its auto-learn feature. To guarantee the accuracy and safety of a product that changes over time requires additional policies and procedures.[26]

In July 2024, the European Union published its Artificial Intelligence Act.[27] The legislation aims to promote human-centred and trustworthy AI while protecting the health, safety, and fundamental rights of individuals from the potentially harmful effects of AI-enabled systems. It applies to all providers of AI systems in the EU market, regardless of where they are established or located, and offers an overarching framework for the creation of local regulations and safeguarding systems. However, the fact that countries have not yet formalised their regulatory guidelines based on the Artificial Intelligence Act creates a lack of clarity, which can hinder AI adoption and lead to increased risk.[28]

The AI Act is the first comprehensive legal framework specifically addressing AI. This is particularly important for the healthcare domain, as other existing harmonisation legislation, such as the European Medical Device Regulation (MDR), do not explicitly cover medical applications of AI.[29]

In addition to AI legislation, new AI technologies must comply with General Data Protection Regulation (GDPR), cybersecurity, and other regulations to ensure responsible use of patient data as well as to prevent data breaches and misuse.

Given the complex interplay between European Regulations and innovation in general, we know that Regulations can boost and incentivise or hamper innovation in healthcare. Ensuring the right balance between regulation and innovation will require significant effort and cooperation from all health and stakeholders.

4.2 International legislative efforts

Outside of Europe, valuable guidelines are also being issued. The U.S. Food and Drug Administration (FDA), Health Canada, and the UK's Medicines and Healthcare products Regulatory Agency (MHRA) have jointly published guidance as the International Medical Device Regulators Forum. 'Good machine learning practice for medical device development: Guiding principles' provides researchers with guidelines that aim to preserve the safety of patients and the quality of research in the field.[30]

4.3 Inclusivity in AI

AI tools should be designed to be accessible, equitable, and beneficial to a wide range of users, regardless of their background, abilities, or circumstances.

To achieve this, AI systems must be trained on diverse data sets to avoid biases and accurately represent a wide array of demographics and perspectives. This is challenging as the quality and inclusivity of data on which AI tools are trained is often problematic, because clinical data used by businesses or researchers often cannot be vetted.[31]

Inclusivity should also be integral to data processing and to avoid algorithmic bias. This bias can arise from various sources, such as the logic or structure of the algorithm itself, the features selected for analysis, or the way outcomes are interpreted. Algorithmic bias can lead to unfair or discriminatory outcomes even if the dataset used is representative. When biases arise in machine learning systems, they compound if left unaddressed and can potentially exacerbate existing healthcare disparities.[31]

Developing inclusive AI systems requires creating accessible interfaces that accommodate users with varying abilities, including those with disabilities, so that everyone can effectively use and benefit from the technology.

To truly foster inclusivity in AI design and development, involving diverse groups in the process is crucial to address the needs and preferences of all potential users. A good practice is the set-up of an equitable AI expert panel including healthcare professionals, patients, researchers, developers, ethics and compliance officers, and privacy officers to inform decision-making.[33]

5. The road ahead: Collaborative efforts for responsible implementation and future innovation

Maximising the potential of AI in cardiology is dependent on multiple factors. The final section of this paper outlines the key considerations for AI-augmented cardiology. To effectively navigate these complexities, the related efforts should be driven from within the expert community.

"A successful project will gain more traction with a joint effort from multiple hospitals, resulting in more budget and more media attention."

Think Tank Participant

5.1 Securing clinicians' confidence and support

Securing widespread support is vital for the effective integration of AI into cardiology services. Gaining the trust and confidence of healthcare and clinical stakeholders requires a robust evidence base that supports the effectiveness, accuracy, value, and impact of these technologies.

While the evidence base is continuing to grow, there is still a lack of standardisation of AI algorithms or the metrics that are used to evaluate them in research.[34] This makes it difficult to make informed decisions about the suitability and impact of AI for different use cases and presents a barrier to adoption and uptake.

