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July - Aug 2025

Paediatrics

- Origami-inspired heart valve grows with children
- Breath analysis breakthrough for monitoring propofol in general anaesthesia

Genetics

- UK scientists launch ambitious world-first project to build synthetic human genome
- Scientists rewrite the rules of gene therapy by manipulating chromosome spacing

In the News

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- Abu Dhabi forges strategic pharmaceutical partnerships to advance life sciences capability
- Nanocomposite hydrogel shows promise for cartilage regeneration in osteoarthritis
- Gene therapy restores hearing in deaf patients across age groups
- World Health Assembly adopts historic pandemic agreement
- WHO scientific panel concludes natural spillover most likely origin of COVID-19

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Prognosis

Medical breakthroughs drive progress

In this issue of *Middle East Health* we look at developments in paediatrics, innovations in genetics and select healthcare news.

The World Health Assembly's recent adoption of the WHO Pandemic Agreement marks a pivotal achievement in global health governance. This legally binding instrument establishes comprehensive measures for pandemic prevention and health system resilience, whilst securing transformative financing reforms through increased assessed contributions. The agreement's implementation timeline requires ratification by 60 countries before entering into force as international law by May 2026, representing unprecedented solidarity among Member States.

In paediatric anaesthesia, researchers at the University of Basel have developed a breakthrough breath analysis technique for real-time propofol monitoring. Using secondary electrospray ionisation high-resolution mass spectrometry, the study achieved robust correlations between exhaled compounds and serum propofol concentrations in children undergoing dental surgery. This non-invasive approach simultaneously monitors drug levels and metabolic stress responses, offering enhanced safety protocols for vulnerable paediatric populations.

Cardiac care for young children has advanced substantially through the development of the IRIS Valve at UC Irvine. This origami-inspired transcatheter pulmonary valve can expand from 12mm to 20mm diameter as children grow, addressing a critical treatment gap for patients weighing less than 20kg. Six-month animal studies demonstrated excellent tissue integration and valve competency. The valve could potentially eliminate multiple surgical interventions throughout childhood.

Gene therapy has entered a new paradigm with the "delete-to-recruit" methodology published in Blood. This technique exploits chromosome architecture to reactivate beneficial dormant genes by physically repositioning enhancers closer to target genes. In sickle cell disease models, the approach achieved 80-90% foetal haemoglobin production whilst demonstrating superior specificity compared to conventional gene editing approaches.

The UK's Synthetic Human Genome Project represents an ambitious leap from genome editing to complete genome synthesis. Wellcome's £10 million investment over five years aims to construct a complete synthetic human chromosome, establishing foundational infrastructure for large-scale genome synthesis. This initiative integrates cutting-edge generative AI with comprehensive ethical frameworks to address societal implications.

These developments collectively illustrate the increasing sophistication of biomedical research, from global health policy frameworks to precision molecular interventions. Each advancement addresses specific unmet medical needs whilst establishing new paradigms for therapeutic development and implementation.

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NEWS

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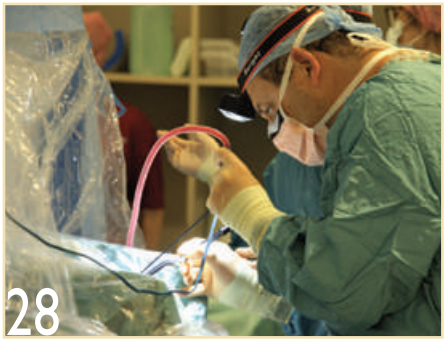
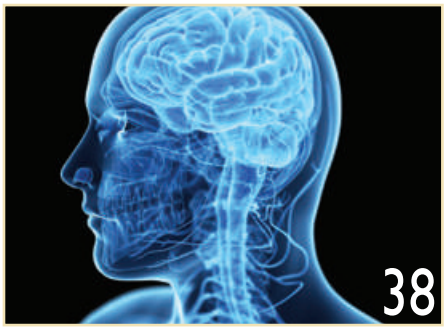
University of Basel, Department of Biomedical Engineering





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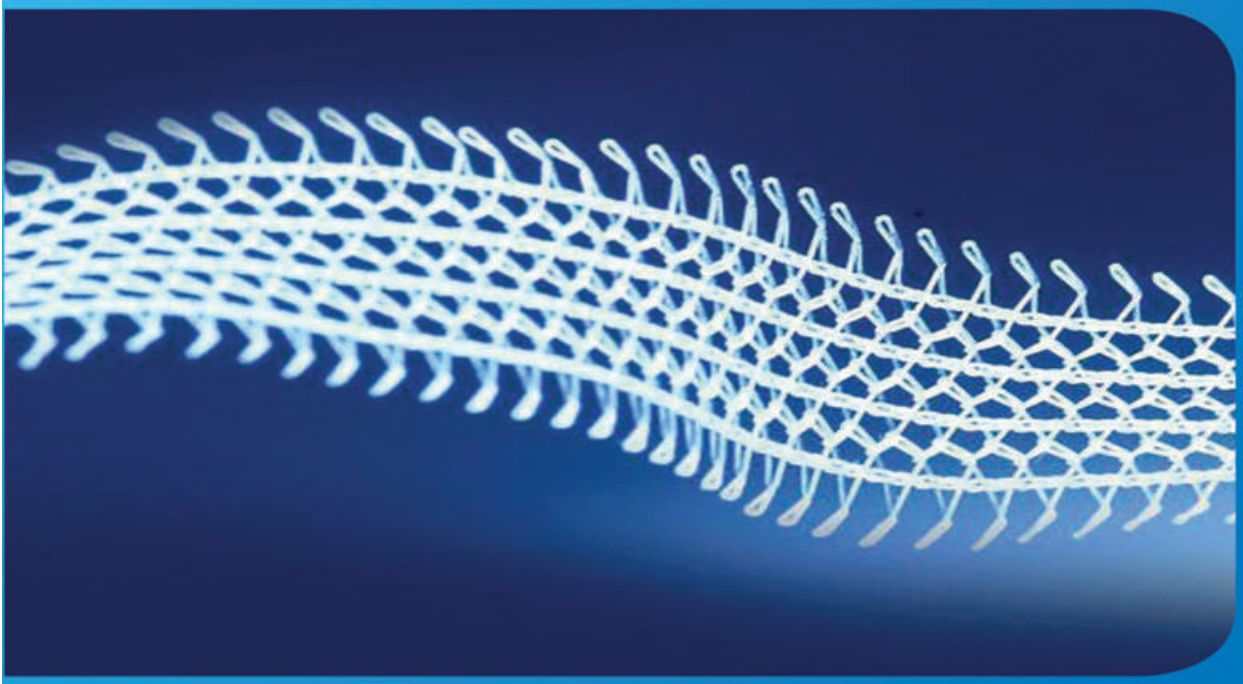

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Update from around the region

Abu Dhabi forges strategic pharmaceutical partnerships to advance regional life sciences capability

The Department of Health – Abu Dhabi has secured three major pharmaceutical partnerships during a week-long strategic mission to the United States, establishing the emirate's position as a regional hub for biopharmaceutical innovation and manufacturing. The agreements with Boehringer Ingelheim, Sanofi, and Abbott were signed at the BIO International Convention in Boston between 17-20 June 2025.

Research platform access unlocks drug discovery potential

The partnership with Boehringer Ingelheim centres on providing Abu Dhabi researchers with access to the company's OpnME platform, a comprehensive drug discovery resource. The platform offers four distinct programmes: Molecule to Order (M2O), Molecule for Collaboration (M4C), opn2EXPERTS (o2e), and opnTALENTS (o25). These initiatives provide access to advanced pharmaceutical compounds, collaborative research opportunities, expert networks, and support for emerging scientific talent.

Dr Asma Ibrahim Al Mannaei, Executive Director of the Health Life Sciences Sector at DoH, emphasised the strategic importance of the collaboration: "We're empowering Abu Dhabi researchers with the opnMe platform, an open portal offering top-tier pharmaceutical compounds, fostering collaboration and safeguarding researchers' rights to their findings. This is about transforming our emirate into a global life sciences hub, speeding up breakthroughs, and building a healthier, resilient future for all."

The agreement enables local researchers to leverage cutting-edge data and resources to address critical biological challenges while maintaining intellectual property rights to their discoveries. This approach represents a significant investment in regional research capacity building and scientific infrastructure development.

Vaccine development acceleration through public-private collaboration

The Memorandum of Understanding with Sanofi focuses specifically on accelerating global vaccine development timelines through the integration of Abu Dhabi's health-technology ecosystem with Sanofi's research capabilities. The collaboration aims to streamline the pathway from early research through to public availability by implementing advanced technologies, real-time data analysis, and parallel clinical trial phases.

Dr Al Mannaei outlined the partnership's objectives: "DoH is partnering with Sanofi to expedite the development of new global vaccines. This initiative aims to shorten the timeline from early research to public availability by utilising advanced technologies, real-time data analysis, and conducting parallel clinical trial phases."

Baptiste de Clarens, General Manager Greater Gulf, Vaccines at Sanofi, described the agreement as "an encouraging step towards advancing global health security whilst reflecting our shared interest in addressing global health challenges through scientific partnership."

The collaboration encompasses regulatory process optimisation, manufacturing preparedness enhancement, and knowledge transfer between local and international experts. Both organisations will advance clinical research planning, optimise resource allocation, and establish funding frameworks designed to enhance healthcare resilience across the region.

Local pharmaceutical manufacturing strengthens supply chain resilience

The partnership with Abbott represents the most comprehensive manufacturing-focused agreement, establishing a framework for local pharmaceutical production in Abu Dhabi. The collaboration addresses four key areas: localisation of Abbott's pharmaceutical portfolio, biosimilar development, digital transformation through electronic patient information systems, and workforce development initiatives.

Dr Noura Al Ghaithi, Undersecretary of the Department of Health – Abu Dhabi, contextualised the partnership within broader regional healthcare strategy: "Following the recent launch of the Health, Endurance, Longevity and Medicine (HELM) Cluster in Abu Dhabi, the emirate proved to be equipped with a holistic, integrated infrastructure that fosters local manufacturing and R&D, positioning it as a regional healthcare gateway and leader in life sciences."

Mazen Bachir, Regional Director for Abbott's established pharmaceuticals business in the Gulf, Emerging Markets and Levant, highlighted the partnership's comprehensive scope: "This partnership will focus on localising existing pharmaceutical products, and jointly exploring the development of biosimilars, supported

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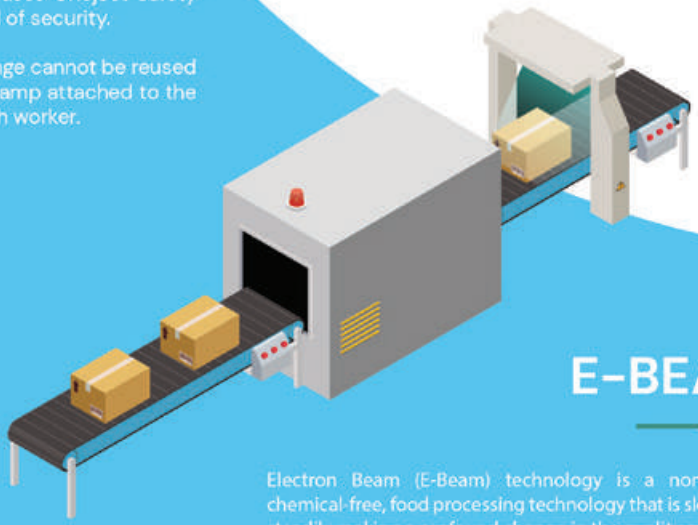

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by regulatory alignment. The collaboration also includes initiatives to digitise life science product information through electronic leaflets in alignment with the UAE's digital health strategy."

Strategic delegation advances healthcare innovation ecosystem

The agreements were secured during a high-level delegation mission to the United States from 14-21 June 2025, led by DoH. The delegation conducted over 20 strategic meetings with public and private sector leaders, focusing on knowledge exchange, investment opportunities, and advanced health solution adoption.

The delegation represented Abu Dhabi's comprehensive innovation ecosystem, including the Abu Dhabi Investment Office, Mubadala BIO, M42, Masdar City, KEZAD, PureHealth, Etihad Cargo, New York University Abu Dhabi, Khalifa University, startAD, and Mohamed bin Zayed University of Artificial Intelligence.

These partnerships collectively position Abu Dhabi to reduce import dependency, strengthen pharmaceutical supply chain resilience, and establish a sustainable healthcare ecosystem. The agreements demonstrate the emirate's strategic approach to healthcare innovation, combining international expertise with local infrastructure to advance regional biopharmaceutical capabilities whilst contributing to global health security objectives.

Global Fertility Network doubles capacity through Saudi Arabia acquisition

Global Fertility Network (GFN) has completed its second major acquisition in Saudi Arabia this year, purchasing a controlling stake in HealthPlus Fertility Center in Jeddah for integration into its expanding regional network. The transaction represents part of a broader 100 million Saudi Riyal (US$27 million) investment strategy aimed at establishing the largest fertility services network in the Kingdom and wider Gulf Cooperation Council region.

Strategic consolidation targets growing demand

The acquisition follows GFN's earlier purchase of Bnoon IVF Center in Riyadh, with both facilities now operating under the unified Bnoon brand. This consolidation has effectively doubled the network's treatment capacity to over 5,000 IVF cycles annually, positioning GFN as the largest standalone assisted reproductive technology provider in Saudi Arabia.

Both acquired centres were previously part of M42's healthcare portfolio between 2022 and 2024, indicating continued consolidation within the regional fertility sector. The expansion strategy extends beyond acquisitions, with a 3,800-square-metre flagship facility currently under construction in northern Riyadh, scheduled to open in December 2025.

"The expansion in Saudi Arabia is part of GFN's broader strategy to establish a regional platform of fertility and women's health centres," said Majd Abu Zant, founder and CEO of Global Fertility Network. "Under the Bnoon name, GFN brings together some of the leading Saudi IVF consultants with decades of clinical experience, supported by state-of-the-art IVF laboratories designed to deliver the highest standards in reproductive care."

Investment backing enables rapid expansion

The growth trajectory is supported by approximately $60 million in equity financing from institutional investors and family offices across Saudi Arabia and the UAE. Dubai Investments, listed on the Dubai Financial Market, has acquired a 34.3% equity stake in the network, providing substantial backing for continued expansion.

Additional facilities are planned for Khobar, Abha, and other Saudi cities as part of the network's regional development strategy. The approach reflects broader healthcare sector trends towards consolidation and standardisation of specialised medical services.

Clinical demand drives market expansion

Regional fertility specialists cite increasing demand for assisted reproductive technologies across the Gulf region. Dr Abdulaziz Muhammad AlShahrani, group medical director at Bnoon and founder of the original Riyadh facility, noted rising numbers of couples seeking treatment for both primary and secondary infertility.

