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AI: Opportunities, Capabilities and Limits

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Artificial Intelligence in Radiology: Realities, Challenges and Perspectives from a Tertiary Cardiac Centre in Greece

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An overview of the digitalisation at Onassis Cardiac Surgery Center in Greece and the application of artificial intelligence (AI) to take advantage of the current realistic opportunities along with future perspectives offered by modern technology.

Key Points

- The use of AI in radiology has led to innovative applications throughout the entire radiology pipeline, from improved scanner performance to automatic disease detection and diagnosis.
- AI will provide healthcare professionals powerful data-driven tools that will meet the increasing need for accurate and rapid diagnostic imaging with the use of prognostic risk scores.
- The contribution of AI to the interpretation of medical images can be considered a given for contemporary clinical practice with increasingly implemented applications in the near future.
- Onassis Cardiac Surgery Center, a tertiary hospital providing specialised cardiac care, is under a transitional period during which the centre is developing full digitisation and investing in the targeted introduction of innovation and artificial intelligence.
- Onassis Cardiac Surgery Center, in collaboration with a private company (3D Life) and the Centre for Research and Technology Hellas (CERTH) engaged the Project 3D4Kardia that offers an innovative approach for an optimal pre-interventional personalised assessment in patients with congenital and acquired heart diseases.

There is enough scientific evidence that Artificial Intelligence (AI) will fundamentally transform diagnostic imaging. The use of intelligent algorithms for segment formation is now based on machine deep learning leading to more concrete, standardised and personalised imaging, propelling medical image analysis field at a rapid pace (Hosny et al. 2018; Yang et al. 2022). The use of AI in radiology has led to innovative applications throughout the entire radiology pipeline, from improved scanner performance to automatic disease detection and diagnosis (Decuyper et al. 2021; Slart et al. 2021). AI will provide healthcare professionals powerful data-driven tools that will meet the increasing need for accurate and rapid diagnostic imaging with the use of prognostic risk scores. The use of AI algorithms will reshape clinical workflows, decrease or even prevent diagnostic errors, increase productivity and decrease costs leading to a personalised outcome-oriented clinical decision-making (Lee et al. 2019; Lin et al. 2020; Lee and Yoon 2021).

The contribution of AI to the interpretation of medical images can be considered a given for contemporary clinical practice with increasingly implemented applications in the near future (Tang 2019). A recent technology review concluded that *"AI methods are now becoming an ubiquitous tool in any medical image analysis workflow and pave the way for the clinical implementation of AI-based solutions"* (Barragán-Montero et al. 2021).

AI algorithms will reshape clinical workflows, prevent diagnostic errors, increase productivity and decrease costs leading to personalised outcome-oriented clinical decision-making

Onassis Cardiac Surgery Center is a tertiary hospital providing specialised cardiac care to patients of all ages with heart disease. The current era is under a transitional period during which the centre is developing full digitisation of its services and investing in the targeted introduction of innovation and artificial intelligence in order to excel its services for the benefit of cardiac patients in Greece.

This article focuses on the origin of this investment in order to take advantage of the current realistic opportunities along with the future perspectives offered by modern technology despite the unique challenges and barriers. Digital transformation is a change management process that increases value for patients, the hospital and the healthcare system.

At a time when integration of technological innovation is considered a primary objective for many industries, many AI algorithms have already proven their benefits in healthcare. A projected next step would be helping everyday practice with intelligent software in order to significantly add value for the entire discipline, while at the same time improving the physician's experience and preventing burnouts. Numerous case studies verify the tangible advantages brought about by AI. Numerous other applications are in development and can be expected in coming years providing added value in patients' care (Dey et al. 2019). For example, in cardiovascular imaging, AI algorithms are used to quantify prognostic imaging biomarkers, to predict cardiovascular risk from images and to integrate data from many different sources in order to provide individualised risk prediction (Lin et al. 2021). Likewise, AI applications for different imaging modalities have also proven their value. According to a three-month clinical implementation phase in a U.S. healthcare network, head CTs can be evaluated in seconds using an intelligent algorithm to detect unknown intracranial bleeding and prioritise the scans for rapid interpretation, which could literally save lives (Arbabshirani et al. 2017). This list could go on with other AI applications that are either at a practical development stage, or under imminent approval for clinical use by health regulatory authorities across the world.

