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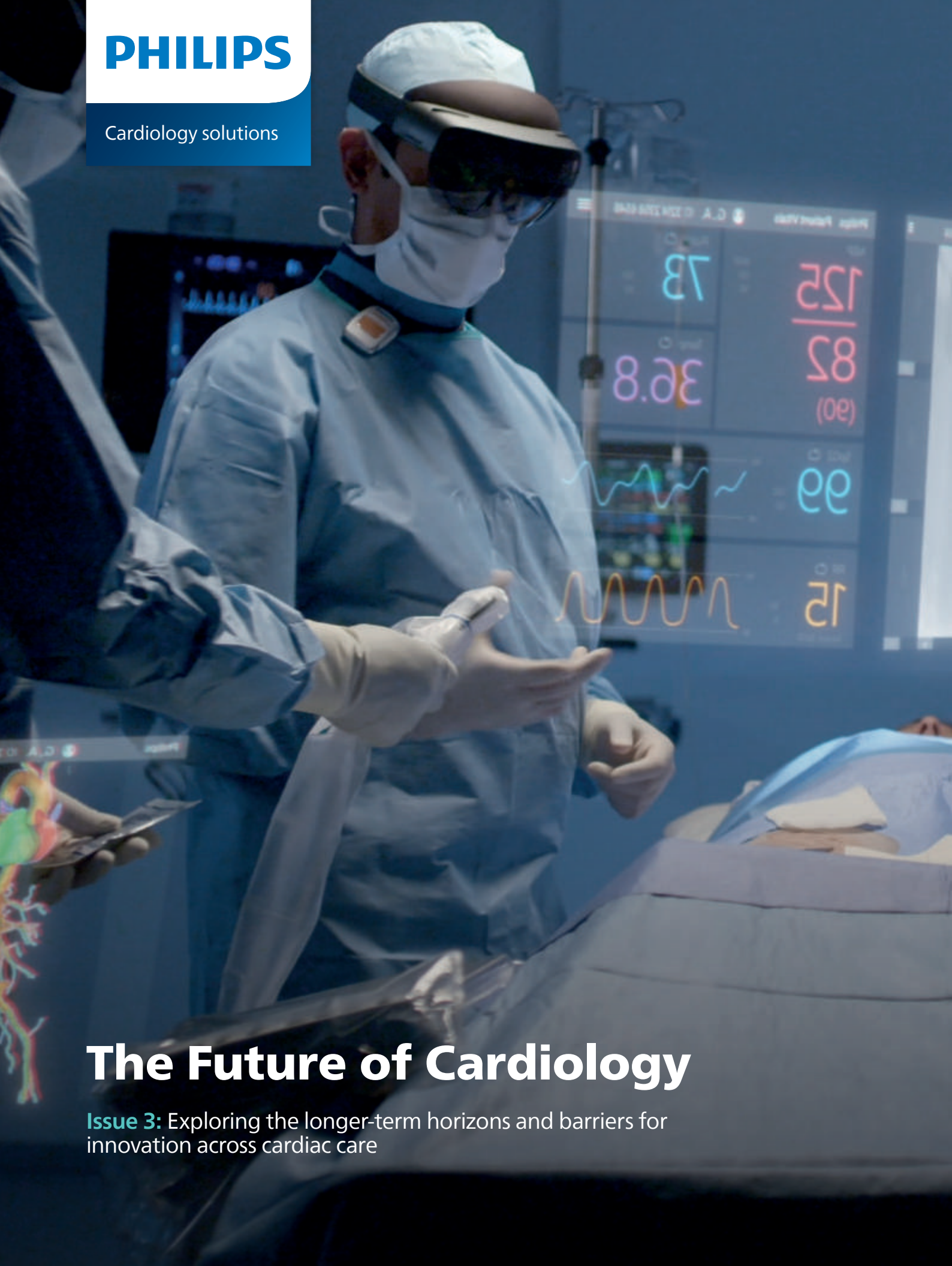
Cardiology solutions



The Future of Cardiology

Issue 3: Exploring the longer-term horizons and barriers for innovation across cardiac care

Digital, virtual, personalisation and intelligence-driven possibilities for cardiology