"We're seeing a noticeable increase in couples seeking fertility treatment, driven by both primary and secondary infertility," AlShahrani said. "With growing awareness, more individuals are also considering fertility treatments to help balance their families and prevent genetic diseases."

Dr Fawaz Adeeb Edris, executive director at the Jeddah facility, highlighted demographic factors contributing to increased service demand. "Studies show that fertility rates across the GCC have steadily declined, while infertility affects around 15% of couples, or more, fuelling a sharp rise in demand for fertility services," he said.

Contributing factors include delayed parenthood, socioeconomic pressures, obesity, polycystic ovary syndrome, and male fertility issues, according to clinical observations from the network's practitioners.

Technology integration supports clinical outcomes

The consolidated network emphasises integration of advanced medical technologies, artificial intelligence, and data-driven approaches to enhance treatment protocols and accessibility. This technological focus aligns with Saudi Arabia's Vision 2030 healthcare innovation objectives, supporting the Kingdom's broader healthcare sector development goals.

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KFSHRC becomes first Middle Eastern centre to implant AI-powered brain-sensing device

King Faisal Specialist Hospital & Research Centre (KFSHRC) has achieved a significant milestone in neurological medicine by becoming the first institution in the Middle East to successfully implant an artificial intelligence-powered brain-sensing device for treating complex neurological disorders. The breakthrough represents a substantial advancement in real-time, adaptive neuromodulation therapy, particularly for patients with Parkinson's disease, epilepsy, and movement disorders.

Closed-loop system delivers personalised neural stimulation

The implanted device employs artificial intelligence to continuously monitor brain electrical activity, detecting abnormal neural signals and delivering precisely targeted electrical impulses to restore neurological balance. The technology operates through a closed-loop system that automatically adjusts stimulation parameters in real time based on individual patient brain activity patterns.

This adaptive approach enables highly responsive, personalised therapy that maintains consistent symptom control throughout the day. Unlike traditional deep brain stimulation systems that deliver constant stimulation, the AI-powered device responds dynamically to changing neural conditions, potentially improving therapeutic outcomes whilst minimising unnecessary stimulation.

Minimally invasive procedure shows promising early outcomes

The surgical implantation procedure is minimally invasive and typically completed within three to five hours. Early clinical results indicate the potential for patients to reduce their medication dependence by up to 50%, subsequently decreasing detrimental side effects and enhancing patient autonomy and quality of life.

Initial outcomes suggest rapid post-operative recovery with tangible improvements in symptom control observable within weeks of implantation. This timeline represents a significant improvement over conventional treatment approaches that may require extended periods for therapeutic optimisation.

Neuroscience centre leads regional innovation in brain health

The successful implementation reflects the clinical excellence and leadership of KFSHRC's Neuroscience Centre of Excellence, which provides comprehensive, multidisciplinary care for both adult and paediatric neurological cases. The centre has established itself as a regional leader in several advanced neurological interventions, including deep brain stimulation for movement disorders, stereotactic EEG for epilepsy management, and AI-based diagnostics for cognitive conditions and autism.

Through continuous innovation and a patient-centred approach, the centre is establishing new standards in regional neuroscience practice and setting benchmarks in precision brain health interventions.

Technical implications for neuromodulation therapy

The integration of artificial intelligence into brain-sensing devices represents a paradigm shift in neuromodulation therapy. Traditional systems require manual adjustment by clinicians based on patient reports and clinical observations. The AI-powered approach enables continuous, objective monitoring of neural activity patterns, allowing for immediate therapeutic adjustments without patient or clinician intervention.

This technology could significantly impact treatment protocols for various neurological conditions, particularly those characterised by fluctuating symptoms or variable neural activity patterns. The device's ability to deliver personalised stimulation based on real-time brain state analysis may improve therapeutic efficacy whilst reducing the burden of medication management.

Institutional recognition reinforces clinical excellence

KFSHRC's achievement comes as the institution maintains its position as a leading medical centre in the region. The hospital has been ranked first in the Middle East and Africa and 15th globally amongst the world's top 250 Academic Medical Centres for three consecutive years. It has also been recognised as the most valuable healthcare brand in the Kingdom and the Middle East, according to the 2025 Brand Finance rankings.

Additionally, KFSHRC was included in the World's Best Smart Hospitals list for 2025 by *Newsweek* magazine, reflecting its commitment to integrating advanced technology into clinical practice.

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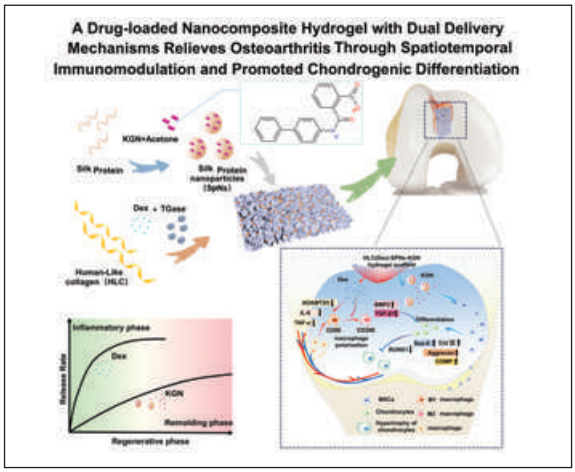

Innovative nanocomposite hydrogel shows promise for cartilage regeneration in osteoarthritis treatment

Chinese researchers have developed a breakthrough dual-drug delivery hydrogel system that addresses both inflammation and cartilage damage in osteoarthritis. The protein-based nanocomposite promotes cartilage repair through controlled release of anti-inflammatory and regenerative molecules, offering new hope for treating this debilitating joint condition.

Osteoarthritis (OA), a leading cause of joint disability worldwide, is characterised by persistent inflammation and impaired cartilage regeneration. Existing treatments have largely failed to effectively target both mechanisms simultaneously. Now, a research team from Northwest University, China, has developed a promising dual-drug-loaded hydrogel system that could revolutionise OA treatment.

The HLC(Dex)–SPNs–KGN hydrogel combines two natural proteins – human-like collagen (HLC) and silk protein nanoparticles (SPNs) – to deliver two key therapeutic molecules with precise temporal control. Published in *Engineering* on 30 May 2025, the study demonstrates how this system promotes cartilage repair through synergistic immune regulation and chondrocyte differentiation.

Dual mechanism targets inflammation and regeneration

The hydrogel's sophisticated design enables spatiotemporal control of drug release, mimicking natural cartilage healing stages. Dexamethasone (Dex), an anti-inflammatory glucocorticoid, is rapidly released early to combat inflammation and polarise pro-inflammatory M1 macrophages into anti-inflammatory M2 macrophages. Meanwhile, kartogenin (KGN) undergoes sustained release for weeks to promote cartilage regeneration by inducing human mesenchymal stem cells (hMSCs) to differentiate into chondrocytes.

The authors note that "combining immune regulation with controlled cartilage induction via a biocompatible hydrogel overcomes limitations of traditional OA treatments." This dual-drug delivery system not only alleviates inflammation but also actively promotes cartilage regeneration, offering a holistic solution for joint repair.

Impressive laboratory results

In laboratory studies, the hydrogel demonstrated remarkable efficacy. Inflammatory RAW264.7 macrophages treated with the hydrogel showed a 75% reduction in pro-inflammatory TNF-α and a 6-fold increase in anti-inflammatory IL-10 compared to controls. Human MSCs co-cultured with the hydrogel exhibited significantly higher expression of cartilage-specific proteins (COMP, Col II, aggrecan, and SOX-9) and genes, with RUNX1 – a key regulator of chondrocyte survival – showing the highest expression.

The hydrogel's porous structure (10–30 μm pore size) supports cell adhesion and nutrient supply, with an impressive gelation efficiency of 95%. Release profiles demonstrated an early burst of Dex (80% released within 40 days) and sustained release of KGN (40% released within 40 days), precisely matching the therapeutic timeline required for optimal cartilage repair.

Promising animal model results

In rabbit knee defect models, the hydrogel completely filled defects with new cartilage tissue, featuring a smooth surface and good integration with surrounding tissue (ICRS grade II). Control groups showed predominantly fibrous tissue (grade III). Micro-CT and histological analyses revealed significantly improved bone mineral density and bone volume/total volume ratio in the hydrogel group, along with reduced levels of inflammatory factors (TNF-α, IL-6, and ADAMTS5).

The authors explain that "the dual mechanism creates a microenvironment conducive to tissue repair" through controlled drug release. "The hydrogel provides controlled release of Dex and KGN using two release mechanisms, with corresponding modulating effects through the different stages of cartilage repair."

Clinical translation prospects

The use of natural proteins like collagen and silk ensures biodegradability and safety, while the nanocomposite structure allows precise modulation of drug release. The team plans to optimise hydrogel purification processes for clinical translation and study long-term safety in larger animal models. They are also exploring the system's applicability to other musculoskeletal injuries, such as tendon or bone defects.

This research highlights the potential of biomaterial-based therapies to revolutionise OA treatment, offering hope to millions affected by this disabling disease. The platform may be adapted for other degenerative diseases requiring spatiotemporal therapeutic control, representing a significant advancement in regenerative medicine approaches to joint repair. MEH

Reference:

Lei, H., & Fan, D. (2025). Dual Protein-Based Nanocomposite Hydrogel Scaffolds Synergistically Promote Cartilage Regeneration Through Chondrocyte Differentiation and Immunomodulation. *Engineering*. https://doi.org/10.1016/j.eng.2025.05.010

Gene therapy restores hearing in deaf patients across age groups

A groundbreaking clinical trial has demonstrated that gene therapy can successfully restore hearing in children and adults with congenital deafness. All ten participants, aged 1.5 to 24 years, showed hearing improvements following treatment, with optimal results observed in 5- to 8-year-olds.

Researchers from Karolinska Institutet and collaborating institutions in China have achieved a significant breakthrough in treating genetic hearing loss, with a new gene therapy showing promise across a broader age range than previously demonstrated. The study, published in *Nature Medicine* on 2 July 2025, represents the first multicentre clinical trial of gene therapy for deafness to include adult participants.

Revolutionary treatment targets genetic cause

The therapy addresses autosomal recessive deafness 9 (DFNB9), a condition caused by mutations in the OTOF gene. These mutations lead to a deficiency of otoferlin, a protein essential for transmitting auditory signals from the ear to the brain. The treatment involves using a synthetic adeno-associated virus (AAV) called Anc80L65 to deliver a functional version of the OTOF gene directly to the inner ear through a single injection via the round window membrane.

"This is a huge step forward in the genetic treatment of deafness, one that can be life-changing for children and adults," says Dr Maoli Duan, consultant and docent at the Department of Clinical Science, Intervention and Technology, Karolinska Institutet, and one of the study's corresponding authors.

Rapid and sustained improvements

The results were remarkably swift, with the majority of patients recovering some hearing within just one month of treatment. At the six-month follow-up, all participants demonstrated considerable hearing improvement, with average sound perception thresholds improving from 106 decibels to 52 decibels.

One particularly striking case involved a seven-year-old girl who rapidly recovered almost all her hearing and was able to hold daily conversations with her mother just four months after treatment. The study authors noted in their discussion that "the effect of gene therapy is rapid, taking 1 month to achieve 62% in PTA [pure-tone average] and 78% in TB-ABR [tone-burst auditory brainstem response] of the total improved hearing at 6 months."

Age-dependent therapeutic effects

A significant finding was the age-dependent nature of the treatment's effectiveness. The researchers observed that "the most improvement (>80 dB) occurred in participants aged between 5 and 8 years old, whereas participants younger and older than this age range showed much less improvement."

This discovery has important implications for treatment timing. "OTOF is just the beginning," says Dr Duan. "We and other researchers are expanding our work to other, more common genes that cause deafness, such as GJB2 and TMC1. These are more complicated to treat, but animal studies have so far returned promising results."

Safety profile and future directions

The treatment demonstrated excellent safety and tolerability. The most common adverse reaction was a reduction in neutrophils, a type of white blood cell, but no serious adverse reactions were reported during the 6-12 month follow-up period.

The study included ten participants across five hospitals in China, with ages ranging from 1.5 to 23.9 years. Seven participants received gene therapy in one ear due to unilateral cochlear implantation, while three received treatment in both ears.

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Dr Maoli Duan, consultant and docent at the Department of Clinical Science, Intervention and Technology, Karolinska Institutet

The authors concluded that "we found that a single injection of AAV-OTOF is well tolerated and safe, effectively improving hearing in DFNB9 patients of various ages." However, they emphasised that "future larger trials are needed to validate these findings."

Expanding therapeutic horizons

This research builds upon earlier studies that had been limited to paediatric populations. The inclusion of adolescents and adults significantly expands the potential patient population for genetic hearing loss treatments. The study's multicentre design and longer follow-up periods provide robust evidence for the therapy's efficacy and safety profile.

The findings suggest that gene therapy could offer hope to the millions of people worldwide affected by genetic hearing loss, marking a pivotal moment in the treatment of congenital deafness.

Reference:

Qi, J., Zhang, L., Lu, L., et. al. (2025). AAV gene therapy for autosomal recessive deafness 9: a single-arm trial. *Nature Medicine*. https://doi.org/10.1038/s41591-025-03773-w

Laser-based technology eliminates need for blood pressure cuffs in continuous monitoring breakthrough

Boston University researchers have demonstrated that speckle contrast optical spectroscopy can accurately monitor blood pressure without traditional cuffs. The technology, which measures blood flow patterns using laser light, achieved up to 31% greater accuracy than existing optical methods when tested on 30 volunteers.

Researchers at Boston University have achieved a significant breakthrough in non-invasive blood pressure monitoring, demonstrating for the first time that speckle contrast optical spectroscopy (SCOS) can provide accurate cuff-free measurements. The findings, published in Biomedical Optics Express on 2 July 2025, could pave the way for continuous cardiovascular health monitoring through wearable devices.

Novel approach addresses hypertension monitoring challenges

The research addresses a critical healthcare need, as hypertension affects nearly half of all adults in the United States and represents the leading cause of cardiovascular disease. Traditional cuff-based measurements, whilst clinically established, present limitations for continuous monitoring due to their cumbersome nature and inability to capture blood pressure variations throughout daily activities.

"This research is a step towards a wearable device that would let people monitor their blood pressure any time, without a cuff," said Ariane Garrett, a doctoral student in Darren Roblyer's laboratory at Boston University.

SCOS represents a sophisticated imaging technique that analyses blood flow by examining speckle patterns formed when coherent light scatters from cells and tissue. Whilst the technology has previously been applied to brain and tissue monitoring applications, this study represents one of the first investigations into its relationship with blood pressure measurements.

