Vol 34 ISSUE 2/25 • June 2025 **EUROPEAN HOSPITAL**

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Precision approach through the eye socket

Orbital gateway to surgical removal of brain tumours

Using a keyhole surgery approach, surgeons have found a new way to access previously difficult-to-reach brain regions with faster recovery times. With the help of 3D modelling technology, the neurosurgeons succeeded in removing complex tumours from the cavernous sinus through the eye socket, avoiding complex brain surgery and enabling their patients to make a quicker recovery.

'The primary advantage is that it provides direct access to the cavernous sinus, which was once thought to be an inaccessible area,' explains Consultant Neurosurgeon Asim Sheikh from Leeds Teaching Hospitals Trust in the UK, one of the European centres performing this procedure. 'This allows safer removal of tumours without the risk of injuring or retracting brain tissue, which would otherwise be required with traditional craniotomy.'

The procedure begins with a small 1–1.5 cm incision at the outer edge of the eye, followed by an internal incision within the eye lining to access the bones. Surgeons then carefully cut a small segment of bone in the outer wall of the eye socket, keeping it attached to tissues and muscles while pushing it outward to create space for surgical instruments. The final step involves drilling the back wall of the eye socket to gain access to the tumour.

This minimally invasive approach leaves patients with only a tiny scar Previously, an operation to remove



recovery, early mobilization, faster discharge home, reduced risk of brain injury, and superior access to deep-seated tumours. As this technique continues to develop, it represents a significant advancement in the treatment of complex brain tumours, offering hope to patients who previously had limited options, the team summarizes.

Article Mark Nicholls

Using 3D models of their patient's anatomy, the surgeons prepare the optimal access to the brain tumour.

practice sessions in the cadaver allows direct access without any lab.

Lisa Ferrie, the Trust's Biomedical Engineer and 3D Planning Service Lead, notes that the 3D technology enables the surgical team to study patient anatomy and prepare for the procedure 'with unparalleled accuracy,' significantly enhancing surgical precision.

compromise of pressure on the brain. We can now reach areas which were once thought to be inoperable, but now are accessible.'

Initially established for trauma patients, the technique was adapted for brain tumour surgery by teams in South Korea and Barcelona, Spain – where Mr. Sheikh trained before introducing it to Leeds in 2023. Neurosurgeons in New York further developed the approach, which is now being taught to specialists in Oxford, Bristol, Edinburgh, and Liverpool.

this approach offers the ability to remove tumours that were previously thought difficult to remove, or even inoperable.

Substantial benefits for patients

Depending on tumour size and consistency, the procedure takes 4-10 hours under general anaesthesia. While there is a risk to affect the patient's eyesight, Mr. Sheikh explains their technique minimizes this concern: 'In our technique, we create room by removing a portion of the outer wall of eye socket and that minimises this risk. We have not had any visual complications so far.'



Sheikh

Mr Asim Sheikh

Mr Asim Sheikh is Consultant Neurosurgeon with subspecialist expertise in skull base and neurovascular surgery at the Leeds General Infirmary. His specialist interests include endoscopic endonasal skull base surgery, open skull base neurosurgery, minimal access surgery and brain tumour surgery. He is a member of the Royal College of Surgeons of England, the Society of British Neurological Surgeons and the British Neurovascular group.

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near the eye, reducing recovery such a tumour would require comtime drastically. The first UK pa- plex brain surgery involving crantient – a 40-year-old stroke nurse with a meningioma in the cavernous sinus – returned to work swiftly, within just three months of her surgery.

3D technology for optimal preparation

Given the procedure's complexity, surgeons at Leeds utilized advanced 3D modelling technology to rehearse the operation before entering the OR, building a 1:1 scale model to plan the surgery. Mr. Sheikh, who works alongside Consultant Maxillofacial Surgeon Jiten Parmer, added that preparation involves neuro-navigation software with 3D segmentation of all structures to virtually perform the surgery, complemented by iotomy and taking a large part of the skull away - risking complications that could include brain injury and seizures, Sheikh said. 'It's a hard-to-reach area,' he continued, 'but this new approach

The Leeds team has successfully performed six such operations for tumours. Mr. Sheikh explained that

The benefits to patients have been reported to be substantial: quicker

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HEALTH IT



A segment of bone is cut and pushed outward to make space, followed by drilling the back wall to access a tumor.

