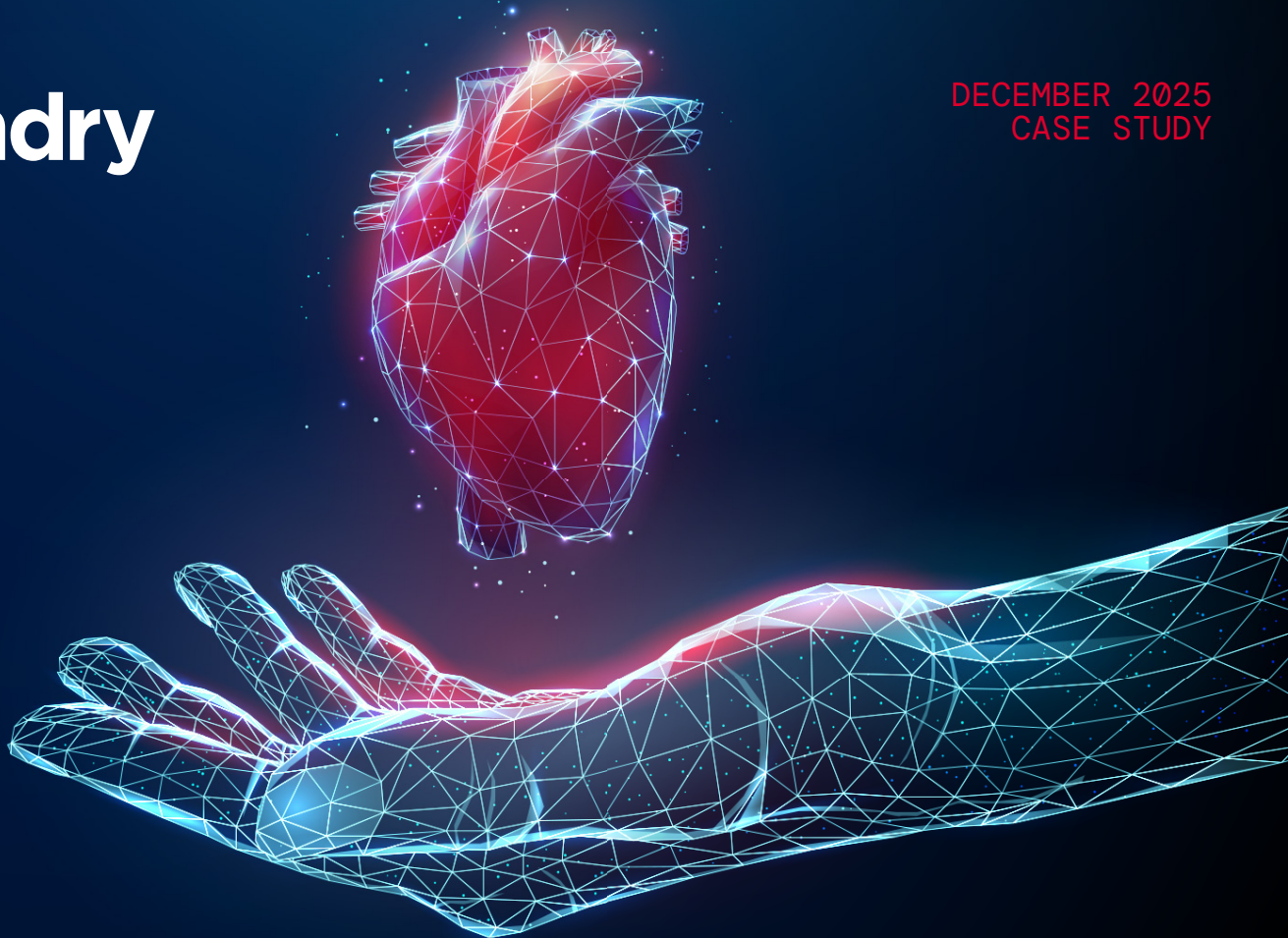




Cardiovascular Diseases: A New Early Warning System and Scarcity

Horus ML has developed a low-cost cardiovascular screening system, which uses AI to rapidly analyse retinal images in primary care settings

Executive Summary

Approximately 50% of heart attacks occur in individuals previously classified as low risk. Preventative healthcare is held back by a lack of effective cardiovascular screening in primary care centres, which don't have the necessary specialised equipment and trained personnel, according to Horus ML, a Madrid-based startup.

Horus has developed a new cardiovascular screening system, called Altheroscope, which combines advanced deep learning algorithms with RetinoLens, a low-cost optical device, to analyse retinal images and detect subclinical atherosclerosis - asymptomatic plaque buildup in the arteries. Designed to generate a diagnosis in less than 10 seconds, Altheroscope could be used by primary care clinicians and even individuals in their homes.