Dual-wavelength system demonstrates superior accuracy

The researchers developed a specialised device incorporating two laser wavelengths (532 nm and 808 nm), enabling acquisition of SCOS waveforms from different tissue volumes. The system operates at higher frame rates than previous iterations, facilitating extraction of fine temporal features from the waveforms and their correlation with blood pressure parameters.

Testing involved 30 volunteers who underwent measurements using both the SCOS device and a continuous blood pressure monitor. The protocol included resting measurements and leg press exercises designed to induce blood pressure changes. Machine learning models were subsequently trained using extracted features from blood flow and volume waveforms to estimate blood pressure.

The study revealed that combining blood flow and volume information yielded up to 31% improved accuracy compared to using blood volume information alone. The integrated approach predicted systolic blood pressure with low average absolute errors of 2.26 mmHg, demonstrating clinical relevance for the technology.

Clinical implications for masked hypertension detection

The research holds particular significance for detecting masked hypertension, a condition where clinic readings fail to reflect true blood pressure patterns. "Studies show that tracking blood pressure throughout the day, and especially at night, provides a better picture of someone's health," explained Roblyer. "A wearable version of our device would be easier and more comfortable for patients and could help doctors catch conditions like masked hypertension."

Future development towards wearable technology

The research team's next phase involves developing a wearable version of the SCOS device. This will require miniaturisation of the system and development of on-device data processing capabilities rather than external analysis. Subsequent testing will evaluate performance during movement and extended wear periods.

"Our results showed that SCOS improves blood pressure estimation by enabling simultaneous measurements of blood flow and volume changes using the wrist or finger," said Garrett. "This opens a new way to track cardiovascular health with optical tools."

The validation measurements obtained from 20 volunteers several weeks later confirmed the sustained improvement in accuracy, supporting the technology's potential for clinical translation. MEH

Reference:

Garrett, A., Kim, B., Gurel, N. Z., et. al. (2025). Speckle contrast optical spectroscopy for cuffless blood pressure estimation based on microvascular blood flow and volume oscillations. *Biomedical Optics Express*, 16, 3004-3016. https://doi.org/10.1364/BOE.560022

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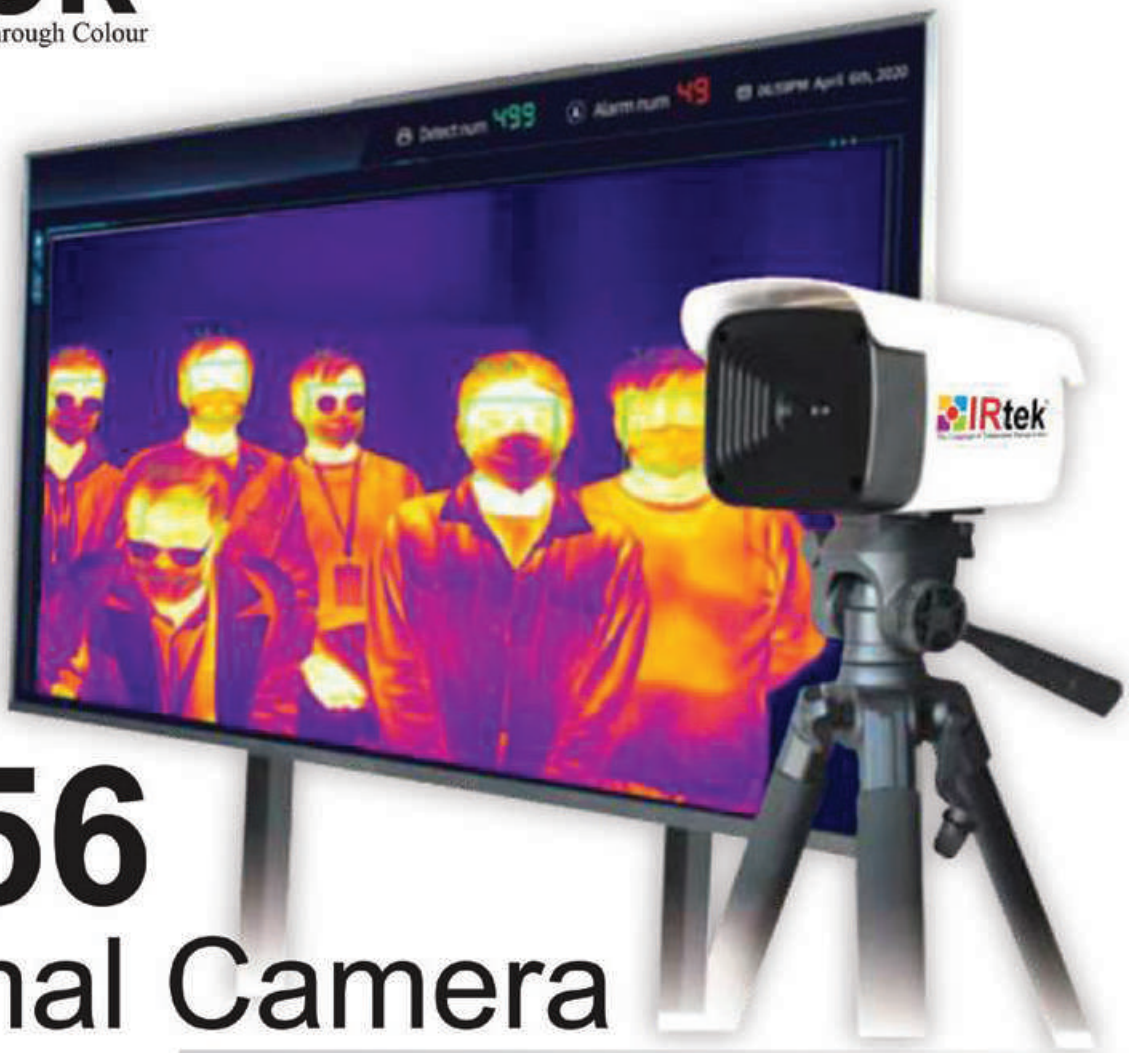

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Seventy-eighth World Health Assembly, Geneva, Switzerland

World Health Assembly adopts historic pandemic agreement and sustainable financing framework

The Seventy-eighth World Health Assembly concluded on 27 May with landmark achievements that fundamentally reshape global health governance, as WHO Member States demonstrated unprecedented solidarity in adopting the world's first pandemic agreement and securing transformative financing reforms. The nine-day assembly, convened under the theme "One World for Health", marked a pivotal moment in international health cooperation following years of intensive negotiations and planning.

Dr Tedros Adhanom Ghebreyesus, WHO Director-General, characterised the outcomes as historic, stating: "The adoption of the Pandemic Agreement and the approval of the next increase in assessed contributions, along with the numerous other resolutions that Member States adopted are a sign to the world that we can achieve cooperation in the face of conflict, and unity amid division."

Pandemic preparedness framework establishes new global architecture

The assembly's most significant achievement was the adoption of the WHO Pandemic Agreement on 20 May, representing the culmination of three and a half years of negotiations by the Intergovernmental Negotiating Body. This legally binding instrument establishes comprehensive measures to prevent future pandemics and strengthen health system resilience globally.

The agreement prioritises equity and access through enhanced global coordination, whilst explicitly respecting national sovereignty. Key provisions include mechanisms for rapid pathogen sharing, ensuring fair and timely access to vaccines, diagnostics and therapeutics, and strengthening technology transfer capabilities alongside financing and supply chain resilience.

Dr Tedros addressed persistent misconceptions surrounding the agreement's scope and authority. "The Pandemic Agreement will not infringe on national sovereignty, period. And the Pandemic Agreement does not give WHO any powers, period," he emphasised. "WHO's job is to make recommendations to governments, but what governments do with those recommendations is entirely up to them."

The agreement's implementation timeline requires negotiation of the Pathogen Access and Benefit Sharing system (PABS) annex over the next year, followed by ratification by 60 countries before entering into force as international law. Member States committed to completing this process by May 2026.

Sustainable financing transformation secures organisational stability

In parallel developments, Member States approved the second 20% increase in

assessed contributions, representing a fundamental shift in WHO's financial architecture. This increase adds US$ 90 million annually in predictable, flexible funding, advancing the organisation's goal of achieving 50% core budget funding through assessed contributions by 2030-2031, compared to just 16% in 2022.

The sustainable financing commitment extended beyond assessed contributions during WHA78's high-level pledging event, where health leaders committed at least US$ 210 million to WHO's Investment Round. This fundraising campaign supports the organisation's global health strategy outlined in the Fourteenth General Programme of Work over the next four years. Combined with the US$ 1.7 billion already secured, these pledges significantly advance WHO's financial sustainability objectives.

Since launching in May 2024, the Investment Round has attracted 35 new contributors, diversifying WHO's donor base and reducing dependence on traditional funding sources. Dr Tedros noted: "This is another major step towards making WHO less dependent on earmarked voluntary funds from a handful of traditional donors."

Comprehensive health resolutions address global challenges

The assembly's scope extended far beyond pandemic preparedness and financing, with Member States adopting approximately 75 items across diverse health domains. Notable achievements included establishing new global health targets, with Member States committing to halve the health impacts of air pollution by 2040, reflecting growing recognition of environmental health challenges.

Noncommunicable disease priorities gained prominence through first-ever resolutions on lung and kidney health, strategically timed to complement upcoming UN General Assembly discussions on noncommunicable diseases. The assembly also addressed rare diseases affecting over 300 million people globally across more than 7,000 conditions, demonstrating commitment to health equity for underserved populations.

Social determinants of health received attention through an innovative resolution promoting social connection, supported by emerging evidence linking social connectivity to improved health outcomes and reduced mortality risk. Additional resolutions targeted lead exposure elimination, digital marketing regulation of breast-milk substitutes and baby foods, and Guinea worm disease eradication acceleration.

The assembly established two new official WHO health campaigns: World Cervical Cancer Elimination Day and World Prematurity Day, expanding the organisation's advocacy framework for priority health issues.

Emergency response capabilities demonstrate global reach

WHO's emergency response capacity received scrutiny during the assembly, with reports detailing responses to 51 graded emergencies across 89 countries and territories over the past year. These included global cholera and mpox outbreaks – the latter constituting a public health emergency of international concern – alongside multiple humanitarian crises.

Working through partnerships with over 900 organisations across 28 health clusters, WHO provided health assistance to 72 million people in humanitarian settings. Significantly, nearly 60% of new emergencies were climate-related, highlighting the growing intersection between climate change and health security.

Member States endorsed WHO's leadership in health emergencies whilst supporting strengthened global architecture through the health emergency prevention, preparedness, response and resilience (HEPR) framework. The assembly also addressed specific regional health needs, including situations in Ukraine and the occupied Palestinian territory.

Scientific standards and innovation drive policy development

The assembly reinforced science-driven approaches through resolutions establishing new norms and standards for health policy implementation. Member States approved measures to strengthen the research base on public health and social measures for outbreak control, recognising evidence-based interventions as fundamental to effective health responses.

Progress on International Health Regulations (2005) implementation received attention, with the Director-General's report noting advancement in global health security architecture. The assembly's commitment to scientific rigour extended to traditional medicine through adoption of a new global strategy balancing cultural practices with evidence-based standards.

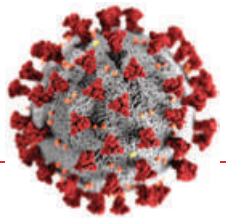
Implications for global health governance

The Seventy-eighth World Health Assembly's outcomes represent a defining moment in global health governance, establishing frameworks that will influence international health cooperation for decades. The pandemic agreement's adoption demonstrates that multilateral consensus remains achievable despite global political tensions, whilst the financing reforms provide organisational stability essential for WHO's expanding mandate.

Dr Tedros reflected on Member States' commitment: "Countries want a strong WHO and are committed to working together with WHO to build a healthier, safer and fairer world. These were strong votes of confidence in WHO at this critical time."

The assembly's comprehensive approach – spanning pandemic preparedness, sustainable financing, emergency response, and diverse health challenges – positions WHO to address contemporary health threats whilst building resilience for future challenges. Implementation success will depend on sustained political commitment and effective translation of resolutions into national health policies and programmes.

- For comprehensive documentation of the assembly's proceedings and adopted resolutions, visit: *https://apps.who.int/gb/e/e_wha78.html* .
- Additional information on WHO's Investment Round is available at *https://www.who.int/about/funding/invest-in-who/investment-round* .



WHO scientific panel concludes natural spillover most likely origin of COVID-19 but laboratory leak cannot be ruled out

After more than five years of investigation, the World Health Organization's Scientific Advisory Group for the Origins of Novel Pathogens has concluded that whilst evidence supports a natural zoonotic spillover as the most likely origin of SARS-CoV-2, critical data gaps prevent definitive conclusions and a laboratory-related incident cannot be ruled out.

The World Health Organization's Scientific Advisory Group for the Origins of Novel Pathogens (SAGO) has published its most comprehensive assessment to date on the origins of SARS-CoV-2, concluding that whilst available evidence supports natural zoonotic transmission, significant data gaps prevent a definitive determination of how the pandemic began.

The 78-page report, published on 27 June 2025, represents the culmination of extensive analysis by 27 independent international scientific experts who reviewed peer-reviewed literature, government reports, and intelligence assessments spanning from the virus's emergence through to 2025.

Evidence supports zoonotic transmission

"The weight of available evidence reviewed by SAGO suggests zoonotic spillover of SARS-CoV-2 into the human population, either directly from bats or through an intermediate host," the authors state. However, they emphasise: "SAGO cannot conclude with certainty where and when this occurred, nor if the HSM [Huanan Seafood Market] was indeed the first instance of spillover into the human population, or the site of further spillover and amplification."

The assessment highlights compelling metagenomic evidence from the Huanan Seafood Market, where researchers identified mitochondrial DNA from animals known to be susceptible to SARS-CoV-2 infection, including raccoon dogs, in the same stalls where environmental swabs tested positive for the virus. "The data confirms that these animals were present before the market was closed on 1 January 2020 and may have been a source for human infection," the report notes.

Genomic analyses revealed evidence of two separate introductions of SARS-CoV-2 lineages into the human population, with evolutionary analyses suggesting these occurred after November 2019. The closest known precursor viruses remain RaTG13 from bats in China (96.1% genomic similarity) and BANAL-52 from Laos (96.8% similarity), though these are still too genetically distant to be direct sources of the pandemic virus.

Laboratory origin hypothesis remains unresolved

Critically, SAGO could not adequately assess the possibility of a laboratory-related incident due to lack of access to essential information. "Information and evidence is also lacking to assess the possibility of a laboratory origin – either the evidence is not available or has not been provided to the scientific community," the authors explain.

The group repeatedly requested access to health records of laboratory staff, documentation on biosafety procedures, and details of coronavirus research conducted at facilities including the Wuhan Institute of Virology and Wuhan Centers for Disease Control. "Without information to fully assess the nature of the work on coronaviruses in Wuhan laboratories, nor information about the conditions under which this work was done, it is not possible for SAGO to assess whether the first human infection(s) may have resulted due to a research related event," the report states.