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'The future of breast MRI is bright'

Breast MRI has emerged as a powerful diagnostic tool, particularly for women with dense breast tissue where traditional mammography faces limitations. In her presentation at ECR 2025, radiographer Hanna Kalliomäki highlighted several technological advances transforming breast cancer detection and diagnosis. From time-saving abbreviated protocols and AI-assisted analysis to contrast-free diffusion techniques and molecular imaging, these techniques are reshaping how radiographers approach breast cancer screening and diagnosis.

The expert from the Päijät-Häme Wellbeing County in Lahti, Finland, explained that breast MRI offers exceptional sensitivity for screening high-risk women and evaluating tumour extent, treatment response, and implant integrity.¹ While mammography remains an effective screening tool, its sensitivity decreases significantly in dense breast tissue, due to the masking effect of fibroglandular tissue. 'Since almost half of the screening population has dense breasts, many of these patients require additional MRI breast imaging,' she pointed out.

AB-MRI: a game changer in patient throughput and comfort

One of the most significant developments is Abbreviated Breast MRI (AB-MRI), which reduces scan times from 30-60 minutes to just ten minutes without compromising diagnostic accuracy.2 'This allows MRI to be used as a screening tool for a broader population, not just those at high risk for breast cancer,' Kalliomäki said, adding that 'AB-MRI is a game changer in terms of patient throughput and comfort. Shorter scan times reduce patient anxiety, minimize motion artifacts, and allow imaging more patients without compromising diagnostic accuracy.'

For radiographers, mastering AB-MRI protocols and optimizing scan parameters for both speed and accuracy represents an important skill development opportunity. benefits to patients who may be



True-negative (a) and true-positive cases (b, c) diagnosed by an AI system (left, original image; right, image diagnosed by AI system). The AI system did not respond to normal breasts (a). The AI system correctly detected and diagnosed invasive ductal carcinoma (IDC) of the right breast (b) and invasive ductal carcinoma of bilateral breasts (c).

C

AI-augmented workflows

Kalliomäki further explored the benefits of artificial intelligence (AI) in image data analysis and lesion classification.^{3,4} Able to detect subtle abnormalities that might be missed by a human observer, these systems help reduce both false positives - which lead to unnecessary biopsies and patient 'You'll also need to explain the anxiety - and false negatives missed cancers.

radiographers but will augment your work'. Radiographers will continue to play vital roles in patient positioning and ensuring high-quality scans – prerequisites for effective AI analysis. Still, understanding how AI tools integrate with imaging workflows will be essential for radiographers moving forward, she stressed.

⁵ Baltzer P. Mann RM. Iima M et al.: Dif-

fusion-weighted imaging of the breast-a

consensus and mission statement from the

EUSOBI International Breast Diffusion-

Weighted Imaging working group; European

https://doi.

2020;

Radiology

019-06510-3

org/10.1007/s00330-

Contrast-free imaging and personalized profiles

Diffusion-Weighted Imaging (DWI). Kalliomäki explained how DWI is able to distinguish between benign and malignant tissues without contrast agents by highlighting areas of abnormal water molecule movement. 'This technique enhances the safety of breast MRI for a wider range of patients, especially for patients with contrast allergies or kidney complications,' she said. Since DWI is sensitive to motion, proper patient positioning becomes even more critical. Radiographers must understand DWI settings and how to adjust them for different patients to obtain high-quality diagnostic images.5

Another increasingly common approach in breast imaging is molecular MRI, which uses targeted contrast agents that bind to specific cancer cells or biomarkers like HER2 receptors. 'This approach visualizes tumour characteristics at the molecular level, offering a personalized approach to imaging,' Kalliomäki pointed out. 'This enhances detection and diagnosis, tailors imaging to patients' profiles, and support targeted therapies like those for HER2-positive breast cancer, potentially improving survival rates and reducing overtreatment.'

The expert advised her colleagues to familiarize themselves with these new agents, as radiographers will need to develop expertise in their safe administration and optimal use within imaging protocols. 'This means you will be part of a team that tailors imaging to each patient's cancer type. Accurate timing and precise contrast administration will be key as these agents are designed to highlight specific tumour characteristics.'

