Expert Perspective: Can Europe Shift from Treating Disease to Preventing It?

Leading scientist calls for a radical shift from reactive medicine to photonics-driven prevention to save Europe's buckling healthcare systems.

BRUSSELS, BELGIUM

Professor Jürgen Popp, one of Europe's leading scientific voices, issued a stark warning that Europe's century-old healthcare model is no longer sustainable and that the continent must urgently shift from treating illness to preventing it where possible and detecting it much earlier.

Professor Popp argues that Europe must transition towards predictive, preventive, personalised and participatory healthcare (P4 medicine) – a proactive healthcare model aimed at maintaining health, identifying disease-associated changes at an early stage and preventing disease progression whenever possible.

Rather than waiting for symptoms to appear before intervening, this vision calls for a fundamental cultural and structural shift: moving away from generic population averages towards a deep, continuous understanding of individual health through light-based diagnostic technologies.

"The healthcare system is largely reactive," says Prof. Popp. "We wait until people become sick. The challenge we face today is recognising biological changes much earlier, long before a patient experiences any symptoms. Photonics combined with AI-driven data analysis gives us the tools to detect and interpret these biological changes long before clinical symptoms appear."

For Professor Popp, photonics is one of the key enabling technologies for preventive medicine, offering Europe an opportunity to improve health outcomes and ease the long-term pressures posed by an ageing population and rising healthcare costs.

This urgent transformation is central to the **Photonics Partnership's Health Grand Challenge**, a long-term strategic vision for reshaping European healthcare.

A New Definition of Health

In Popp's view, the core of this transition is a shift away from generic medical averages. Because every human body responds differently to disease and treatment, the future of medicine lies in establishing an individual's personal health baseline.

"By tracking a person's unique health baseline over time, healthcare providers can identify subtle, micro-level changes in the body. This approach does not mean telling citizens how to live their lives; instead, it empowers individuals with precise, early

information about their own bodies, enabling them to take preventive action before a minor shift becomes a serious chronic medical condition," said Popp.

A Single Drop of Blood

For Popp, this transformation will be driven by a convergence of next-generation technologies. Popp points to emerging research showing that photonic technologies can extract rich molecular information from easily accessible biological samples such as blood, saliva and other body fluids. Combined with AI-supported analysis, these measurements could provide continuous insight into an individual's health status long before disease becomes clinically apparent. "By analysing white blood cells with advanced optical techniques, emerging photonic technologies show considerable promise for rapidly characterising immune cell responses and supporting earlier detection of infections."

In the future, photonic sensing technologies, molecular diagnostics, wearable sensors, and AI-supported computational models could become part of a continuously learning health-monitoring ecosystem capable of detecting the earliest biological changes associated with infection, chronic diseases, or even cancers. Rather than relying on occasional visits to the doctor, healthcare could become an ongoing process of monitoring, enabling patients and clinicians to intervene long before symptoms appear.

"The ultimate objective is to weave these technologies into everyday life, creating a continuous loop of health awareness rather than a sporadic system of emergency doctor visits," Popp said.

Digital Twins: The Future of Lifelong Healthcare?

At its most ambitious, the Health Grand Challenge aims to create Personalised Optical "Digital Twins" – highly accurate, individualised virtual representations of an individual's biology.

Drawing on continuously acquired optical, molecular, clinical and lifestyle data, integrated through artificial intelligence, a Personalised Optical Digital Twin becomes a dynamic computational representation of an individual's health.

This technology shifts healthcare from a series of disconnected emergency appointments to a continuous, lifelong partnership. As we progress from infancy to old age, our digital twin would evolve alongside us, flagging microscopic health risks years before they manifest and helping clinicians make more informed, data-driven decisions tailored to each person.

In Europe, implementing this shift is both a healthcare necessity and an unprecedented economic opportunity. By pioneering the regulatory frameworks, software systems, and hardware components required for digital twin medicine, the

continent could help ease the growing financial burden on public health budgets. Rather than spending billions on managing advanced chronic illnesses, healthcare systems could progressively redirect more resources. Ultimately, this could improve the quality of life for millions of citizens and position Europe's technology base at the forefront of global medical innovation. Europe already possesses world-leading capabilities in photonics, artificial intelligence, medical technologies and clinical research. The challenge now is to integrate these strengths into a coherent innovation ecosystem capable of transforming healthcare.

"The scientific foundations are in place," says Prof. Popp. "The challenge now is how quickly Europe can integrate, validate and scale them to change fundamentally how we maintain health and manage disease. Ultimately, the vision is no longer simply to diagnose disease earlier. The vision is to maintain health for as long as possible through predictive, preventive, personalised and participatory healthcare, supported by continuously updated Personalised Optical Digital Twins."

The Health Grand Challenge is not a single technology programme. It is a long-term European initiative that brings together photonics, artificial intelligence, medicine, industry, healthcare providers, regulators and citizens to fundamentally reshape healthcare.