Persistent data gaps hamper investigation

The assessment identifies numerous outstanding investigations that could clarify the pandemic's origins. These include access to more than 500 genetic sequences from early COVID-19 patients that remain unpublished, detailed information about animal sources at wet markets in Wuhan, and comprehensive upstream investigations of wildlife farms supplying the Huanan market.

SAGO found no credible evidence supporting the cold chain hypothesis – that frozen imported products introduced the virus to China – nor theories of deliberate viral manipulation. "Hypotheses submitted to the SAGO or available in the public domain on intentional manipulation of the virus however, are not supported by accurate science," the authors conclude.

Call for continued investigation

The report emphasises the moral imperative of understanding COVID-19's origins: "This is not solely a scientific endeavour it is a moral and ethical imperative. Understanding the origins of SARS-CoV-2 and how it sparked a pandemic is needed to help prevent future pandemics, save lives and livelihoods, and reduce global suffering."

SAGO urges all governments, particularly China, to share additional data and allow independent investigations. "The COVID-19 pandemic has caused so much suffering and devastation globally for the world not to know exactly how this pandemic started," the authors state.

The assessment concludes that until critical information gaps are addressed, "the origins of SARS-CoV-2 and how it entered the human population will remain inconclusive." MEH

Reference:

World Health Organization. (2025). Independent assessment of the origins of SARS-CoV-2 from the Scientific Advisory Group for the Origins of Novel Pathogens (SAGO). *World Health Organization*, 27 June 2025. *https://www.who.int/publications/m/item/independent-assessment-of-the-origins-of-sars-cov-2-from-the-scientific-advisory-group-for-the-origins-of-novel-pathogens*

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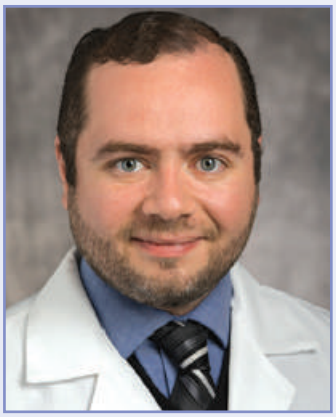
WCM-Q to host inaugural conference on climate-related health challenges

"The MENA faces a significant gap in climate-health research, policy integration, and healthcare preparedness."

The Eastern Mediterranean Region (EMR) is particularly vulnerable to climate change, with rising temperatures posing serious health risks. According to the *World Health Organization*'s (WHO) regional framework for 2023-2029, the EMR emits only 8.25 percent of the world's greenhouse gases, but its temperatures and other climatic hazards are changing twice as fast as in the rest of the world. The effects of these hazards on health are substantial, resulting in more extreme weather events, an increase in cases of non-communicable diseases, and the emergence and spread of infectious diseases.

Climate change and environmental degradation are increasingly recognized as critical public health challenges. However, the Middle East and North Africa (MENA) region lacks sufficient awareness, research, and policy action to address these issues. Health systems across the region are underprepared to combat health risks driven by extreme temperatures, air pollution, resource scarcity, and other environmental factors.



Dr. Sadeer Al-Kindi

Dr. Nasrin Mesaeli

Exploring the Nexus of Climate, Health, and Environment

To address the intersection of climate change, environmental pollution, and human health, with a specific focus on the unique challenges faced by the MENA region, Weill Cornell Medicine-Qatar (WCM-Q) is scheduled to host its inaugural conference, **CHE2025**, under the theme "Exploring the Nexus of Climate, Health, and Environment" on **October 25-26, 2025**, in **Doha, Qatar**.

The conference will feature plenary sessions, expert panels, and an interactive poster session where participants will explore evidence-based strategies for mitigating climate-related health impacts and engage with practical solutions in areas such as sustainable healthcare, innovation in patient care, and urban design. CHE2025

aims to equip attendees with actionable insights to strengthen resilience and advance climate-health integration in research, policy, and practice.

Key conference themes include the impact of climate change and environmental pollution on human health and the role of environmental toxins, especially in relation to chronic diseases. Other areas of focus include sustainable urban planning and healthcare delivery, the food-energy-water-health nexus, and strategies for achieving net-zero emissions in healthcare systems.

The conference is directed by Dr. Sadeer Al-Kindi, a WCM-Q alumnus and preventive and imaging cardiologist at Houston Methodist DeBakey Heart & Vascular Center in the United States, and Dr. Nasrin Mesaeli, an associate professor of biochemistry at WCM-Q.

Highlighting the urgency of addressing health challenges related to climate change in the MENA region, Dr. Al-Kindi said: "Climate change and environmental degradation contribute to a growing burden of disease through pathways such as extreme heat, poor air quality, vector-borne illnesses, and food and water insecurity. These impacts strain health systems and disproportionately affect vulnerable populations. The MENA region is particularly exposed due to its arid climate, rapid urbanization, and limited natural resources. Unlike other regions, MENA faces a significant gap in climate-health research, policy integration, and healthcare preparedness, making targeted action and investment crucial."

Dr. Al-Kindi also serves as an associate professor and associate director for cardiovascular prevention & wellness, as well as associate director of the Center for Cardiovascular Computational and Precision Health at Houston Methodist & Weill Cornell Medicine. He has published extensively on the environmental determinants of cardiovascular disease.

The two-day conference will feature an impressive lineup of speakers from prominent international institutions, including Case Western Reserve University; the World Health Organization Regional Office for the Eastern Mediterranean; Johannes Gutenberg University Mainz; Harvard University; New York University; Houston Methodist & Weill Cornell Medicine; the University of Colorado Boulder; the University of California San Diego; the Qatar Research, Development and Innovation Council; Hamad Bin Khalifa University; and Texas A&M University at Qatar; among others.

The conference will focus not only on the influence of environment and climate on human health but also highlight how healthcare practices contribute to environmental pollution.

Dr. Mesaeli said: "The conference will focus not only on the influence of environment and climate on human health but also highlight how healthcare practices contribute to environmental pollution. The ultimate goal is to increase awareness among health workers about the interplay between environment and health and help develop strategies to deliver high-quality patient care with minimal environmental effect." Her research focuses on the role of endoplasmic reticulum stress in the development of diseases, specifically lung cancer and metabolic syndrome.

The conference is designed for physicians, nurses, allied health professionals, pharmacists, public health experts, academics, students, and researchers interested in environmental health, climate change, and healthcare sustainability.

Dr. Al-Kindi added: "The conference seeks to build regional capacity by fostering collaboration among healthcare professionals, researchers, and policymakers, and providing practical, evidence-based strategies to integrate climate resilience into healthcare systems. It serves as a catalyst for regional action and a platform for global knowledge exchange."

CHE2025 is accredited in Qatar by the Department of Healthcare Professions-Accreditation Section (DHP-AS) of the Ministry of Public Health (MoPH) and internationally by the Accreditation Council for Continuing Medical Education (ACCME).

The conference is coordinated by WCM-Q's Division of Continuing Professional Development (CPD), which offers high-quality professional development opportunities for physicians and other healthcare professionals. CPD programs are designed based on identified needs and the latest scientific and medical advancements, aiming to increase competence, enhance performance in practice, and improve patient care.

For further information or to register to attend, please scan the QR code.

Breath analysis breakthrough delivers real-time propofol monitoring in paediatric anaesthesia

Researchers at the University of Basel have developed a non-invasive breath analysis technique that can monitor propofol concentrations and detect metabolic stress responses during general anaesthesia in children. The pilot study demonstrates robust correlations between exhaled compounds and serum propofol levels whilst revealing oxidative stress markers linked to surgical interventions.

Revolutionary monitoring approach transforms anaesthetic management

A groundbreaking study published in *Anesthesiology* has unveiled a transformative approach to monitoring general anaesthesia in paediatric patients through real-time breath analysis. The research, led by Professor Pablo Sinues from the Department of Biomedical Engineering at the University of Basel and the University Children's Hospital Basel, represents a significant advancement in personalised anaesthetic care.

The pilot study examined 10 children undergoing propofol-based anaesthesia for dental surgery, collecting 47 breath samples and 37 blood samples throughout the procedures. Using secondary electrospray ionisation high-resolution mass spectrometry (SESI-HRMS), researchers achieved remarkable precision in detecting propofol and its metabolites in exhaled breath.

"Propofol is quite volatile and can be easily measured in a person's breath," explains Sinues. The study revealed that breath analysis closely matched blood concentrations, with the strongest correlations showing partial R^2 values exceeding 0.65 and adjusted P values less than 0.001.

Technical precision meets clinical practicality

The SESI-HRMS technique offers exceptional sensitivity and specificity, capturing a comprehensive metabolic profile that extends far beyond traditional drug monitoring. Dr Jiafa Zeng, the study's first author, collected breath samples using specially developed plastic bags, enabling laboratory analysis within three minutes of collection.

The research identified propofol itself (partial R^2 = 0.889) and its known metabolite, 2,6-diisopropyl-1,4-quinone (partial R^2 = 0.693), alongside several additional compounds exhibiting strong associations with serum propofol concentrations. These included propofol isopropyl ether and two unidentified compounds with molecular formulae $C_9H_{12}O$ and $C_{12}H_{16}O$, both plausibly related to propofol through structural or metabolic modifications.

To distinguish between metabolic origins and potential formulation impurities, researchers analysed the headspace of propofol formulations. The ratio of 2,6-diisopropyl-1,4-quinone to propofol signals was significantly higher in patients' breath than in the formulation (17% versus 2%; P = 0.005), confirming that the majority of observed signals resulted from hepatic metabolism rather than contamination.

Metabolic fingerprinting reveals surgical stress responses

Beyond drug monitoring, the study uncovered a remarkable metabolic cascade triggered by surgical intervention. Among 958 features detected in positive ion mode, 349 showed significant differences between pre- and post-induction samples after false discovery rate correction. Notably, 173 features were significantly upregulated whilst 78 were downregulated following propofol induction.

The researchers identified 35 compounds through database queries, revealing two distinct chemical groups: fatty aldehydes (comprising 10 compounds) and benzene derivatives (including 9 compounds). The fatty aldehydes, particularly 4-hydroxynonenal, represent well-characterised markers of oxidative stress, indicating the body's response to surgical trauma.

"With this method, we can not only determine the propofol concentration, but also measure how the body reacts to the anaesthesia and the surgery," notes Sinues. This dual capability could prove invaluable for detecting rare but serious complications, particularly propofol infusion syndrome, which can affect children.

Clinical implications and future applications

The study's findings hold particular significance for paediatric anaesthesia, where dosing complexities are heightened due to developmental pharmacokinetic variations. Neonates, for instance, may

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display propofol clearance rates only 10 to 38% of adult levels, with ongoing maturation affecting pharmacokinetics over time.

Current clinical practice relies on target-controlled infusion models incorporating age, weight, height, and sex to improve dosing precision. However, genetic factors, developmental status, and pathophysiological conditions introduce substantial interpatient variability. The breath analysis technique offers real-time feedback that could complement existing approaches.

As the authors note in their discussion: "Advanced TCI models, such as the Eleveld model, already incorporate age, weight, height, and sex to improve dosing precision. Still, genetic factors, developmental status, and pathophysiological conditions introduce interpatient variability in metabolism and clearance."

Technological integration and clinical workflow

The research demonstrates seamless integration into standard surgical workflows without disrupting routine procedures or causing discomfort to clinicians or patients. Breath samples were analysed on-site using SESI-HRMS, providing mass spectral readouts typically within 15 minutes of collection.

Future developments could reduce this timeframe dramatically. The authors suggest that direct integration of mass spectrometry into ventilator systems could achieve near real-time monitoring within seconds. Indeed, proof-of-concept studies have already demonstrated continuous breath monitoring via SESI-HRMS at 10-second intervals.

Pharmacometabolomics: personalising therapeutic approaches

The study exemplifies the emerging field of pharmacometabolomics, which leverages metabolic profiles to predict individual drug responses and advance precision medicine. Unlike static pharmacogenomics, this approach offers dynamic insights influenced by diet, microbiome composition, disease states, and environmental factors.

The researchers emphasise that "pharmacometabolomics leverages metabolic profiles to predict individual drug responses, thereby advancing precision medicine... This approach is particularly valuable for managing the interindividual variability observed in vulnerable populations, such as pediatric or critically ill patients."

Oxidative stress monitoring and safety implications

The detection of fatty aldehydes, particularly markers of lipid peroxidation, provides crucial insights into surgical stress responses. These metabolic shifts reflect the body's response to increased energy demands, muscle protein breakdown, and reactive oxygen species production during surgery.

The correlation network analysis revealed tight regulation among oxidative stress markers, suggesting that breath analysis could serve as an early warning system for metabolic complications. Given that severe metabolic acidosis represents a hallmark of propofol infusion syndrome, this rich metabolic fingerprint could potentially monitor both drug concentrations and flag individual-level adverse effects.

Future directions and clinical validation

Whilst this pilot study demonstrates remarkable proof-of-concept, larger validation studies are essential to confirm clinical utility. The authors acknowledge several limitations, including the substantial capital investment required for SESI-HRMS instrumentation, though cost analysis suggests per-sample expenses (approximately $20) comparable to other clinical tests.

The research team received funding from the Swiss National Science Foundation and conducted the study as part of the Exhaled Breath Analysis by Secondary Electrospray Ionisation–Mass Spectrometry in Children and Adolescents (EBECA) initiative.

Transforming anaesthetic care through metabolic monitoring

This pioneering research represents a significant step towards individualised anaesthetic management through non-invasive breath analysis. By simultaneously monitoring drug concentrations and metabolic responses, the technique offers unprecedented insights into both anaesthetic exposure and physiological impact.

University of Basel, Department of Biomedical Engineering

First author Jiafa Zeng pushes the breath from the sample bag into a mass spectrometer to analyze the metabolites in the exhaled air.

The authors conclude: "On-site SESI-HRMS breath pharmacometabolomics can capture robust correlations between exhaled signals and serum propofol concentrations while revealing significant metabolic shifts likely linked to oxidative stress. Integrating these data with established pharmacokinetic models and electroencephalography-based measures could advance individualised anaesthetic management."

Reference:

Zeng, J., Stankovic, N., Singh, K. D., et. al. (2025). Breath Analysis of Propofol and Associated Metabolic Signatures: A Pilot Study Using Secondary Electrospray Ionization High-resolution Mass Spectrometry. *Anesthesiology*. https://doi.org/10.1097/ALN.0000000000005531

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Families also benefit from psychosocial support, financial counseling, and educational resources—creating a nurturing environment where they can focus on what matters most: their child's health and recovery.