Kalliomäki also highlighted two promising new techniques; breast MRI spectroscopy and synthetic correlated diffusion imaging (CDI). While the former analyses the chemical composition of breast tissue for specific metabolites elevated in tumours⁶, the latter synthesizes multiple DWI images from raw data.7 'By offering biochemical insights beyond structural imaging,

'Imaging is teamwork'

'The future of breast MRI is bright,' Kalliomäki concluded, pointing out the AI-driven precision diagnostics poised to revitalize the field. The advent of non-contrast imaging techniques and whole breast MRI screening for dense breasts was also welcomed by the expert, who only expressed some concern over implementation challenges due to limited MRI availability.

Kalliomäki concluded her presentation with an important reminder: 'The new innovations are poised to reshape how we screen for and diagnose breast cancer.8,9 Radiographers are integral for the successful implementation of these advances in breast MRI technologies. The expertise of radiographers and radiologists together ensures imaging protocols are optimized, leading to improved diagnostic accuracy and enhancing patient care. Imaging is teamwork.'

Article: Wolfgang Bebrends



Hanna Kalliomäki

Hanna Kalliomäki is a radiographer at Päijät-Häme Wellbeing County in Lahti, Finland

apprehensive about MRI due to the traditionally long durations,' Kalliomäki pointed out.

Despite this, the expert reassured new imaging techniques, such as her audience that 'AI won't replace

spectroscopy adds another dimen-Advances also include promising sion to comprehensive breast assessment,' she said.

1 Mann RM, Balleyguier C, Baltzer PA et al.: Breast MRI: EUSOBI recommendations for women's information; European Radiology https://doi.org/10.1007/s003 2015: 30-015-3807-z

² Sardanelli F, Magni V, Rossini G, Kilburn-Toppin F, Healy NA, Gilbert FJ: The paradox of MRI for breast cancer screening: high-risk and dense breasts-available evidence and current practice; Insights into Imaging 2024; https://doi.org/10.1186/s13244-02 4-01653-4

³ Adachi M, Fujioka T, Mori M et al.: Detection and Diagnosis of Breast Cancer Using Artificial Intelligence Based assessment of Maximum Intensity Projection Dynamic Contrast-Enhanced Magnetic Resonance Im-Diagnostics 2020; https://doi. ages; org/10.3390/dianostics1 0050330

⁴ Chen Y, Shao X, Shi K, Rominger A, Caobelli F: AI in Breast Cancer Imaging: An Update and Future Trends; Seminars in Nuclear Medicine 2025; https://doi.org/10.1053/ j.semnuclmed.2025.01.008

⁶ Bitencourt A, Sevilimedu V, Morris EA, Pinker K, Thakur SB: Fat Composition Measured by Proton Spectroscopy: A Breast Cancer Tumor Marker?; Diagnostics 2021; https://doi.org/10.3390/diagnostics11030564 7 Tai CA, Gunraj H, Hodzic N et al.: Enhancing Clinical Support for Breast Cancer with Deep Learning Models Using Synthetic Correlated Diffusion Imaging. In: Wu S, Shabestari B, Xing L (eds): Applications of Medical Artificial Intelligence; Applications of Medical Artificial Intelligence; https://doi. org/10.1007/978-3-03 1-47076-9_9

'It only takes one radiologist to stop child abuse'

Covid-19 has intensified domestic violence rates worldwide, with children among the most vulnerable victims. At the ECR 2025 radiology congress in Vienna, Prof Dr Rick R. Van Rijn presented insights into how radiologists can identify injuries suspicious for non-accidental trauma (NAT) in children through systematic imaging approaches. From comprehensive skeletal surveys to specific neurological imaging protocols, the expert explained how these techniques are essential for early diagnosis, enabling timely and potentially life-saving intervention.

The WHO reports that six out of ten children under age five - approximately 400 million worldwide - regularly experience violence from parents or caregivers. Data from the Netherlands show that one in 30 children suffer from a form of abuse, of them a quarter are reported to be the victim of physical abuse. Van Rijn, a paediatric forensic radiologist at the Amsterdam University Medical Center (UMC) and Netherlands Forensic Institute, highlighted that child abuse, particularly abusive head trauma, is a major contributor to fatalities, disabilities, and developmental challenges in infants.¹ However, he pointed out that many hospitals still do not have consistent procedures in place for addressing suspected cases.