5.2 Managing financial and workload impact

AI-augmented systems and technology can be prohibitively expensive. Qualitative datasets as input for AI, development, validation, hardware, and software costs put burden on capital expenditures. Required support from experts including data scientists, IT professionals, compliance experts, and others raise the operative cost of implementing artificial intelligence in healthcare. This will continue to be a barrier to uptake in Europe, particularly while there is limited data to support the real-world value of AI systems in cardiology. However, costs are heading in the right direction, with the cost to train an AI system down 1,000-fold since 2017.[6]

Integration of AI systems are associated with an increased workload across the health system.

This is due to the need for in-depth training, testing of systems, reorganisation of clinic procedures and processes, patient education and data collection, as well as privacy procedures.

Reducing the cost of AI technology and building systems that seamlessly integrate with existing workflows will be the key to adoption in the future.

5.3 Ensuring human-led care remains central

AI has the potential to enhance patient outcomes in multiple ways, but it is important that its development and integration remains focused on its potential to assist and augment human-centred care and not replace it.

Equally, human control and oversights will always be pivotal to the effective use of AI, from maintaining the continued diversity, quality, and robustness of the data used to train AI algorithms, to ensuring the ongoing accuracy of its outputs.[34]

The key to improving cardiology outcomes lies in a future wherein AI gives clinical teams the time and scope to enhance their expertise.

Equally, awareness and literacy of patients around digital health and AI must be fostered to achieve optimal outcomes.[35]

> "Patients should always have access to their data. There should be sufficient involvement of patients in their data handling, which can open the discussions during consultations with physicians."
>
> Think Tank Participant

In the end, the patient and the physician should be able to make a well-informed choice if they would integrate the AI advice or not, and the final decision always rests with the patient.

5.4 Increasing trust: Making AI intuitive and explainable

The impact of AI technology depends on its adoption by clinicians and its acceptance by patients. To achieve this, AI systems must be designed around effective human-computer interfaces that are intuitive to use and are able to secure the trust of those important stakeholders.

Another key to securing acceptance is the ability to understand how AI perform their tasks.

Some current AI models are considered 'black boxes', as their way of arriving at the output cannot be understood or explained.

Counteraction comes from a significant and rising body of research into 'explainable AI' (XAI) systems, where each decision made during the AI analysis can be traced and explained.[36] Its advances should provide more confidence in the outputs of AI technology in the future.

6. Conclusion: Collaborating to realise the potential of AI for patients

AI is already transforming healthcare at a rapid pace, with systems and tools that are driving earlier and more accurate diagnoses, expediting and enhancing care delivery while improving patient outcomes.[37]

> "AI solutions should enhance, not replace, the medical knowledge that we possess.."
>
> Think Tank Participant

Achieving seamless integration of AI at its full potential in cardiology will require dedication, investment, innovation, and commitment to overcoming the many challenges involved.

It will require adaptation and harmonisation of systems and health infrastructure, integration of data and health records, and buy in from the entire health ecosystem, as well as continual improvement and honing of AI.

This can only be achieved through true collaboration and joint efforts between health and policy stakeholders, AI providers, industry partners and patients.

About Daiichi Sankyo

Daiichi Sankyo is an innovative global healthcare company contributing to the sustainable development of society that discovers, develops, and delivers new standards of care to enrich the quality of life around the world. With more than 120 years of experience, Daiichi Sankyo leverages its world-class science and technology to create new modalities and innovative medicines for people with cancer, cardiovascular, and other diseases with high unmet medical need.

With the launch of DSPACE, its European digital innovation hub, Daiichi Sankyo shows commitment to transform cardiology and revolutionise patient outcomes by leveraging its expertise in providing innovative medicines and healthcare services. True to its philosophy, 'We care for every heartbeat', DSPACE aims for holistic support. Add-on services and digital technologies can help protect people from cardiovascular disease by identifying risks earlier and assisting those who suffer from it by supporting HCPs in making the best decisions together with their patients.

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