As well as lowering diagnostic costs, the system promises to prevent progression to severe cardiovascular events, and reduce hospitalisations. Horus believes Altheroscope

will also address gender bias in cardiovascular diagnosis through automated, unbiased screening. To accelerate development, the start-up has secured more than over €750,000 in public funding.

Now performing clinical validation of the new system with Madrid's Hospital Infanta Leonor, Horus is aiming to have Altheroscope in use by 20 primary care centres and three hospitals in Spain by the end of 2025. Following a successful Spanish deployment, it is planning to sell the system internationally, targeting countries with similar healthcare systems.

Horus estimates that Altheroscope can address a global market of one billion people who currently have no access to effective cardiovascular screening, as they live in underserved rural and resource-limited areas where specialised cardiovascular care is unavailable.

Cardiovascular diseases are the leading cause of mortality worldwide, according to the World Health Organisation.¹ Studies show that approximately 50%² of heart attacks occur in individuals previously classified as low risk.

About 60% of people aged 40-55 have subclinical atherosclerosis (asymptomatic plaque buildup in the arteries³), according to a research lead by Borja Ibanez, Scientific Director at CNIC (Spanish National Center for Cardiological Research)⁴. But 58% of these patients are classified as low risk by traditional risk calculators and therefore remain undiagnosed. This critical gap in preventive healthcare is due to a lack of specialised equipment and trained personnel to perform early cardiovascular screening in primary care centres, according to Horus ML.

Founded in Madrid in October 2022, Horus ML is developing an AI-based cardiovascular screening system, called Altheroscope, which analyses retinal images to detect subclinical atherosclerosis. The solution combines advanced deep learning algorithms with RetinoLens, a low-cost optical device designed for intuitive use in primary care environments.

The system processes retinal images through convolutional neural networks and transformer models, providing cardiovascular risk assessments in under 10 seconds

Jesús Prada Alonso - Founder and CEO of Horus

The system processes retinal images through convolutional neural networks and transformer models, providing cardiovascular risk assessments in under 10 seconds, explains Jesús Prada Alonso, founder and CEO of Horus. This rapid processing speed is designed to enable integration into routine primary care workflows without disrupting clinical operations. "This approach democratises access to advanced cardiovascular screening by eliminating the need for expensive ultrasound equipment or specialised medical personnel," Jesús Prada Alonso adds. "The technology integrates seamlessly with existing healthcare information systems through APIs, making implementation straightforward for facilities of varying sizes."

One billion people could benefit

Moving screening from hospitals to primary care, where the vast majority of people receive their regular medical attention, would enable the early detection in asymptomatic patients classified as low risk – that could be a game changer for cardiovascular disease prevention. Horus ML estimates that Altheroscope can address a global market of one billion people who currently have no access to effective cardiovascular screening.

"The technology reduces diagnostic costs, prevents progression to severe cardiovascular events, and decreases hospitalisations," explains Jesús Prada Alonso. "Beyond efficiency gains, the system addresses gender bias in cardiovascular diagnosis through automated, unbiased screening."

¹ World Health Organization. (2021). Cardiovascular diseases. [https://www.who.int/es/news-room/fact-sheets/detail/cardiovascular-diseases-\(cvds\)](https://www.who.int/es/news-room/fact-sheets/detail/cardiovascular-diseases-(cvds))

² Canto JG, Kiefe CI, Rogers WJ, et al. NRM Investigators. Number of coronary heart disease risk factors and mortality in patients with first myocardial infarction. JAMA. 2011;306(19):2120-7.

³ Plaque buildup in the arteries can lead to serious cardiovascular events like heart attack or stroke if left unaddressed

⁴ Ibanez B, Fernández-Ortiz A, Fernández-Friera L, García-Lunar I, Andres V, Fuster V. Progression of early subclinical atherosclerosis (PESA) study: JACC focus seminar 7/8. Journal of the American College of Cardiology. 2021 Jul 13;78(2):156-79.



This democratisation of access to advanced diagnostic technology is particularly significant for underserved rural and resource-limited areas where specialised cardiovascular care is unavailable.”

Altheroscope draws on Horus ML’s expertise in medical image analysis – the startup has already deployed similar deep learning systems at Hospital Universitario Miguel Servet and other hospitals, while Horus’ leadership team has more than 10 years of combined team experience in AI applications for healthcare. To bridge the gap between technology development and clinical implementation, the start-up has supplemented this AI expertise with clinical knowledge (cardiologists and physicians), and healthcare project management experience.