Exploring the longer-term horizons and barriers for innovation across cardiac care

In the first article in our Future of Cardiology series, Ruben Olivier, Cardiovascular Solutions Lead at Philips UK&I, explored the immediate innovations impacting cardiology as we start to move through the COVID-19 pandemic. These present day opportunities were also supported in the second article with a plotted vision of medium-term innovations that we can anticipate. These included the earlier and more targeted diagnosis for improved chronic disease management and its positive affect on prevention, coupled with the widespread behaviourial changes being brought about by the advent of wearable smart technology that is creating a shift in the everyday understanding of peoples' (and GPs') relationships with their hearts.

"The future is already here – it just isn't very evenly distributed."[1]

And yet, what of the longer term?

What radical innovations are likely to disrupt and change the face of cardiology as we currently know it and how will technologies such as artificial intelligence and virtual reality adapt the patient and clinician experience?

In this feature, the last in a series of three, Ruben Olivier concludes his longer term explorations into the future of cardiology and, using McKinsey's horizons for growth framework, introduces his projections for Horizon 3: Longer term innovations to expect in cardiology, 2-3 years out.

Ruben Olivier, Cardiovascular Solutions Lead at Philips UK&I

1 William Gibson, author, The Economist

Horizon 3: Longer-term innovation in cardiology
Timeframe: 2-3 years out

The near zero radiation goal

Exposure to ionising radiation continues to be an important healthcare concern for patients and staff exposed during diagnostic imaging or interventional procedures.

The dream of near zero X-ray ablation has already been realised and manufacturers continue to strive for the zero-radiation goal.

Ruben Olivier believes the leap is approaching: "In real world terms in the next 2-3 years, we'll see a significant reduction through Philips FORS which is now FDA and CE approved. Add to that KODEX-EPD where we have non-contact mapping of cardiac structure, intravascular and intra-coronary ultrasound. A complete inside out visualisation. All these imaging methods are not fully integrated yet into a single system but are available. We have Augmented Reality (AR) and Virtual Reality (VR) systems within patient care already existing and are piloting customer meetings, education sessions, virtual visits and the integration of these technologies into our image guided therapy systems. All these technology aspects are being brought together at the right time in the right place with automation and Artifical Intelligence (AI). AI helps to reduce clinical time which helps to reduce appointment waiting times. AI can also be performed on multiple systems since the intelligence is in the data processing rather than the modality. This confluence of innovation and technology is bringing us close to near zero radiation with zero compromise."[2, 3]

By arriving at the point where we are today to have the discussion surrounding zero radiation, is a testimony to the years and months of dedicated research and investment into patient outcomes, and the protection of the medical professionals delivering the care.

Longer-term wins: Delivering on the vision and the promise that healthcare will make lives better, aligning with the innovative partners to incorporate a single unified view of the heart through harnessing the best of what Philips can offer with other market leaders.

2 Di-electric imaging reduces the need for flouro screening during AF ablations and CRT implants in patients with CHF. No compromise in the quality of the procedure, no compromise in the device implanted. Less harmful exposure to the patient and staff. Azurion reduces radiation by 17%, and FORS is a fibre optic real shape device visualisation.

3 Impact of latest generation cardiac interventional X-ray equipment on patient image quality and radiation dose for trans-catheter aortic valve implantations, Amber J Gislason-Lee, Claire Keeble, Christoper J Malkin, Daniel Egleston, Josephine Bexon, Stephen M Kengyelics, Daniel Blackman and Andrew G Davies, British Journal of Radiology, Vol. 89, No. 1067; Published Online:29 Sep 2016https://doi.org/10.1259/bjr.20160269: https://www.birpublications.org/doi/10.1259/bjr.20160269

The cardiac digital twin

Digital twins are virtual models of systems that are updated dynamically by being connected to their physical counterparts using an ongoing and diverse set of sensors and medical and lifestyle data points. A digital twin represents a significant opportunity for diagnosis and then treatment, without the need for radiation or exposure to any other secondary imaging modality.