Guiding Global Pediatric Care Standards

Our hospital's impact extends far beyond Los Angeles. Through strategic partnerships, training programs, and knowledge exchange, the Center for Global Health collaborates with healthcare institutions across the Middle East to elevate standards of pediatric care. CHLA experts provide education and mentorship to clinicians worldwide, helping to build sustainable healthcare capacity in local communities.

Your Partner in Pediatric Excellence

At Children's Hospital Los Angeles, we don't just treat patients, we transform lives and shape the global future of complex pediatric healthcare. The Center for Global Health represents the pinnacle of this mission, combining compassion, expertise, and innovation to improve the health of children worldwide.

CHILDREN'S HOSPITAL LOS ANGELES CENTER FOR GLOBAL HEALTH

For international patient referrals, contact us at: *internationalpatientreferrals@chla.usc.edu* or +1-323-361-8737.

- For more information on our Center for Global Health, visit us at *CHLA.org/GlobalHealth* .

Every specialist, every breakthrough, every innovation — All focused on your child's extraordinary care.

CHLA.org/GlobalHealth

Complex care is our everyday routine

Children's Hospital LOS ANGELES

A groundbreaking gene therapy for children with AADC deficiency

Great Ormond Street Hospital (GOSH) International and Private Care can offer gene therapy for children with AADC deficiency. GOSH is one of only a few facilities in the world offering this effective treatment for this debilitating and life-limiting condition.

Eladocagene exuparvovec

This gene therapy is used for the treatment of patients aged 18 months and older, with a deficiency of the protein called aromatic L-amino acid decarboxylase (AADC). The protein is essential to make certain chemicals that the body's nervous system needs to work properly. The treatment has been shown to be effective in many patients.

AADC deficiency is an inherited condition caused by a variation (change) in the gene that controls the production of AADC (also called dopa decarboxylase or DDC gene). The condition prevents development of the child's nervous system, which means that many of the body's functions do not develop correctly during childhood, including movement, eating, breathing, speech, and mental ability. Most children with onset of disease in infancy do not achieve head control.

The condition is rare but often fatal, affecting every aspect of young life – physical, mental and behavioural development. Children with AADC deficiency have painful episodes where their bodies contort and stiffen, their eyes roll out of their control, they experience digestive issues, low blood sugar levels, behavioural problems, and poor sleep. Unfortunately, children with AADC deficiency rarely reach adulthood as they are prone to respiratory infections and can even stop breathing during their episodes.

A healthy version of the gene that causes AADC deficiency

Eladocagene exuparvovec is a recombinant adenoassociated virus serotype 2 (AAV2)-based gene therapy, containing the human DDC gene that, once delivered to the brain, is designed to overcome the underlying genetic variation that causes a lack of the AADC protein. When a functioning DDC gene is delivered to a part of the brain involved in this condition (the putamen), AADC can be produced, leading to the production of much needed chemicals in the brain, serotonin and dopamine. The gene therapy is delivered directly to the brain with millimetre accuracy using robotic-guided surgery, guided by a highly skilled multidisciplinary surgical team using state-of-the art positioning systems.

This gene therapy treatment is undertaken by a multidisciplinary GOSH team including Professor Manju Kurian, Consultant Paediatric Neurologist, Mr Kristian Aquilina, Consultant Neurosurgeon, Dr Lucinda Carr, Consultant Paediatric Neurologist and Dr Ravi Shihurkar, GOSH Consultant Anaesthetist.

Gunreet's story

Gunreet was just nine months old when she was diagnosed with AADC deficiency. Mum Sandeep, said: "When Gunreet was about seven months old, I noticed she wasn't reaching her milestones at the same age that her older brother did. She couldn't hold her own head up or reach out for items. She cried a lot and always wanted to be held."

After Gunreet arrived at GOSH she underwent genetic testing and was diagnosed with AADC deficiency.

In February 2024, she underwent the specialist surgery to have the new gene therapy: "Since having the gene therapy, Gunreet has made great progress. She cries less, smiles more, and can reach for objects. She can hold her head up and is trying to sit up, she's recently learnt how to roll from her stomach to her back which is fantastic to see."

Gunreet's learning development will be monitored and the family hopes she will be able to start at a school with specialist support for her in January next year thanks to the progress she has been making.

Effectiveness

European Medicines Agency (EMA): the benefits of this novel treatment were shown in three main studies involving 28 children aged 1.5 to 8.5 years with severe AADC deficiency confirmed by a genetic test. The main measures of effectiveness were head control and the ability to sit unassisted. The studies showed that around 70% of patients (14 out of 20) were able to control head movement and around 65% of patients (12 out of 20) could sit unassisted two years after treatment. Data from scientific literature showed that patients with severe AADC deficiency who have not received any treatment could not achieve these developmental milestones. Several patients have been treated at GOSH under this new programme, all responded well to the gene therapy.

AADC deficiency is a rare condition, but often a cruel one. We know children with the condition have painful episodes that can last for hours and, as their condition progresses, their life becomes more and more limited. It's incredible to me that I can now prescribe novel gene therapies under similar processes to paracetamol and antibiotics.

We work collaboratively across teams inside and outside the hospital, from physios and surgeons to dietitians and speech therapists, alongside partnerships with companies who supply these therapies.

– *Professor Manju Kurian*

Why choose GOSH

Great Ormond Street Hospital (GOSH) in the heart of London is a globally renowned specialist children's hospital and the leading paediatric hospital in Europe, championing innovation and providing ground-breaking treatments for the rarest and most complex conditions across 67 specialties and sub-specialties. We have 300,000 young visitors every year, and International and Private Care treats more than 6,000 patients from around the world annually. The service is tailored to the treatment of international patients, and our dedicated international team ensure excellent patient and family experience from referral to discharge.

Research and Innovation are central to everything we do. We are committed to achieving the best possible results by consistently measuring the outcomes and value against the highest international standards.

GOSH's Multi-Disciplinary Team (MDT) approach allows children with rare and complex diseases to receive the best possible care. MDTs lead to better clinical decision-making and improved overall quality of treatment. This approach allows children to receive the best possible care from world-leading clinicians, all under one roof.

GOSH has the largest paediatric neurosurgery unit in the UK. The highly skilled and experienced team offers specialized care for conditions like hydrocephalus, brain and spinal tumours, and epilepsy. It performs around 1,000 procedures annually.

GOSH treats the majority of children diagnosed with AADC Deficiency in the United Kingdom and is the only delivery site for this potentially lifesaving and life-changing gene therapy.

Contact us:

For more information about Great Ormond Street Hospital and how we can assist you, please contact our Gulf Office:

- Email: *GulfOffice@gosh.nhs.uk*
- Phone: +971 4 3624722
- Website: *www.gosh.ae*

Excellence in adolescent oncology: UCLH's multidisciplinary approach

Cancer treatment for teenagers can present a unique set of challenges, both clinically and psychologically. Adolescence is a time of physical change, growing independence, and changing social identity. When cancer becomes part of the story too, the need for specialised, holistic care is paramount. At UCLH Private Healthcare, multidisciplinary expertise isn't just routine meetings; it's a fully integrated support system through every stage of a patient's journey.

Expertise at every stage

We often think of multidisciplinary teams (MDTs) as groups of specialists who meet periodically to review cases. Although this is a vital stage of treatment planning, UCLH Private Healthcare's teenage and young adult cancer team takes the MDT approach further, with multidisciplinary excellence in care at every step.

As an international centre for teenage cancer treatment, UCLH's team is specifically trained in adolescent oncology. From haematologists to psychologists, everyone involved understands the nuances of treating teenagers—not just clinically but holistically. This age-appropriate focus differentiates UCLH from adult-focused services, with care tailored to the patient's developmental stage, recognising the clinical and psychological challenges adolescence brings.

An example is Patient L. Diagnosed with chronic myeloid leukaemia in blast crisis, this 15-year-old boy arrived in the UK from the UAE with complex medical needs. From the moment he was admitted to the teenage and young adult cancer ward at University College Hospital, London, he met a network of specialists who made sure his treatment plan addressed not only his cancer but the challenges of both adolescence and being treated away from home.

Patient L: A case study in integrated expertise

Patient L's care began with an immediate reassessment to review his previous treatment plan and recommended changes including multi-agent chemotherapy and targeted molecular treatment. He had significant complications throughout treatment which required extensive monitoring and adjustments to his care plan.

During his stay, a network of professionals worked together including:

- **Imaging specialists**: Conducting CT scans, ultrasounds, and MRIs to track his condition
- **Consultant haematologists with teenage cancer expertise**: recommending treatment options, taking into consideration the increased risk of toxicity in this age group
- **Psychologists and counsellors**: Providing age-appropriate emotional support
- **Dietitians**: Helping to mitigate the effects of aggressive treatment on his ability to eat
- **Activity coordinators**: Providing opportunities for entertainment, education and peer interaction, reducing isolation and supporting his mental health
- **Fertility specialists**: Protecting his fertility prior to treatment
- **Advocates**: Working with his family to assist in the cultural and logistical complexities of overseas treatment.

The team's understanding of the adolescent experience shaped every decision, ensuring Patient L received age-appropriate and culturally sensitive care.

The psychological impact of cancer in adolescence

Teenagers face different challenges to younger children and adults with cancer. Their social identity and body image evolve rapidly, making the emotional toll of treatment particularly difficult. Physical changes caused by chemotherapy, disruptions to education, and separation from peers add stresses that require specialised support.

At UCLH Private Healthcare, psychological care extends beyond formal therapy. While psych-oncology plays a vital role, some patients prefer informal interactions. Activity coordinators, nurses, and even allied health professionals provide safe spaces for conversation, with psychological well-being a priority.

Multidisciplinary excellence

Unlike hospitals where MDTs happen periodically, UCLH promotes continuous collaboration. Consultants lead care pathways, coordinating referrals to specialist teams. Nurses, who spend the most time with patients, offer insights that can inform medical decisions. And regular discussions with key experts keep everyone focused on the patient's needs.

Patient L's journey is typical for a patient at UCLH Private Healthcare; MDT expertise beyond meetings, specialists working seamlessly together, and a deep understanding of adolescent-specific cancer treatment and care. Compassion, expertise, and a commitment to world-class care remain at the forefront all the way.

- For more information, visit: *www.uclhprivatehealthcare.co.uk* or email: *uclh.ipo@nhs.net*

Specialist care for young people with cancer and blood disorders, provided in the heart of London

University College Hospital, London, UK

UCLH's highly specialised haematology service is dedicated to patients aged 13-18 years old who have been diagnosed with a blood-related cancer or other blood disorders. Our specialist solid tumour service also treats younger patients.

We offer state-of-the-art treatment options including haemopoietic stem cell transplantation, radio-isotope therapy and CAR-T cell therapy. All patients are cared for by a highly skilled multidisciplinary team led by a named consultant.

As well as providing world-class care, our wards have been designed for young people to make their stay in hospital as comfortable and enjoyable as possible.

University College Hospital is based in leafy Bloomsbury, a short walk from Oxford Street and London's West End, with quick and easy transport links across the city.

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Origami-inspired heart valve grows with children to transform paediatric care

Researchers at UC Irvine have developed the IRIS Valve, an innovative transcatheter pulmonary valve that can expand from 12mm to 20mm diameter as children grow. The origami-inspired device successfully demonstrated safety and efficacy in six-month animal studies, offering hope for treating congenital heart defects in patients weighing as little as 8kg.

A groundbreaking development in paediatric cardiac care has emerged from the University of California, Irvine, where researchers have successfully developed and tested a growth-accommodating heart valve designed specifically for young children with congenital heart defects. The IRIS Valve represents a paradigm shift in transcatheter pulmonary valve replacement (TPVR), addressing a critical gap in treatment options for children weighing less than 20kg.

Closing the treatment gap for vulnerable patients

Congenital heart defects affect approximately 1% of births in the United States and Europe, with over 1 million children living with these conditions in the US alone. Many patients require surgical intervention early in life to address right ventricular outflow tract abnormalities, but these initial repairs are typically temporary solutions. Progressive pulmonary valve regurgitation often develops, necessitating valve replacement to prevent right ventricular failure.

Current transcatheter pulmonary valve systems require patients to weigh at least 20kg due to the large delivery catheter sizes needed – typically 22 French or larger. This weight threshold leaves younger children without minimally invasive treatment options, forcing them to wait and risk right ventricular dilation whilst their hearts continue to grow.

"We are pleased to see the Iris Valve performing as we expected in laboratory bench tests and as implants in Yucatan mini pigs, a crucial measure of the device's feasibility," said lead author Professor Arash Kheradvar from UC Irvine's Department of Biomedical Engineering. "This work represents the result of longstanding collaboration between our team at UC Irvine and Dr Michael Recto at Children's Hospital of Orange County built over several years of joint research and development."

Engineering meets ancient art

The IRIS Valve's innovative design draws inspiration from origami folding techniques, enabling the device to accommodate anatomical growth through balloon expansion whilst maintaining complete valve competency. The trileaflet valve features porcine pericardial leaflets precisely engineered to maintain their arc length during expansion, ensuring adequate coaptation across the entire 12mm to 20mm diameter range.

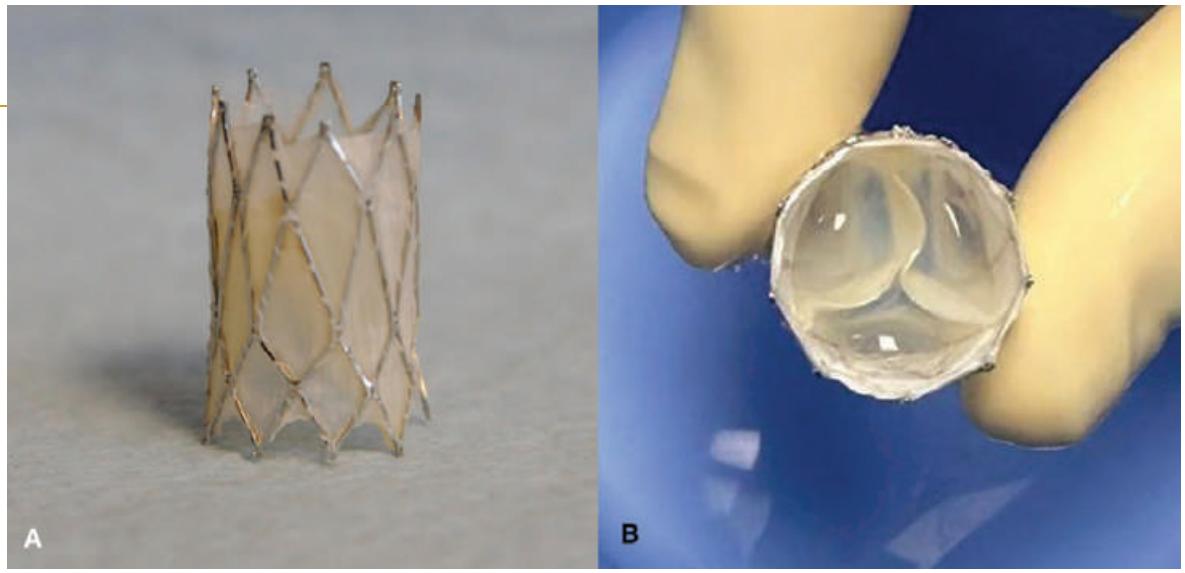
As detailed in the *Journal of the American Heart Association* published on 18 June 2025, the valve's unique geometry allows the leaflets to adapt to the stent's radial expansion by adjusting their height as the diameter increases. This design ensures the trileaflet configuration remains fully coapted throughout the expansion process.