Europe's guideline, "The Radiological Investigation of Suspected Physical Abuse in Children," establishes a standard for best practices. However, it sets demanding criteria, such as requiring double reading or forensically trained radiographers – a standard that remains hard to obtain in many countries. 'What any radiologist can do, regardless of specialization, is ensure radiographs are of sufficient quality for expert review,' Van Rijn advised.

Recognizing red flags

First of all, it is important to recog-



The 35 radiographs recommended by "The Radiological Investigation of Suspected Physical Abuse in Children".

lum, Angle of the jaw, Cheeks, Eyelids or Subconjunctivae, "4" represents infants four months and younger with any bruise, anywhere, and "p" means the presence of patterned bruising. 'Any of these signs should immediately raise concerns,' Van Rijn stated. He recounted a tragic case where medical professionals dismissed unexplained bruising in an infant who later died from abuse, underscoring the life-or-death importance of vigilance.

Inconsistencies in reported history or trauma mechanism provide another crucial warning sign. 'When parents claim a 4-month-old walked and fell, that's immediately suspicious since children typically begin walking around eleven months,' he explained.

Comprehensive imaging: the critical first step

A proper skeletal survey requires 35 radiographs of the child – a standard that cannot be compromised. 'If you miss minor fractures, you risk missing child abuse,' Van Rijn warned. This thoroughness is justified by statistics: one-third of children under the age of 2 years examined for a reported fracture have additional unreported fractures, and 40% of abusive head The follow-up skeletal survey, conducted after two weeks, requires fewer images but remains, even if the first skeletal survey is negative, essential. At the follow-up, radiographs should include the chest in three directions, upper and lower arms, upper and lower legs, and spot radiographs of areas with initial concerns or identified metaphyseal fractures.

Van Rijn illustrated the importance of this with a case of a 7-week-old with whooping cough whose follow-up radiographs revealed healing posterior rib fractures only visible after callus formation had begun – a clear indicator of previous trauma that would have otherwise gone undetected.

"This meticulous approach to follow-up imaging ensures that no signs of healing trauma are missed, providing critical evidence for identifying abuse. However, imaging should not stop at skeletal surveys – neurological imaging plays an equally vital role in unpattern of recurrent trauma in these cases.'

Neurological imaging is essential in two key scenarios: when a child presents with neurological symptoms, and even when no neurological symptoms are apparent but physical abuse is suspected in an infant. Van Rijn underscored the importance of imaging in the latter scenario by recounting a chilling example from a French study. 'In some cases, caregivers admitted to shaking their child to make them stop crying. It worked – until one day, the child didn't wake up anymore. It died,' he explained.

Van Rijn emphasized the importance of neurological imaging for forensic purposes. This evidence provides an entry point to engage with parents and offer support. 'No one wakes up and says, "I will kill my child." We know that there are certain risk factors associated with an increased risk of child abuse, understanding and identifying these factors should lead to adternational consensus statement published in JAMA Pediatrics⁴, all contact children, i.e. siblings or other children in the same household, should be screened based on age-specific protocols:

If no findings indicative of abuse are observed at physical examination or based on clinical history, the child is screened as a contact child using age-based protocols:

- Under 1 year: Perform a brain MRI (adding spine MRI if brain findings are abnormal) and a full skeletal survey.
- • Ages 1–2 years: Perform a full skeletal survey.
- Ages 2–5 years: No radiological screening is required unless physical findings suggest abuse.

If findings indicative of abuse are present, the child is investigated as per (inter)national guidelines for an index case.

A call to action

'It only takes one radiologist to stop child abuse,' Van Rijn concluded, noting that an international consensus guideline for imaging in suspected child physical abuse (IGISPA) is in development. His message was clear: radiologists armed with proper protocols and vigilance can make life-changing – and potentially life-saving – differences for vulnerable children.

Author: Tim Hofmann



Rick R. van Rijn is a professor of forensic radiology at Emma Children's Hospital – Amsterdam UMC, specializing in paediatric and forensic imaging. A leader in his field, he has published over 250 articles, chaired major radiology societies, and was named an honorary fellow of the Royal College of Radiologists in 2025.

nise possible signs of abuse. The "TEN-4-FACESp" rule provides radiologists with a systematic approach to identifying suspicious bruising in children under the age of 4 years.