Onassis Cardiac Surgery Center, in collaboration with a private company (3D Life) and the Centre for Research and Technology Hellas (CERTH) engaged the Project 3D4Kardia that offers an innovative approach for an optimal pre-interventional personalised assessment in patients for the whole range and categories of congenital and acquired heart diseases. It enables cutting-edge clinical research, 3D digital modelling, 3D printing and virtual reality technologies resulting in improvements in clinical outcomes, patient experience, clinician performance and cost reduction. Based on our preliminary analysis there is evidence that the pre-interventional assessment based on the combination of 3D-modelling and 3D-printing improves clinical outcome and performance in all moderate and high-risk interventions of structural and congenital heart diseases and contributes to the following improvements:

- Reduction of surgical/interventional time
- Reduced rate of complications
- More accurate and individualised selection of implants
- Reduction of cost
- Faster recovery after surgery/intervention
- Improved quality of life
- Better care experience

At the practical level it provides an optimal preoperative evaluation of patients and an improved training experience for our medical teams through the development of a virtual reality platform offering better semantic visualisation of each pathogenesis and details personalised to the patient, based on real clinical cases. The project has been co-financed by the European Regional Development Fund of the European Union and Greek national funds through the Operational Program Competitiveness, Entrepreneurship and Innovation, under the call RESEARCH–CREATE–INNOVATE (project code:T2EDK-04012).

All the above facts do not mean that there are no challenges to be overcome. The first challenge we have to deal with is the increasing demand for diagnostic imaging in combination with the almost stable number of radiology specialists. This leads to greater demands for work efficiency and productivity. In our case the interpretation of heart and thorax imaging is demanding and the use of algorithms is beneficial. Moreover, the image resolution is continuously improving and the product is not just pictures but rather data.

In the case of radiology data, the volume of pictures is tripled every year and accurate interpretation without the use of computerised digital processing is quite demanding and time consuming. Use of imaging biomarkers and radiomics under automated procedures and extensive datasets seem to be the future (Hwang et al. 2019; Decuyper et al. 2021; Lin et al. 2020). The identification of novel biomarkers and applications of deep machine learning algorithms to cardiovascular imaging techniques will further improve diagnosis and prognostication for patients with cardiovascular diseases.

Recently the European Association of Nuclear Medicine (EANM) and the European Association of Cardiovascular Imaging (EACVI) published a position paper to provide an overview regarding modern machine learning-based artificial intelligence, to highlight current applications and to enhance strategies that support its clinical application in the field of cardiovascular imaging using nuclear cardiology (hybrid) and CT techniques (Slart et al. 2021).

Moreover, radiologists need to obtain new skills in order to facilitate deep learning. This means that they have to invest in long training cycles for a better understanding of big data usage and complex hardware specifications understanding (Yang et al. 2022). Therefore it is a challenge to decide the use of the existing algorithms because they usually only perform single tasks. This poses a dilemma for radiologists; either they will restrict the use of AI to specific cases, or they will try to integrate various algorithms developed from different vendors into their IT systems. The latter could raise issues as far as both practicability and compatibility are concerned. Hence, to fully take advantage of the benefits of AI applications new forms of comprehensive solutions for clinical routine should be developed (Kotter and Ranschaert 2021). Finally, there are also a variety of ethical implications around the use of AI in healthcare. As Davenport and Kalakota (2019) commented *"the use of AI to make or assist clinical decisions raise issues of accountability, transparency, permission and privacy"*.

An additional challenge is the reduction or even prevention of diagnostic errors. Previous studies reveal that there is a mean of 4% error in radiology diagnoses, a rate that varies depending on the procedure and the available time (Sokolovskaya et al. 2015; Waite et al. 2017; Kotter and Ranschaert 2021). Algorithms that enable data-based image analysis with artificial intelligence and machine learning methods seem to be the optimal choice for the near future.

It is well known that the use of machine learning in medical imaging is not new. Nevertheless the current algorithms are more powerful than traditional applications. Notably, image data availability is an important hurdle for implementation of AI in the clinical setting. Willemink et al. (2020) proposed federated learning, interactive reporting, and synoptic reporting as approaches to address data availability in the future (Willemink et al. 2020; van Ginneken 2017). The use of artificial neural network for deep machine learning is promising in developing high complexity models even in non-linear contexts (Lee et al. 2019; Sarker 2021). Implementation of AI in clinical practice undoubtedly will result in many ethical, medical, occupational and technological changes in healthcare.

To this effect, various strategies are emerging. Many software providers form consortiums with an eye to coordinating their AI applications. At the same time, big companies of the industry are already working to design right from the start integrated AI assistance systems so that they can provide multifunctional support. Onassis Cardiac Surgery Center invested in state of the art technologies for outstanding image quality that combine AI in medical imaging, resulting in higher automation, productivity and standardisation. The use of a recognition algorithm in combination with a 3D diagnostic software automatically detects anatomical structures, simplifies workflows in diagnostic imaging and decreases diagnostic errors (Hosny et al. 2018).