Clinical validation underway

For the Altheroscope project, Horus’ primary validation partners are Fundación para la Investigación e Innovación Biomédica at Hospital Universitario Infanta Leonor and Hospital Universitario del Sureste, which are both in Madrid. Having completed the development of APIs to integrate the solution into healthcare systems and established offline data exchange processes, Horus is now performing clinical validation of Altheroscope using actual patient data with Hospital Infanta Leonor through prospective testing in primary care circuits. Juan Torres Macho, head of the internal medical service, Hospital Universitario Infanta Leonor, praises the Horus team for an “excellent level of professionalism that understands and quickly adapts to the needs of clinicians.”

In the tests, Horus is targeting an AUROC (area under the receiver operating characteristic curve) for Altheroscope of greater than 0.85 (a value above 0.80 is generally considered clinically useful), with a negative predictive value exceeding 90%. That would indicate, in the case of negative result from the Altheroscope, there is a greater than 90% probability that the patient does not have subclinical atherosclerosis. Achieving these targets would confirm that the Altheroscope can reliably

detect subclinical atherosclerosis. As it engages with primary care centres and the Spanish public health system, Horus is pursuing CE medical device compliance for Altheroscope.

Solid financial foundations

To accelerate development, the start-up has secured more than over €750,000 in public funding through various programmes, including H2020 SHAPES and CDTI AI4TeenDep, as well as applying for grants for additional support. Horus intends to raise further funding through Madrid Community health innovation grants and European programmes to support expanded deployment and further technological evolution.

In addition to Altheroscope, Horus’ existing portfolio includes Horus Echonet for cardiac function evaluation, and Mental Health Triage for psychiatric assessment, both of which have been deployed in clinical environments – the company says it serves 18 healthcare facilities across multiple countries and has partnerships with healthcare institutions in Spain, Portugal, UK, Italy and Colombia.

“The team has established partnerships with major healthcare institutions including Hospital Clínico San Carlos and Hospital Doce de Octubre, creating a strong foundation for Altheroscope’s deployment,” notes Jesús Prada Alonso. “Patent applications are in process for the technology, protecting intellectual property while maintaining full ownership of developed solutions.”

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In 2024, Horus generated €450,000 in revenue, representing a 350% increase from the previous year. Horus says it has maintained a positive cash flow since its first year of operation, with projected reserves exceeding €200,000 by end of 2024.

International expansion planned

By the end of 2025, Horus is aiming to have Altheroscope in use by 20 primary care centres and three hospitals. Assuming a successful Spanish deployment, it is then planning to sell the system internationally, targeting countries with similar healthcare systems to that in Spain.

“Unlike typical tech companies that develop standalone products, we follow a collaborative approach, creating personalised solutions integrated directly into each healthcare institution’s existing systems,” says Jesús Prada Alonso. “Our focus is exclusively on clinical-assistive applications rather than healthcare management, addressing problems that directly impact patient outcomes.”

Horus is also exploring technology partnerships with retinography device manufacturers based on revenue-sharing models. In the medium-term, Horus is planning to develop a mobile application that will enable patient self-assessment using RetinoLens at home, which would dramatically expand population reach.

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Jesús Prada Alonso - Founder and CEO of Horus

By the end of the decade, Horus is aiming to deploy Altheroscope in 1,500 primary care centres, 50 hospitals, and have trained over 5,000 healthcare professionals. It is also targeting €2.5 million in revenue by 2026, with expansion to €5.2 million by 2030 through organic growth.

Harnessing AI across healthcare

“We’re not a non-profit, but we have strong vocational commitment to improving healthcare, allowing us to pursue projects with high social impact even when they’re not the most immediately profitable,” explains Jesús Prada Alonso. “Our generalist approach across multiple AI healthcare applications (image analysis, precision medicine, remote monitoring) rather than single-product focus provides diversification and allows us to continuously innovate in new clinical problem areas.”

In time, Horus ML believes Altheroscope will help increase healthcare equity by reducing disparities between urban centres with specialised care and rural or resource-limited areas. The start-up has chosen a business model that is designed to support rapid expansion across healthcare systems without requiring massive infrastructure investments.

More broadly, the new system demonstrates the broader potential of AI in democratising advanced medical diagnostics, potentially serving as a model for other disease screening applications. “By proving that sophisticated diagnostic capabilities can be deployed in primary care through AI and low-cost devices, Altheroscope challenges the traditional hospital-centric model of specialised diagnostics,” concludes Jesús Prada Alonso. “This could accelerate the shift toward preventive medicine and early intervention across multiple disease categories.”

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Horus ML

Horus ML provides a comprehensive platform that enables access to various artificial intelligence-based solutions for the healthcare sector, focusing on the clinical care area.

We have developed specialized tools that enhance clinical decision-making with intelligent assistance in three key areas: diagnostic imaging, precision medicine, and remote monitoring.

For more information, visit: www.horusml.com/en

Altheroscope

Advanced solution based on artificial intelligence for the early detection of atherosclerosis in primary care by means of retinography analysis.

For more information, visit: www.aitheroscope.com/en

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