The stent itself is laser-cut from stainless steel 304 and incorporates an expanded polytetrafluoroethylene (ePTFE) skirt sewn inside the stent wall to prevent paravalvular leaks. Finite element analysis confirmed the stent's ability to be crimped to a 3mm diameter for loading into a 12 French transcatheter system and subsequently expanded to 20mm without structural failure.

> Once the Iris Valve comes to fruition, it will save hundreds of children at least one operation – if not two – throughout the course of their lives. It will save them from having to undergo surgical pulmonary valve placement, as the Iris Valve is delivered via a small catheter in the vein and can be serially dilated to an adult diameter.
> *– Dr Michael Recto, interventional paediatric cardiologist at Children's Hospital of Orange County*

Rigorous preclinical validation delivers promising results

The research team conducted extensive preclinical testing, including both benchtop studies and six-month animal trials using Yucatan mini pigs weighing 8-17kg. The choice of Yucatan pigs was particularly appropriate, as their first year



Agwu et al. J Am Heart Assoc. 2025;14:e041932. doi: https://doi.org/10.1161/JAHA.125.041932

A, The completed valve with sewn in ePTFE skirt, leaflets, and stent in a 20 mm size. The stent is laser cut from stainless steel 304 from a 3.4 mm tube and expanded. The ePTFE skirt is laser cut and sewn on inside the wall of the stent to prevent paravalvular leak. B, Demonstration of leaflet coaptation at 20 mm. The valve's leaflets elicit adequate surface area contact for the valve ensuring coaptation is met throughout the 12 to 20 size range of the valve.

of life roughly corresponds to the first 18 years of human development, making them an ideal model for testing growth-accommodating devices.

Fracture testing demonstrated remarkable durability, with the valve stent successfully expanding to 26mm diameter without evidence of fracture – a capability that will enable future valve-in-valve procedures as patients reach adulthood. The finite element analysis revealed stress values averaging less than 1130 MPa during compression, well below the ultimate tensile strength of stainless steel 304.

The animal studies proved particularly successful, with all implanted valves demonstrating excellent integration within the pulmonary valve annulus and intact valve integrity. Echocardiographic evaluation confirmed valve competency with no evidence of regurgitation or paravalvular leak. Importantly, transvalvular gradients improved following balloon expansion, with pressure drops decreasing from 49mmHg to 9.3mmHg in one case and from 8.9mmHg to 2.2mmHg in another.

Cutting-edge flow analysis reveals optimal performance

The researchers employed cutting-edge echocardiographic particle image velocimetry (Echo-PIV) to evaluate blood flow patterns around the implanted valve. This technique, which applies particle tracking algorithms to contrast-enhanced echocardiography, revealed smooth, unidirectional flow from the right ventricle into the pulmonary artery during systole, with no regurgitant flow during diastole.

Tissue integration confirms biocompatibility

Six-month histopathological analysis revealed excellent tissue integration and biocompatibility. The examination showed dense integration of the IRIS Valve material into the right ventricular outflow tract wall, consistent with expected scarring responses. Various levels of chronic inflammation were evident, characterised by mixed lymphocytes and macrophages responding to the ePTFE skirt and suture materials – responses typical of successful implant integration.

Crucially, no neutrophils were present, and there were no signs of infection. The tissue samples demonstrated observable overgrowth surrounding the porcine leaflet material, indicating successful tissue integration within the pulmonary valve annulus.

Transforming treatment pathways for young patients

The IRIS Valve offers several significant advantages over current treatment paradigms. Its ability to be delivered through a 12 French catheter system makes it the smallest delivery system for any transcatheter heart valve, enabling treatment of children as small as 8kg. The growth-accommodation feature could eliminate the need for one or possibly two additional surgical interventions that are typically required as children mature.

"Once the Iris Valve comes to fruition, it will save hundreds of children at least one operation – if not two – throughout the course of their lives," explained Dr Michael Recto, interventional paediatric cardiologist at Children's Hospital of Orange County. "It will save them from having to undergo surgical pulmonary valve placement, as the Iris Valve is delivered via a small catheter in the vein and can be serially dilated to an adult diameter."

The authors conclude: "The IRIS Valve offers a promising solution for earlier treatment of heart valve disease in paediatric patients with congenital heart defects, potentially improving outcomes in this vulnerable population."

Pathway to clinical translation

The research team is now actively engaged with the US Food and Drug Administration to define the required experiments and documentation for first-in-human authorisation. Next-phase preclinical testing is funded by the Brett Boyer Foundation, which supports research into congenital heart disease treatments.

"We are actively engaged with the U.S. Food and Drug Administration to define and carry out the required experiments and documentation for first-in-human authorization of the Iris Valve," Professor Kheradvar said. "Our team is urgently advancing the Iris Valve through preclinical studies to enable its clearance for first-in-human use."

This innovative approach to paediatric valve replacement represents a significant step forward in addressing the unique challenges of treating congenital heart disease in growing children.

Reference:

Agwu, N., Chau, D., Kelley, G. S., et. al. (2025). Preclinical evaluation of a growth-accommodating transcatheter pulmonary valve system for young children. *Journal of the American Heart Association*, 14, e041932. *https://doi.org/10.1161/JAHA.125.041932*

SJD Barcelona Children's Hospital: A Year of Global Recognition, Innovation, and Impact in Paediatric Healthcare

SJD Barcelona Children's Hospital, with over 150 years of history, stands as one of Europe's leading centres for paediatric care, research, and innovation. In 2024 and early 2025, the hospital has achieved a series of remarkable milestones garnering international recognition, launching pioneering projects, and furthering its mission to deliver world-class, compassionate healthcare to children and families from around the globe.

International Recognition and Five-Star Global Hospital Rating

This year, SJD Barcelona Children's Hospital was awarded the prestigious five-star rating in the international Global Hospital Rating from Newsweek, a testament to its unwavering commitment to clinical excellence, patient-centred care, and leadership in complex paediatric medicine. As Spain's first single-speciality hospital in paediatric oncology and the second of its kind in Europe, the SJD Pediatric Cancer Centre Barcelona has become a benchmark for advanced cancer treatment, attracting patients and recognition from across the world.

Pioneering Advanced Therapies and Research

SJD Barcelona Children's Hospital continues to lead in the development and application of advanced therapies. The hospital recently launched a state-of-the-art platform dedicated to the production and development of cutting-edge treatments, such as CAR-T cell therapies. This facility, part of the SJD Pediatric Cancer Centre Barcelona, includes an R&D laboratory, cleanrooms, and cryopreservation capabilities, enabling the hospital to offer therapies available in only a handful of centres worldwide.

Notably, SJD Barcelona Children's Hospital was among the first hospitals globally to offer CART-19 immunotherapy and, in collaboration with Memorial Sloan Kettering Cancer Center in New York, anti-G2 immunotherapy with naxitamab for refractory high-risk neuroblastomas. The hospital also develops oncolytic viruses for the treatment of eye tumours, underscoring its role as a global innovator in paediatric oncology.

Driving Paediatric Innovation: 3D Modelling and Robotic Surgery

Innovation at SJD Barcelona Children's Hospital extends beyond clinical care. The hospital has embraced emerging technologies such as 3D modelling and robotic surgery, which are being used to plan and execute complex paediatric procedures. These tools improve precision, safety, and outcomes in areas like neurosurgery, oncology, and orthopaedics – underscoring SJD Barcelona Children's Hospital's commitment to leading the future of paediatric surgery.

Comprehensive Care and Family-Centered Approach

SJD Barcelona Children's Hospital is not only defined by its clinical achievements but also by its holistic, family-centred care model. The hospital's facilities are designed to create a healing environment, incorporating art, music, therapy dogs, and even canine-assisted operations to reduce anxiety and pain for young patients. Initiatives such as the Family Council and Youth Council ensure that the voices of patients and their families are central to the hospital's ongoing improvement efforts.

Expanding Networks and Global Reach

SJD Barcelona Children's Hospital continues to extend its global influence. In 2024, international patient care grew by 16%, underscoring its appeal as a global destination for specialized paediatric treatment. The hospital also welcomes clinicians from across the globe for training in innovative techniques such as 3D surgical planning, robotic-assisted procedures, and novel therapies. SJD Barcelona Children's Hospital is recognized internationally for its leadership in clinical trials and collaborative research, particularly in oncology and rare diseases.

Clinical Excellence and Outcomes

With more than 3,400 specialized professionals, SJD Barcelona Children's Hospital treats over 450,000 patients annually, including some of the most complex cases in paediatric medicine. The hospital boasts a 90% survival rate for focal brain tumours, an 85% cure rate for localized osteosarcomas, and notable outcomes in paediatric leukaemia, particularly acute lymphoblastic leukaemia. Its expertise spans paediatric surgery, foetal surgery, cardiology, neurology, rare diseases, orthopaedics, neurosurgery, and oncology, making it a reference centre not only in Spain but across Europe and beyond.

Looking Ahead

As SJD Barcelona Children's Hospital continues to set new standards in paediatric care, research, and innovation, its achievements in 2024 and 2025 serve as a beacon of hope for children and families worldwide. Through global recognition, pioneering therapies, and a steadfast commitment to holistic, family-centred care, SJD reaffirms its place at the forefront of international paediatric medicine – where healing, compassion, and discovery go hand in hand.

- For more information, visit: *www.sjdhospitalbarcelona.org/en*

SJD
Sant Joan de Déu
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World-class paediatric care in Barcelona for rare and complex diseases

Every year, over **400 children** and teenagers with cancer receive expert care.

Taiwanese biomed company revolutionises regenerative medicine with supercritical CO2 organ processing breakthrough

During a visit to the Medical Taiwan trade exhibition in June, *Middle East Health* spoke to Taiwanese biomedical company, Acro Biomedical. The company has achieved the seemingly impossible: transforming pig organs into human-compatible transplants that completely bypass immune rejection. Their groundbreaking supercritical carbon dioxide extraction technology strips away immunogenic components whilst preserving tissue architecture, creating universal donor organs from an unlimited animal source. With corneal transplants already approved in Taiwan and bone grafts showing remarkable success, this breakthrough could finally solve the global organ shortage crisis that claims thousands of lives annually.

Scientists in laboratories at Acro Biomedical, a Kaohsiung, Taiwan-based biomedical company, are rewriting the rules of organ transplantation. Their revolutionary supercritical carbon dioxide ($SCCO_2$) extraction technology has achieved what was once thought impossible: transforming pig organs into human-compatible transplants that bypass the body's immune rejection mechanisms entirely.

The breakthrough has already delivered tangible results. In March 2025, Taiwan's Ministry of Health and Welfare granted approval for the company's ABCcolla® Collagen Ophthalmic Matrix, marking the world's first commercially approved animal-to-human corneal transplant technology. This achievement represents a paradigm shift for the millions of patients awaiting this life-changing procedure.

Addressing humanity's organ crisis

The numbers paint a stark picture of medical need. Over 20 million people worldwide suffer from corneal blindness, yet only 100,000 corneal transplants are performed annually – leaving a devastating gap between supply and demand. The global corneal transplant market, valued at $500 million in 2024, is projected to double to $1 billion by 2033, driven by an ageing population and rising awareness of vision care.

Traditional transplantation relies on human donors, creating bottlenecks that result in preventable suffering and death. Acro Biomedical's innovation circumvents these limitations by tapping into an abundant alternative source: carefully processed porcine tissues that share remarkable structural similarities with human organs.

Revolutionary technology decoded

The company's proprietary $SCCO_2$ process operates under precisely controlled conditions – 350 bar pressure and temperatures of 35-45°C – where carbon dioxide achieves a unique supercritical state. In this phase, CO_2 exhibits both gas-like penetration and liquid-like density, enabling complete tissue infiltration whilst remaining entirely non-toxic and leaving no harmful residues.

"We simply remove all the immunogens from the tissue," explains Dr Dar-Jen Hsieh, Chairman and CEO of Acro Biomedical. "The collagen scaffold material remains for human application. Human and porcine tissues are 99% identical, so this material won't cause immune rejection. Your stem cells will recognise this collagen material as self-material."

Research published in *Acta Biomaterialia* [1] demonstrates the technology's extraordinary efficiency. DNA analysis reveals that the $SCCO_2$ process eliminates 99.1% of genetic material from porcine corneas – far exceeding the 50 ng/mg threshold considered safe for medical implants. Crucially, the process preserves complete collagen structures essential for tissue function whilst removing all cellular proteins that typically trigger immune responses.

Clinical validation transforms vision

The technology's most remarkable validation came through corneal transplantation studies. In controlled trials, animals suffering from induced corneal blindness recovered functional vision within 30 days of receiving $SCCO_2$-processed implants. A pet dog, completely blind from corneal damage, regained sight and maintained clear vision throughout extended observation periods.

The processed corneas demonstrate optical properties virtually identical to human tissue, with light transmittance measurements confirming preservation of visual clarity. Mechanical testing reveals sufficient strength to withstand traditional surgical procedures, including conventional suturing techniques familiar to ophthalmologists worldwide.

Following rigorous clinical trials, the ABCcolla Collagen Ophthalmic Matrix now offers hope to patients suffering from corneal melting, trauma, infections, and severe injuries. The technology serves as a viable alternative to human donor corneas, with significantly reduced rejection risks.

Expanding frontiers: bone regeneration breakthrough

Building on corneal success, Acro Biomedical has developed decellularised porcine bone grafts that address substantial global demand for bone substitute materials. Current procedures often require harvesting tissue from patients' own bodies – creating additional surgical sites and limiting available material quantities.

Research published in the *Journal of Tissue Engineering and Regenerative Medicine* [2] demonstrates that $SCCO_2$-processed bone

Dr. Dar-Jen Hsieh, Chairman and CEO of Acro Biomedical

Acro Biomedical's collagen ophthalmic matrix for cornea regeneration

grafts maintain complex porous architecture essential for new bone formation. Unlike high-temperature sintering processes that destroy natural collagen and distort structures, the $SCCO_2$ method preserves critical features for tissue regeneration.

In rabbit studies comparing performance to Bio-Oss – the current gold standard bovine bone substitute – histomorphometric analysis revealed equivalent bone regeneration outcomes. However, the $SCCO_2$-processed material offers distinct advantages: complete retention of natural collagen, preserved microarchitecture, and demonstrated freedom from viral contamination.