Back in 2015, Philips launched Philips HeartModel – a clinical application that allows cardiologists to assess several cardiac functions that are relevant to diagnosis and treatment of patients with cardiovascular disease. It automatically generates 3D views of the left heart chambers of a patient, based on a set of 2D ultrasound images. HeartModel also calculates how well the heart is pumping blood, which is an important indicator of possible heart failure.

HeartModel is just one such futuristic innovation already in market. Another, Philips HeartNavigator, combines CT images captured before the procedure into a single image of a patient's heart anatomy with an overlay of live X-ray information during surgery. Beforehand, the tool simplifies procedure planning, helping the surgeon to select the right device. During surgery, it provides real-time 3D insight to position the device. The virtual becomes a guide for the physical, enhancing the skills of the surgeon and reducing the need for continuous radiation exposure.

In the future, tools like HeartModel and HeartNavigator could be paired with virtual reality (VR) technology to enable lifelike simulations that help clinicians to practice and methodically plan complex procedures.

Researchers are also developing patient-specific heart visualisations in VR, exploring their potential as a diagnostic instrument.[4,5] With advances in 3D printing, patient-specific models could even be used to create customised prostheses and implants.

Equally promising is the use of Augmented Reality (AR) in the operating room, with a patient-specific 3D model overlaid on the patient's body. AR enables a surgeon to 'see through' the skin and understand the underlying anatomy before making an incision. It can also serve as a navigational aid during procedures, potentially improving their accuracy and supporting precision. AR applications have shown encouraging first results in, for example, lower limb and spinal surgery, paving the way for similar applications in heart surgery.[6]

The abstract, The 'Digital Twin' to enable the vision of precision cardiology, published in the European Heart Journal[7] posits that, while there are still significant barriers, the digital twin, i.e., the dynamic integration and augmentation of patient data using mechanistic and statistical models, ultimately represents the route towards realising the vision of precision medicine: "Precision cardiology will be delivered, not only by data, but also by the inductive and deductive reasoning built in the digital twin of each patient. Treatment and prevention of cardiovascular disease will be based on accurate predictions of both the underlying causes of disease and the pathways to sustain or restore health. These predictions will be provided and validated by the synergistic interplay between mechanistic and statistical models. The early steps towards this vision have been taken, and the next ones depend on the coordinated drive from scientific, clinical, industrial, and regulatory stakeholders in order to build the evidence and tackle the organisational and societal challenges ahead."[8]

Longer-term wins: A digital twin of ourselves based on multiple data source integrations, available for diagnosis and then treatment without the need for radiation or the exposure to any other secondary imaging modality might only be 2-3 years from now.

4 How a virtual heart could save your real one, Nov 12, 2018, Philips, https://www.philips.com/a-w/about/news/archive/blogs/innovation-matters/20181112-how-a-virtual-heart-could-save-your-real-one.html
5 Virtual reality visualization of patient specific heart model, Matthew Bramlet, Kuocheng Wang, Alexander Clemons, Nathaniel Christopher Speidel, Steven M Lavalle & Thenkurussi Kesavadas, Journal of Cardiovascular Magnetic Resonance, volume 18, Article number: T13 (2016) https://jcmr-online.biomedcentral.com/articles/10.1186/1532-429X-18-S1-T13
6 How a virtual heart could save your real one, Nov 12, 2018, Philips, https://www.philips.com/a-w/about/news/archive/blogs/innovation-matters/20181112-how-a-virtual-heart-could-save-your-real-one.html
7 The 'Digital Twin' to enable the vision of precision cardiology, Jorge Corral-Acero, Francesca Margara, Maciej Marciniak, Cristobal Rodero, Filip Loncaric, Yingjing Feng, Andrew Gilbert, Joao F Fernandes, Hassaan A Bukhari, Ali Wajdan Manuel Villegas Martinez, Mariana Sousa Santos, Mehrdad Shamohammdi, Hongxing Luo, Philip Westphal, Paul Leeson, Paolo DiAchille, Viatcheslav Gurev, Manuel Mayr, Liesbet Geris, Pras Pathmanathan, Tina Morrison, Richard Cornelussen, Frits Prinzen, Tammo Delhaas, Ada Doltra, Marta Sitges, Edward J Vigmond, Ernesto Zacur, Vicente Grau, Blanca Rodriguez, Espen W Remme, Steven Niederer, Peter Mortier, Kristin McLeod, Mark Potse, Esther Pueyo, Alfonso Bueno-Orovio, Pablo Lamata European Heart Journal, Volume 41, Issue 48, 21 December 2020, Pages 4556 4564, https://doi.org/10.1093/eurheartj/ehaa159
8 The 'Digital Twin' to enable the vision of precision cardiology, Jorge Corral-Acero, Francesca Margara, Maciej Marciniak, Cristobal Rodero, Filip Loncaric, Yingjing Feng, Andrew Gilbert, Joao F Fernandes, Hassaan A Bukhari, Ali Wajdan Manuel Villegas Martinez, Mariana Sousa Santos, Mehrdad Shamohammdi, Hongxing Luo, Philip Westphal, Paul Leeson, Paolo DiAchille, Viatcheslav Gurev, Manuel Mayr, Liesbet Geris, Pras Pathmanathan, Tina Morrison, Richard Cornelussen, Frits Prinzen, Tammo Delhaas, Ada Doltra, Marta Sitges, Edward J Vigmond, Ernesto Zacur, Vicente Grau, Blanca Rodriguez, Espen W Remme, Steven Niederer, Peter Mortier, Kristin McLeod, Mark Potse, Esther Pueyo, Alfonso Bueno-Orovio, Pablo Lamata European Heart Journal, Volume 41, Issue 48, 21 December 2020, Pages 4556 4564, https://doi.org/10.1093/eurheartj/ehaa159