In conclusion, let's not forget that AI is a technology based on learning, in the sense that it is an innate characteristic of intelligent algorithms to learn by processing large amounts of data and then accordingly adjust and optimise their internal parameters. As Slomka et al. (2017) concluded *"the upcoming developments will not replace the role of physicians but will provide them with highly accurate tools to detect disease, stratify risk in an easy-to-understand manner and optimise*

Radiologists need to obtain new skills in order to facilitate deep learning... they have to invest in long training cycles for a better understanding of big data usage

patient-specific treatment and further tests".

It is only natural then, that regular updates of the applications are still necessary. This obviously means that already operating application with tangible results can only get better in the future. Cloud-based infrastructures along with user feedback will help algorithms to be adapted at a faster pace, and new applications to be integrated into existing AI systems. It seems that it will not be long before we can really talk about comprehensive, AI-powered whole-body imaging. Finally, healthcare managers should enhance transformation of AI implementation - from speeding up workflows to improved diagnostics and cost-effective outcomes - making patient care more effective and efficient.

Conflict of Interest

None. ■

REFERENCES

Arbabshirani MR, Plis S, Sui J, Calhoun VD (2017) Single subject prediction of brain disorders in neuroimaging: Promises and pitfalls. NeuroImage. 145(Pt B):137-165.

Barragán-Montero A, Javaid U, Valdés G et al. (2021) Artificial intelligence and machine learning for medical imaging: A technology review. Physica medica. 83:242-256.

Davenport T, Kalakota R (2019) The potential for artificial intelligence in healthcare. Future healthcare journal. 6(2):94-98.

Decuyper M, Maebe J, Van Holen R, Vandenberghe S (2021) Artificial intelligence with deep learning in nuclear medicine and radiology. EJNMMI physics. 8(1):81.

Dey D, Slomka PJ, Leeson P et al. (2019) Artificial Intelligence in Cardiovascular Imaging: JACC State-of-the-Art Review. Journal of the American College of Cardiology. 73(11):1317-1335.

Hosny A, Parmar C, Quackenbush J et al. (2018) Artificial intelligence in radiology. Nature reviews. Cancer. 18(8):500-510.

Hwang EJ, Park S, Jin KN et al. (2019) Development and Validation of a Deep Learning-Based Automated Detection Algorithm for Major Thoracic Diseases on Chest Radiographs. JAMA network open. 2(3):e191095.

Kotter E, Ranschaert E (2021) Challenges and solutions for introducing artificial intelligence (AI) in daily clinical workflow. European radiology. 31(1):5-7.

Lee D, Yoon SN (2021) Application of Artificial Intelligence-Based Technologies in the Healthcare Industry: Opportunities and Challenges. International journal of environmental research and public health.18(1):271.

Lee L, Kanthasamy S, Ayyalaraju RS, Ganatra R (2019) The Current State of Artificial Intelligence in Medical Imaging and Nuclear Medicine. BJR open. 1(1):20190037.

Lin A, Kolossváry M, Išgum I et al. (2020) Artificial intelligence: improving the efficiency of cardiovascular imaging. Expert review of medical devices. 17(6):565-577.

Lin A, Kolossváry M, Motwani M et al. (2021) Artificial Intelligence in Cardiovascular Imaging for Risk Stratification in Coronary Artery Disease. Radiology. Cardiothoracic imaging. 3(1):e200512.

Sarker IH (2021) Deep Learning: A Comprehensive Overview on Techniques, Taxonomy, Applications and Research Directions. SN computer science. 2(6):420.

Slart R, Williams MC, Juarez-Orozco LE et al. (2021) Position paper of the EACVI and EANM on artificial intelligence applications in multimodality cardiovascular imaging using SPECT/CT, PET/CT, and cardiac CT. European journal of nuclear medicine and molecular imaging. 48(5):1399-1413.

Slomka PJ, Dey D, Sitek A et al. (2017). Cardiac imaging: working towards fully-automated machine analysis & interpretation. Expert review of medical devices. 14(3):197-212.

Sokolovskaya E, Shinde T, Ruchman RB et al. (2015) The Effect of Faster Reporting Speed for Imaging Studies on the Number of Misses and Interpretation Errors: A Pilot Study. Journal of the American College of Radiology. 12(7):683-688.

Tang X (2019) The role of artificial intelligence in medical imaging research. BJR open. 2(1):20190031.

van Ginneken B (2017) Fifty years of computer analysis in chest imaging: rule-based, machine learning, deep learning. Radiological physics and technology. 10(1):23-32.

Waite S, Scott JM, Legasto A et al. (2017) Systemic Error in Radiology. AJR. American journal of roentgenology. 209(3):629-639.

Willemink MJ, Koszek WA, Hardell C et al. (2020) Preparing Medical Imaging Data for Machine Learning. Radiology. 295(1):4-15.

Yang G, Ye Q, Xia J (2022) Unbox the black-box for the medical explainable AI via multi-modal and multi-centre data fusion: A mini-review, two showcases and beyond. An international journal on information fusion. 77:29-52.