Comprehensive pathogen elimination

Beyond structural preservation, the $SCCO_2$ process delivers exceptional safety through comprehensive pathogen elimination. Viral inactivation studies demonstrate clearance exceeding 6 $\log_{10}$[22] reduction factors across multiple virus types, including DNA and RNA variants, enveloped and non-enveloped species.

This pathogen clearance capability addresses transplantation medicine's fundamental concern: preventing infectious agent transmission from donor to recipient. Traditional processing methods struggle to achieve such comprehensive sterilisation whilst maintaining tissue integrity.

Extensive biocompatibility testing according to ISO-10993 standards confirms the processed tissues' safety profile. In vitro cytotoxicity studies, genotoxicity assessments, and comprehensive animal studies all demonstrate non-toxic characteristics and excellent biocompatibility.

Strategic market positioning and expansion

With comprehensive patent protection covering 94 international patents and additional applications pending, Acro Biomedical holds a unique position in the regenerative medicine market. The company strategically focuses on high-value applications including corneal reconstruction, bone grafting, and emerging aesthetic treatments.

Taiwan's regulatory approval provides a foundation for international expansion, though each country maintains distinct pathways for xenograft materials. The company has adopted medical tourism as an interim strategy, establishing Taiwan as a destination for patients seeking corneal transplants whilst building clinical experience for broader market penetration.

"Our vision is to solve the global shortage of tissues and organs, ensuring that every patient in need of a corneal transplant receives timely treatment," says Dr Hsieh. "This approval is not just recognition of our technology but a beacon of hope for patients awaiting transplantation."

Pioneering organ regeneration frontiers

Beyond current applications, the company's research pipeline investigates processing kidneys, hearts, and various soft tissues. Early demonstrations show promise for complete organ regeneration, with kidney scaffolds regenerating functional structures within eight weeks and custom bone grafts shaped according to 3D scans enabling single-operation reconstructive procedures.

The technology's versatility extends to innovative applications, including hair regeneration treatments, for alopecia for example, where decellularized porcine follicles are ground into particles and implanted under the skin of the head. They stimulate natural hair growth within one month of injection. "When you inject those particles under the skin, your stem cells migrate to the area and differentiate into hair follicle cells. You grow hair within one month – a lot of hair," Dr Hsieh says.

Transforming transplantation medicine

Industry observers recognise that successful animal-to-human organ transplantation could fundamentally reshape medical practice. The virtually unlimited supply of porcine organs, combined with processing technology that eliminates rejection risks, addresses organ shortages responsible for thousands of preventable deaths annually.

The economic implications prove equally significant. With the global tissue engineering market exceeding billions annually and substantial growth projected as populations age, Acro Biomedical's technology positions itself at the forefront of a medical revolution.

The company's work demonstrates how innovative engineering approaches can solve fundamental biological problems. The $SCCO_2$ technology elegantly sidesteps immunological barriers that have historically limited xenotransplantation whilst preserving biological functionality essential for successful tissue regeneration.

This breakthrough offers compelling evidence that the future of transplantation medicine may depend not on finding more human donors, but on perfecting the transformation of animal organs into human-compatible alternatives – finally providing sustainable solutions to organ shortages that have challenged medicine for decades.

Reference:

1. Huang, Y. H., Tseng, F. W., Chang, W. H., Peng, I. C., Hsieh, D. J., Wu, S. W., & Yeh, M. L. (2017). Preparation of acellular scaffold for corneal tissue engineering by supercritical carbon dioxide extraction technology. *Acta Biomaterialia*, 58, 238-243. *https://doi.org/10.1016/j.actbio.2017.05.060*

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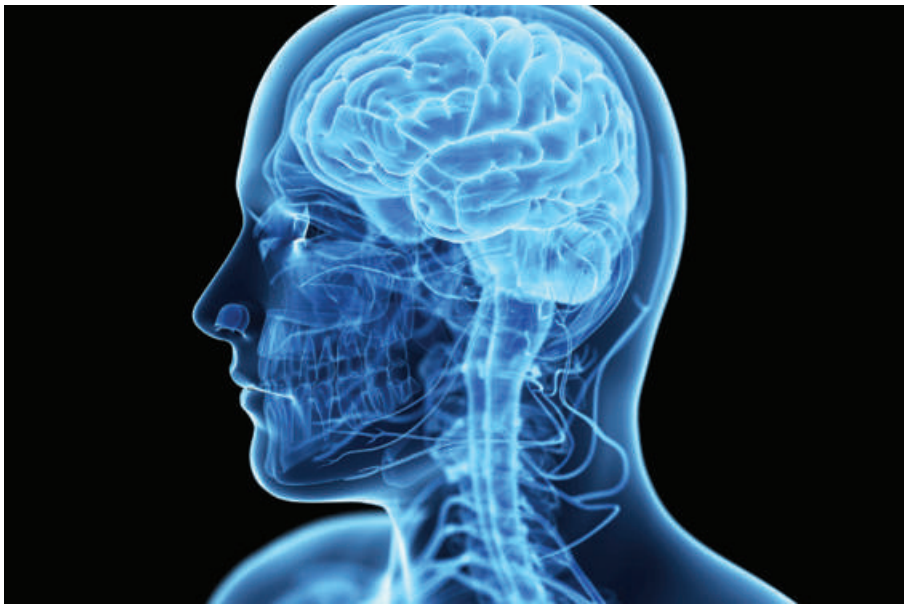
- Additional news stories from Medical Taiwan 2025 will be available online at *www.MiddleEastHealth.com*

Multimodal brain imaging breakthrough: Stacking technique dramatically improves cognitive ability predictions

Researchers have developed a revolutionary "stacking" approach that combines multiple MRI modalities to predict cognitive abilities with unprecedented accuracy. The technique achieves correlations of 0.5-0.6 when predicting current cognitive performance and remarkably predicts childhood intelligence from middle-aged brain scans.

A groundbreaking study published in *PNAS Nexus* on 24 June 2025 has demonstrated that combining multiple brain imaging modalities through machine learning "stacking" can dramatically improve the prediction of cognitive abilities whilst addressing critical challenges in brain-wide association studies (BWAS).

The research, led by Narun Pat and colleagues from the University of Otago and collaborating institutions, analysed brain imaging data from 2,131 participants aged 22 to 100 across three major datasets in the United States and New Zealand. Their innovative approach tackles three fundamental challenges that have long plagued neuroimaging research: predictability, test-retest reliability, and cross-cohort generalizability.



Revolutionary approach combines diverse brain imaging data

Traditional brain-wide association studies typically rely on a single MRI modality to predict cognitive abilities, often yielding modest results. The stacking technique represents a paradigm shift by integrating structural MRI measures (such as cortical thickness), resting-state functional connectivity, task-based functional connectivity, and task-evoked blood-oxygen-level-dependent (BOLD) contrasts into a unified prediction model.

"Scientists have had limited success in predicting cognitive abilities from brain MRI," the authors explain in their significance statement. "We proposed a machine learning method, called stacking, to draw information across different types of brain MRI."

The methodology works by first building separate prediction models for each MRI modality, then treating the predicted values from these individual models as features for a higher-level "stacked" prediction model. This hierarchical approach allows researchers to capture complementary information from different brain imaging techniques that might be missed when using any single modality in isolation.

Remarkable predictive accuracy achieved across datasets

The stacked models demonstrated exceptional predictive performance across all three datasets examined: the Human Connectome Project Young Adults (873 participants, aged 22-35), Human Connectome Project Aging (504 participants, aged 35-100), and the Dunedin Multidisciplinary Health and Development Study (754 participants, aged 45).

When predicting cognitive abilities at the time of scanning, stacked models achieved out-of-sample correlations of approximately 0.5-0.6, substantially higher than the 0.42 correlation reported in recent meta-analyses of single-modality approaches. The "Stacked: All" models, which incorporated all available MRI features, consistently outperformed individual modalities across different machine learning algorithms.

Perhaps most remarkably, the Dunedin Study's longitudinal design enabled a unique demonstration of the technique's power.

Using multimodal MRI data collected when participants were 45 years old, the stacked models successfully predicted cognitive abilities measured at ages 7, 9, and 11 years with a correlation of 0.52.

"Using brain imaging at age 45, the model predicted childhood cognitive scores (ages 7, 9, and 11) with a .52 Pearson's correlation – indicating a substantial degree of predictive accuracy," according to the authors.

Task-based imaging emerges as key driver

The analysis revealed that task-evoked BOLD contrasts were the primary drivers of the improved predictive performance. Specific tasks showed particularly strong associations with cognitive abilities: the working-memory task in younger adults and the facename task in older adults and middle-aged participants.

The authors note that "stacking, especially with fMRI task contrasts, allowed us to use MRI of people aged 45 years to predict their childhood cognitive abilities reasonably well." This finding challenges the traditional reliance on resting-state connectivity and structural measures in cognitive prediction studies.

However, not all task contrasts contributed equally. Some tasks, such as gambling paradigms, showed poor predictive performance, highlighting the importance of task selection in cognitive neuroimaging studies.

Reliability challenges addressed through ensemble approach

Test-retest reliability has been a persistent concern in neuroimaging research, particularly for task-based measures. Previous studies had identified poor reliability for task contrasts across different scanning sessions, raising questions about their utility as stable markers of individual differences.

The stacking approach substantially improved test-retest reliability, achieving excellent intraclass correlations (ICC > 0.75) even when using only task-based fMRI data. The "Stacked: All" models reached ICC values of 0.79 and 0.89 for the two datasets with repeat scanning sessions.

"For test-retest reliability, stacked models reached an excellent level of reliability across HCP Young Adults and Dunedin Study, even when we only included fMRI during tasks in the models," the authors report.

This improvement appears to result from the ensemble nature of stacking, where multiple sources of information compensate for the variability inherent in any single measure.

Cross-dataset generalizability demonstrates robustness

Perhaps most importantly for clinical translation, the stacked models showed significant cross-dataset generalizability. When models trained on one dataset were applied to completely independent datasets with different participants, scanners, and protocols, they maintained above-chance predictive performance.

The "Stacked: Non Task" models, which combined structural and resting-state measures, achieved a correlation of 0.25 when tested across datasets. Whilst lower than within-dataset performance, this level represents meaningful cross-sample applicability and suggests the models capture fundamental brain-cognition relationships rather than dataset-specific artefacts.

Generalizability was strongest between the two Human Connectome Project datasets, which shared similar protocols, compared to the independently conducted Dunedin Study. This pattern highlights both the promise and limitations of current approaches.

Clinical implications and future directions

The study establishes what the authors describe as "a valuable benchmark for how stacking can strengthen the use of brain MRI as a reliable and robust neural marker of cognitive function." This has significant implications for both research and clinical applications.

In their discussion, the authors emphasise the potential for understanding stable cognitive traits: "If the aim of BWAS is to capture the stable trait of cognitive abilities, the current approach of stacking multimodal MRI data from one time point seems appropriate."

The ability to predict childhood cognitive abilities from middle-aged brain scans is particularly intriguing, suggesting that neural signatures of cognitive capacity remain detectable decades later. This finding could inform our understanding of cognitive development and potentially identify early markers of cognitive decline.

However, the authors acknowledge important limitations. The inability to test task-based models across all datasets due to different protocols limits the generalizability assessment of the most predictive approaches. They recommend that researchers applying these models to new data "follow the procedures of the original datasets as much as possible."

Methodological innovation drives progress

The success of the stacking approach reflects broader trends in computational neuroscience towards ensemble methods and multimodal integration. By combining information across different scales and types of brain measurement, researchers can capture a more comprehensive picture of brain-behaviour relationships.

The authors conclude that "combining different modalities of MRI into one prediction model via stacking seems to be a viable approach to realize this dream of cognitive neuroscientists" of reliably associating cognitive abilities with brain variations.

This research represents a significant advance in brain-based prediction of cognitive abilities, offering a methodological framework that could transform how neuroscientists approach individual differences research. As the field moves towards more robust and generalisable findings, the stacking approach provides a promising pathway for developing clinically useful neural markers of cognitive function.

Reference:

Tetereva, A., Knodt, A. R., Melzer, T. R., et. al. (2025). Improving predictability, reliability, and generalizability of brain-wide associations for cognitive abilities via multimodal stacking. *PNAS Nexus*, 4(6), pgaf175.

https://doi.org/10.1093/pnasnexus/pgaf175

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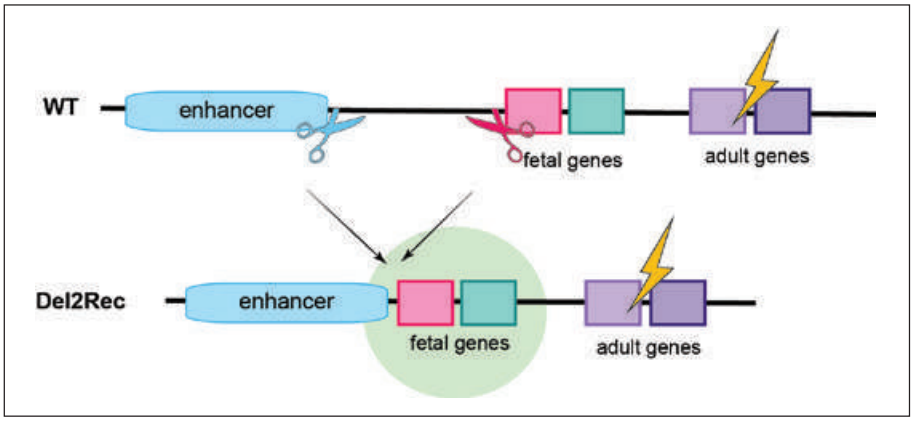
Scientists rewrite the rules of gene therapy by manipulating chromosome spacing

Researchers have developed a pioneering gene therapy strategy that physically repositions dormant genes on chromosomes to unlock their therapeutic potential. The "delete-to-recruit" technique uses precision DNA editing to eliminate spacer sequences, dramatically reactivating fetal globin genes that promises to provide new hope for patients with sickle cell disease and beta-thalassemia.

A groundbreaking study published in *Blood* on 19 June 2025 has unveiled an entirely new paradigm for gene therapy that challenges conventional approaches to treating genetic disorders. The research demonstrates how the physical spacing of genes on DNA strands plays a crucial role in their activation, opening unprecedented therapeutic possibilities for hereditary blood diseases.



Anna-Karina Felder. © Hubrecht Institute.

Schematic representation of delete-to-recruit technology in sickle cell disease and beta-thalassemia. The black lines represent the DNA. In the starting situation (above), the adult globin genes (purple) are broken and fetal globin genes (pink and green) are inactive. The enhancer (blue) lies at some distance from the fetal genes. Application of delete-to-recruit technology (below) brings the enhancer closer to the fetal genes, activating them. To achieve this, the intermediate piece of DNA was cut out with CRISPR-Cas9 (scissors).

