What if nanomedicine made the leap from potential to reality?

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Nanomedicine Over the Edge

Within Reach | **Transitional** | Visionary

Advanced machine intelligence, open data, and genomic research unlock nanomedicine's potential by solving critical toxicity challenges, enabling advances in precision medicine.

UNCERTAINTIES

Technology, Values

MEGATREND (Most significant)

Materials Revolution

TRENDS

Bioinformatics
Biotechnology
Longevity & Vitality
Open Data
Precision/Personalised Medicine

TECHNOLOGIES

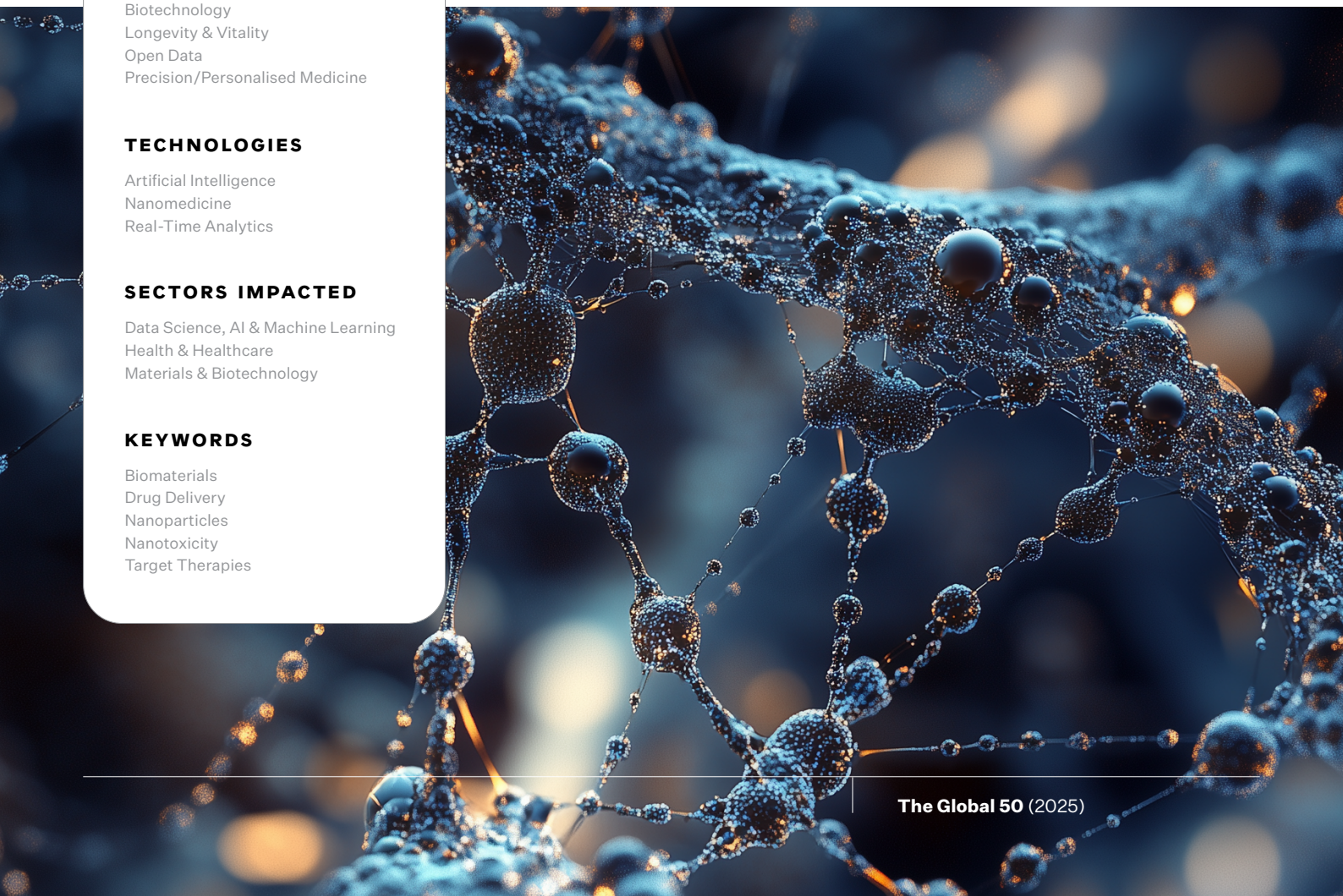
Artificial Intelligence
Nanomedicine
Real-Time Analytics

SECTORS IMPACTED

Data Science, AI & Machine Learning
Health & Healthcare
Materials & Biotechnology

KEYWORDS

Biomaterials
Drug Delivery
Nanoparticles
Nanotoxicity
Target Therapies



WHY IT MATTERS TODAY

In 2023, nearly half

47%

of healthcare providers around the world **report worsening access to healthcare**

The limitations of a one-size-fits-all approach to healthcare underscore the growing need for personalised medicine.[588] Unlike standardised treatments applied broadly, personalised medicine seeks to tailor therapies. This innovative strategy focuses on the unique genetic, environmental and lifestyle factors of each patient, enabling healthcare providers to deliver targeted therapies that are more effective and have fewer side effects. Using advanced diagnostic tools and molecular profiling, personalised medicine allows earlier disease detection and intervention, ultimately leading to improved health outcomes.[589]

At a time when healthcare facilities are under strain around the world,[590] nanotechnology can help to build a more resilient healthcare model.[591] In 2023, nearly half (47%) of healthcare providers around the world reported worsening access to healthcare. The industry is facing increased hospital costs and rising labour costs (driven in part by staffing shortages), and people have lower disposable incomes, making it harder for them to cover unexpected medical costs.[592]

Rapid advancements in biotechnology and bioinformatics are paving the way for the further development of nanomedicine. At a scale of one-billionth of a metre, nanobiotechnology can improve disease detection (e.g. ovarian cancer), and diabetes management through biosensors, targeted drug delivery, enhanced imaging quality, and wound healing.[593] While successful applications exist in bone regeneration,[594] breast cancer treatment,[595] genetic disorders,[596] and glaucoma treatment,[597] challenges remain with long-term toxicity and stability of nanomaterials.[598]

THE OPPORTUNITY

BENEFITS

Early disease detection; enhanced preventative care; targeted drug delivery; autonomous medicine; reduced burden on healthcare; advances in understanding environmental toxicity.

RISKS

Misdiagnosis and treatment; unknown side effects caused by biomaterials; unknown long-term effects or toxicity; regulatory challenges; potential job displacement in healthcare.

A comprehensive approach combining advanced machine intelligence, open data,[599] and genomics helps overcome the challenge of nanotoxicity in nanomedicine. This approach provides a deeper understanding of how nanoparticles may affect our bodies and our genes,[600] including their potential role in epigenetics – the way our genes respond to external factors – and can help turn clinical successes into reality.[601]

Nanomedicine holds great potential to dramatically improve the accuracy, efficiency and sensitivity of diagnostic testing and treatment, but nanotoxicity remains a critical barrier to widespread adoption.[602] From nanotubes, nanorods and nanofibres, to nanowires, nanoplates and nanoparticles, nanomaterials can enter the body through breathing, ingestion, injection or skin contact, with each method carrying its own risks.[603] While breathing carries the greatest risk, nanotoxicit
health risks related to long-

Advanced machine intelligence, open data, and genomics can help overcome **nanotoxicity challenges, turning clinical successes in nanomedicine into reality**