The cardiology team of the future

Despite the rapid slew of innovations, most systems are designed not to differ from existing procedures. Instead, the value of these innovations is that they can capture the data in such a format that it becomes easily accessible.

And while the cardiac team of the future is unlikely to change (and will continue to comprise cardiologist, cardiac nurse, community nurse, GP with special interest, Cardiac physiologist, echocardiographer and cardiographer), Ruben Olivier projects that their roles will adapt:

"The clinical team will be much closer to the data and will need to be selective in terms of data, interpretation and the holistic view of the patient. The team will manage the patient long before the acute intervention and well after the discharge. The value would be in the patient retention. The teams are likely to have an information overload and it is Philips' responsibility as solution providers and data integrators to work with the clinical teams to present the data in an actionable patient and population centric format, which utilises AI to predict the exact data they require for the interventions.

"In the future, we'll see clinical teams capture early onset disease patterns via a plethora of data and present it into an expert algorithm to identify if the patient has high or low affinity towards cardiac related diseases, if they would benefit from an early-stage intervention or if we need to monitor progress until the interventional impact can provide maximum impact on quality of life. If anything, the role of the cardiologist will change to encompass data collection, interpretation and management and the team will be able to make an educated diagnosis based on an entire array of information at their fingertips. The patient data will be "alive" and dynamically change with the data feeds to provide patient specific predictive analytics. It's a dramatic change from putting a needle in an arm."

In addition to being data-driven, Ruben Olivier predicts that the cardiology teams of the future will also take a far more holistic approach to cardiology:

"The automation of diagnosis and treatment is ever closer, but the benefit is that clinical teams will get closer to their patient – which is exactly the reason why healthcare professionals pursue their chosen career in the first place. Teams will recognise the key markers such as the impacts of lifestyle and mental health to manage patients before they become symptomatic."

Longer-term wins: Decisions would be made on patient specific data and how that holistic dataset might impact social health, insurance, pensions and even healthcare contributions.

The role AI must play in cardiology

Cardiology is notionally one of the best fields in which to use AI, because it has sets of problems, such as, complex patients, the need for decision support, wearable technology which aims to aid cardiologists in making better decisions, improve workflow, productivity, cost-effectiveness and ultimately patient outcomes.

Investment in AI is also already increasing in the healthcare space. In 2020, then Health Secretary, Matt Hancock, announced a £250 million investment to launch a new National Artificial Intelligence Lab, which will use the power of AI to improve cancer screening, modern heart disease and dementia treatments, as well as ensuring more personalised care for patients.