Revolutionary distance-based gene activation

The innovative "delete-to-recruit" (Del2Rec) methodology represents a fundamental shift from traditional gene therapy approaches. Rather than adding new genetic material or directly modifying faulty genes, this technique exploits the natural architecture of chromosomes to reactivate beneficial but dormant genes.

"In this study, we discovered that it's possible to activate a gene by bringing it closer to an enhancer," explains Anna-Karina Felder, one of the study's first authors from the Hubrecht Institute. The research team, led by collaborators from the De Laat group, Erasmus MC, and Sanquin, used CRISPR-Cas9 technology as molecular scissors to precisely excise DNA segments between enhancers and their target genes.

The technique specifically targets the beta-globin gene cluster, where fetal globin genes (HBG) become naturally silenced after birth. In healthy development, adult globin genes take over haemoglobin production. However, in conditions like sickle cell disease and beta-thalassemia, these adult genes are defective, leading to severe anaemia and life-threatening complications.

Mechanism of therapeutic gene reactivation

The research reveals that genomic distance serves as a critical regulatory mechanism for developmental gene silencing. The team demonstrated that "linear recruitment of the normally distal strong HBB enhancer to developmentally silenced embryonic HBE or fetal HBG promoters, through deletion or inversion of intervening DNA sequences, results in their strongly reactivated expression in adult erythroid cells."

This discovery assigns new functional significance to previously considered "non-regulatory" DNA sequences. By maintaining physical separation between enhancers and genes, these genomic regions enable precise developmental control over gene expression programmes.

The Del2Rec strategy proved remarkably effective across multiple experimental models. In HUDEP-2 cells, a human adult erythroid cell line, the technique achieved 80-90% fetal haemoglobin production. Similar success was observed in patient-derived sickle cell disease cell lines and primary hematopoietic stem cells from healthy donors.

Therapeutic advantages over existing approaches

Current gene therapy for sickle cell disease

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Wouter de Laat was group leader at the Hubrecht Institute from 2008 to 2024. He is currently Head of Research at the Department of Genetics at UMC Utrecht, professor of Biomedical Genomics at the UMC Utrecht and Investigator at Oncode Institute.

Emile van den Akker is group leader at Sanquin Research. He is an investigator of the ZonMw PSIDER consortium TRACER (treating hereditary anemias through stem cell research).

Sjaak Philipsen is group leader at the Erasmus MC Department of Developmental Biology. He is coordinator of the ZonMw PSIDER consortium TRACER (treating hereditary anemias through stem cell research) and an investigator of the EU Pathfinder consortium EdiGenT (new prime editing and non-viral delivery strategies for gene therapy).

and beta-thalassemia, approved in Europe in 2024, modifies globin repressor genes to reactivate fetal globin expression. However, this approach carries significant limitations, including extreme cost that restricts accessibility and potential unknown consequences from affecting multiple genes.

Del2Rec offers several compelling advantages. The technique specifically targets the physical relationship between enhancers and genes without introducing foreign genetic elements. "Editing the distance to an enhancer, instead of the genes themselves could offer a versatile therapeutic approach," Felder concludes.

The research demonstrated that Del2Rec could circumvent both cost and safety concerns associated with current therapies. In sickle cell disease models, the technique markedly reduced cell sickling under hypoxic conditions, suggesting significant therapeutic potential.

Broader applications beyond globin disorders

The versatility of Del2Rec extends beyond beta-globin genes. The research team successfully applied the technique to the alpha-globin locus, reactivating the embryonic HBZ gene by recruiting the R2 enhancer. This broader applicability suggests the method could potentially address various genetic conditions where beneficial backup genes exist but remain developmentally silenced.

The study also revealed that both deletions and inversions of intervening DNA sequences could achieve gene reactivation, provided sufficiently strong enhancers were recruited to target gene promoters. This flexibility offers multiple strategic approaches for optimising therapeutic outcomes.

Technical precision and safety considerations

The Del2Rec methodology demonstrated remarkable precision in experimental applications. Digital droplet PCR analysis revealed that even when only 16% of chromosomal alleles carried the intended 25-kilobase deletion, substantial fetal globin reactivation occurred. Flow cytometry confirmed increased proportions of cells producing fetal haemoglobin, while high-performance liquid chromatography validated therapeutic protein levels.

Importantly, the technique preferentially activated the most proximal fetal globin gene (HBG2), suggesting efficient enhancer capture. Chromatin accessibility studies using ATAC-seq and histone modification analyses confirmed that Del2Rec induced genuine promoter reactivation rather than spurious transcriptional read-through.

Clinical translation potential

The research provides crucial groundwork for developing new therapeutic strategies. Testing in primary CD34+ hematopoietic stem and progenitor cells – the cells responsible for producing all blood cell types – demonstrated that Del2Rec could function in clinically relevant cell populations.

"While we're still in the early stages, this research lays important groundwork for the development of new gene therapies," Felder notes. The approach showed comparable efficacy to existing BCL11A-targeting strategies while potentially offering greater specificity and reduced off-target effects.

The flexibility of Del2Rec in target site selection provides opportunities to optimise editing efficiency while minimising undesired genomic rearrangements – a significant advantage over single-target approaches that lack such adaptability.

What the future holds

This work fundamentally expands our understanding of genome organisation and gene regulation. The authors propose that "by providing linear separation they may support genes to autonomously control their transcriptional response to distal enhancers," revealing new principles governing developmental gene expression.

Beyond immediate applications to hemoglobinopathies, Del2Rec could potentially address other genetic conditions where reactivating developmental backup genes might compensate for defective adult counterparts. The broader field of gene therapy could benefit from this alternative approach that manipulates enhancer-gene relationships rather than gene sequences themselves.

The research represents a paradigm shift toward understanding genome architecture as a therapeutic target, potentially revolutionising how we approach genetic disease treatment through spatial genomic manipulation rather than traditional gene addition or correction strategies. MEW

Reference:

Felder, A. K., Tjalsma, S. J. D., Verhagen, H. J. M. P., et. al. (2025). Reactivation of developmentally silenced globin genes through forced linear recruitment of remote enhancers. *Blood*, advance online publication. *https://doi.org/10.1182/blood.2024028128*

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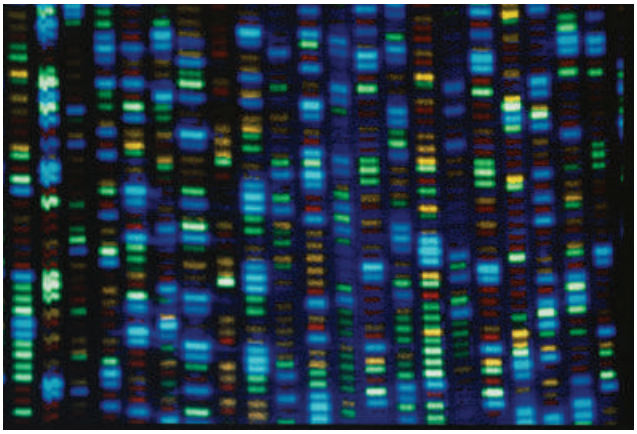

Courtesy: National Human Genome Research Institute

In the evolving landscape of modern medicine, gastroenterology is experiencing a quiet revolution. No longer confined to reactive diagnostics, it now stands at the forefront of proactive, precision-guided care. At the heart of this shift in the region is Medcare Royal Speciality Hospital's newly launched Advanced Endoscopy and Gastroenterology Centre, a facility built to set new standards in minimally invasive gastrointestinal care.

In a scientific undertaking rivalling the original Human Genome Project's ambition, UK researchers have launched the world's first comprehensive programme to synthesise complete human genetic material from scratch. The Synthetic Human Genome Project (SynHG) represents a quantum leap from reading and editing DNA to actually writing entirely new genetic code, potentially transforming biotechnology and medicine within the next decade.

Wellcome's £10 million investment over five years will establish the foundational infrastructure for large-scale genome synthesis, with researchers targeting proof-of-concept through constructing a complete synthetic human chromosome – approximately 2% of total human DNA – within the project timeline. This milestone would validate methodologies for eventually building entire synthetic genomes, opening unprecedented possibilities for treating genetic diseases and enhancing human health.

Revolutionary leap from editing to synthesis

The project, led by Professor Jason Chin from the Generative Biology Institute at Ellison Institute of Technology, Oxford, and the MRC Laboratory of Molecular Biology, brings together elite research teams from Cambridge, Kent, Manchester, Oxford, and Imperial College London. Unlike conventional genome editing technologies that modify existing DNA sequences, synthetic genomics enables researchers to construct entirely novel genetic material with precision-engineered functions.

"The ability to synthesize large genomes, including genomes for human cells, may transform our understanding of genome biology and profoundly alter the horizons of biotechnology and medicine," Professor Chin explained. "With SynHG we are building the tools to make large genome synthesis a reality, and at the same time we are pro-actively engaging in the social, ethical, economic and policy questions that may arise as the tools and technologies advance."

The technical advantages over traditional approaches are substantial. Synthetic genomics allows changes at greater scale and density with enhanced accuracy and efficiency, enabling researchers to determine causal relationships between genome organisation and biological function. This capability could revolutionise therapeutic development, creating targeted cellular therapies impossible through conventional methods.

Cutting-edge technologies drive unprecedented scale

Previous synthetic biology achievements have been limited to microbial organisms. Scientists successfully developed synthetic genomes for bacteria including E. coli, but today's technology cannot produce the large, complex genetic material found in crops, animals, and humans. The SynHG project specifically targets these limitations through innovative approaches combining generative AI, advanced robotics, and machine learning.

Professor Patrick Yizhi Cai from the University of Manchester highlighted the technological integration: "We are leveraging cutting-edge generative AI and advanced robotic assembly technologies to revolutionize synthetic mammalian chromosome engineering. Our innovative approach aims to develop transformative solutions for the pressing societal challenges of our time."

Dr Julian Sale from the MRC Laboratory of Molecular Biology emphasised the research potential: "The ability to synthesise large segments of human chromosomes – or even entire genomes – will enable us to test current theories about how genes and other genetic elements interact to govern genome function with unprecedented precision and scale."

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Medical breakthroughs within reach

The therapeutic implications span multiple medical domains, from genetic diseases to organ regeneration. Synthetic chromosomes could enable development of virus-resistant tissue transplants, designer cellular therapies for inherited disorders, and precision treatments targeting specific cancer mutations. The approach promises to create disease-resistant cellular populations suitable for repopulating damaged organs in liver, heart, and immune system applications.

Professor Tom Ellis from Imperial College London contextualised the advancement: "Synthesis of chromosomes for bacteria and yeast has given us a new understanding of DNA and unlocks new approaches to biotechnology. Taking this to the next scale with the much larger chromosomes of mammalian cells is a challenge that will drive innovation."

The project's focus on human rather than model organisms like mice accelerates translational potential. Michael Dunn, Director of Discovery Research at Wellcome, noted: "Our DNA determines who we are and how our bodies work and with recent technological advances, the SynHG project is at the forefront of one of the most exciting areas of scientific research."

Addressing fundamental biological mysteries

Despite decades of genome sequencing advances, significant knowledge gaps persist regarding genome function. Professor Robin Lovell-Badge from the Francis Crick Institute, commenting on the project's importance, highlighted these challenges: "Despite all the knowledge gained from sequencing human genomes, there is a lot we do not understand about how they work. The protein encoding parts are fairly straightforward, but these comprise only a small fraction of the total."

Critical genome components including telomeres, centromeres, and repetitive elements remain poorly understood. Many genetic segments may represent evolutionary relics with unclear functions, making traditional investigation approaches time-consuming and unrewarding. Synthetic genomics offers a revolutionary alternative approach.

"Being able to build and redesign segments or entire human chromosomes will be important – after all you can only truly understand something if you can build it from scratch," Professor Lovell-Badge explained. "And if you understand what is relevant and important, it may be possible to refine or improve aspects of its activity."

Comprehensive ethical framework embedded throughout

Recognising synthetic genomics' profound societal implications, the project integrates extensive ethical research from inception. The Care-full Synthesis programme, led by Professor Joy Zhang from the University of Kent's Centre for Global Science and Epistemic Justice, conducts empirical studies across Europe, Asia-Pacific, Africa, and the Americas to establish accountable scientific practices.

"With Care-full Synthesis, through empirical studies across Europe, Asia-Pacific, Africa, and the Americas, we aim to establish a new paradigm for accountable scientific and innovative practices in the global age – one that explores the full potential of synthesising technical possibilities and diverse socio-ethical perspectives with care," Professor Zhang said.

The programme employs an innovative 'ODESSI' approach – Open, Deliberative, Enabling, Sensible & Sensitive, and Innovative – to science-society dialogue. This framework ensures diverse community perspectives inform technological development whilst addressing regional variations in ethical priorities and regulatory requirements.

Sarah Norcross from the Progress Educational Trust emphasised the importance of public engagement: "The public must have a clear understanding of what this research entails, while researchers and funders must have a thoroughgoing understanding of where the public wants to go with this science."

Global applications beyond human health

Synthetic genomics applications extend far beyond medical therapeutics. The technology promises development of climate-resistant crop varieties capable of withstanding extreme weather conditions, addressing agricultural vulnerabilities exacerbated by climate change. Engineered microorganisms could produce pharmaceuticals and chemicals with minimal environmental impact, whilst synthetic bacteria might remediate pollution or convert waste into usable energy.

These applications demonstrate synthetic genomics' potential to address interconnected global challenges through integrated biological solutions. The project's comprehensive approach ensures that technological development considers environmental sustainability and global equity from the outset.

Timeline and future trajectory

The five-year project timeline focuses on establishing proof-of-concept rather than complete genome synthesis. Success in creating a synthetic human chromosome would validate core methodologies whilst providing platforms for more ambitious future endeavours. Even as engineering biology technologies improve, reliably building complete synthetic human genomes will likely require decades.

The project's ambitious scope reflects growing confidence in synthetic biology's potential. Professor Lovell-Badge expressed enthusiasm for the comprehensive approach: "I am therefore very enthusiastic about the project being launched by Wellcome, but not just about the scientific possibilities. It is critical when developing new technology to understand not just issues of potential utility, but also those concerned with safety and risk."

As synthetic genomics transitions from experimental concepts toward practical applications, the SynHG project's integration of technical innovation with ethical frameworks may establish new paradigms for developing transformative biotechnologies. The success of this groundbreaking initiative could influence synthetic biology's trajectory for decades, potentially delivering revolutionary advances in human health whilst maintaining public trust and social responsibility.

The project represents not merely a technical achievement but a new model for conducting transformative science – one that balances unprecedented innovation with comprehensive ethical consideration, ensuring that the power to write life's code serves humanity's broadest interests.

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