Moving forward, AI-powered technologies could do a lot towards helping to relieve some of the pressures placed upon health systems by redefining how serious illnesses are clinically assessed and therefore treated. From imaging to risk assessment, AI may free up time for doctoring while improving patient care, but Ruben Olivier believes hurdles remain.

He explains: "AI has to earn its status as a service improvement tool and the algorithms associated should be linked to current and relevant research and that should drive the AI inputs. Machine learning and AI are impossible without data so we need a pool of pliable clean data. How do we create that whole population data and addressable parameters and metrics?"

The value of AI is likely to be most valued in prediction of disease and precision medicine. In cardiology, it can definitely help to identify patients with abnormal heart rates, abnormal blood circulation, increased respiratory rates and escalates patients up the "triage ladder" that have much higher risk factors. And yet, how can it evolve? Ruben Olivier has an idea:

"At the moment we use AI to help us triage complex patients that enables healthcare professionals to treat the highest risk patients first;[9,10] second in line is treating the patients with less acute and non-threatening conditions at a deferred stage – the process of priority is absolutely necessary and correct, but we shouldn't have to choose between these two cohorts of patients. The opportunity must then be for AI to break the cycle and help us perform early diagnosis and intervention, diverting patients to more appropriate settings, such as Community Diagnostic Centres (CDCs), for diagnosis so we can treat earlier before the issue turns into a chronic disease. The link between AI and out of hospital diagnosis and remote treatment centres is a significant opportunity."

9 AI triage system by Advanced slashes patient waiting times, May 2021, Healthcare Global https://healthcareglobal.com/technology-and-ai-3/ai-triage-system-advanced-slashes-patient-waiting-times?page=2

10 The healthcare technology revolution: AI-assisted doctors, Dec 2020, Med Tech News, https://www.med-technews.com/medtech-insights/ai-in-healthcare-insights/the-healthcare-technology-revolution-ai-assisted-doctors_1/

There is also a school of thought that cardiologists should think of AI more as "augmented" intelligence rather than artificial, given that humans are still an integral part of its application. The article, AI in Cardiology at TCTMD.com,[11] predicts that the technology will soon be viewed through a different lens.

Ann Marie Navar, MD, PhD, UT Southwestern Medical Center, Dallas, TX), commented to TCTMD.com in the AI in Cardiology article, on the subject that: "We don't talk about statistics as a field. We don't say, 'What are the challenges of statistics?' because there's like millions of applications of statistics and it depends on both where you're using it, which statistical technique you're using, and how good you are at that particular technique," she said. "We're going to look back on how we're talking about AI now and laugh a little bit at trying to capture basically an entirely huge set of different technologies with a single paintbrush, which is pretty impossible."[11]

It's a grounding perspective that reminds us that AI offers significant potential for cardiology when integrated with all the other emerging solutions. The key to realising the future of cardiology, however, is collaboration.

Ruben Olivier concludes: "Heart care is as dynamic as its patients' needs are complex. Cardiac patients and healthcare providers need to seamlessly connect, ensuring that all data is actionable and all care across the continuum is clinically smart. Realising a future of cardiology which transcends the horizons detailed here and enters into a new era of preventative and precision medicine, requires us to work together as strategic partners in the transformation of healthcare."

These are complex systems which require specific building blocks to provide the overall desired outcomes; reducing cardiac mortality and improving quality of life.

Philips has an extensive and unrivalled portfolio in cardiovascular solutions, connecting population health management and healthy living to precision diagnostics and targeted treatment inside and outside of the traditional hospital environments, building on the vision to make life better within a digitally safe and secure environment.

These are Ruben Olivier's longer-term innovation projections for the future of cardiology. For immediate and medium term innovation projections, read the additional articles in this Future of Cardiology Series. ›

11 AI in Cardiology: Where We Are Now and Where to Go Next, Yael L Maxwell, tctmd, March 30 2021, https://www.tctmd.com/news/ai-cardiology-where-we-are-now-and-where-go-next

Interested to learn more?

Lets talk. Even better, lets collaborate

We'd love to help you apply Operational Intelligence to help solve your key people, process and technology challenges. For more information, please visit https://www.philips.co.uk/cardiologysolutions

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