TEN-4-FACESp² stands for bruising to the Torso, Ears, Neck, Frenu-

trauma cases reveal additional fractures elsewhere in the body.³

covering hidden patterns of abuse.'

Advanced neurological imaging: beyond the obvious

Neurological imaging extends beyond cases with clear symptoms of abuse. 'This isn't just for clinical findings but for forensic purposes,' Van Rijn clarified. 'There's a strong equate interventions helping both the child as well as the parents/ caregivers.

Protecting the siblings: extending the safety net

When abuse is identified, the investigation shouldn't stop with the index patient. According to the in-

¹ Felitti VJ, Anda RF, Nordenberg D et al.: Relationship of childbood abuse and bousebold dysfunction to many of the leading causes of death in adults. The Adverse Childbood Experiences (ACE) Study; American Journal of Preventive Medicine 1998; HTTPS://DOI. ORG/10.1016/S0749–3797(98)00017–8 ² Pierce MC, Kaczor K, Lorenz DJ et al.: Validation of a Clinical Decision Rule to Predict Abuse in Young Children Based on Bruising Characteristics; JAMA Network Open 2021; HTTPS://DOI.ORG/

10.1001/JAMANETWORKOPEN.2021.5832

³ Loos MLHJ, Abmed T, Bakx R, van Rijn RR: Prevalence and distribution of occult fractures on skeletal surveys in children with suspected non-accidental trauma imaged or reviewed in a tertiary Dutch bospital; Pediatric Surgery International 2020;36:1009–1017; HTTPS://DOI. ORG/10.1007/S00383–020–04706-Z ⁴Mankad K, Sidpra J, Mirsky DM et al.: International consensus statement on the radiological screening of contact children in the context of suspected child physical abuse; JAMA Pediatrics 2023;177:526–533; HTTPS://DOI.ORG/10.1001/JAMAPEDI ATRICS.2022.6184 Launch of new national programme

A new "impulse" for equitable lung cancer screening in France

Lung cancer accounts for nearly one-fifth of all cancer deaths in the EU, yet unlike breast, colorectal, and cervical cancers, no organized screening programme exists to detect the disease before symptoms appear. This September, France will attempt to change that with an ambitious pilot programme that could reshape European lung cancer detection. Professor Marie-Pierre Revel presented the details at the French Thoracic Imaging Society Spring Days in Marseille, conveying the urgent need for this measure and its immense preventive potential.

Detect early, treat only when necessary, and protect the vulnerable from unnecessary stress or harm: This is the essence of IM-PULSION (Implementation of pulmonary cancer screening by scanner in the population), France's pioneering pilot programme for population-based lung cancer screening, the Head of the Imaging Department at Cochin Hospital in Paris outlined.

A structured approach to early detection

The programme will include 20,000 participants aged 50-74, all with a significant smoking history - defined as at least one pack per day for 20 years, either current smokers or those who quit less than two decades ago. The participants will undergo three CT scans over four years: baseline, one-year follow-up, and a final scan after two more years if previous results are normal.





Marseille, where the French Thoracic Imaging Society Spring Days took place.

The new programme builds on the CASCADE study from 2022. addressing key challenges identified. 'We learned from CASCADE that not every nodule is cancer,' Revel said. 'And not every positive scan requires a biopsy or surgery.' The design prioritizes minimizing overdiagnosis, patient anxiety, and unnecessary interventions while maintaining effective early detection.

Expanding training, exploring AI potential

One of Impulsion's most notable innovations lies in its radiologist training model. Drawing from the certification programme of the previous study, endorsed by the European Society of Radiology (ESR), the team has developed a rigorous national training pathway for general radiologists - those outside thoracic specialties - who will read the scans.

Artificial intelligence (AI) will also play a central role in the screening process, Revel explained. The first 2,500 cases will undergo double reading by both

radiologists and AI. 'The idea is that AI could become the second reader,' she explained. 'If the first radiologist and AI agree, a second human reader may no longer be necessary.'

This "belt and braces" approach aims to help standardize detection while addressing resource limitations in a field where highly trained thoracic radiologists remain scarce.

Reaching beyond the usual suspects

To recruit participants, the programme will access occupational health networks at major French employers like Stellantis, Danone and SNCF. This strategy puts a

greater emphasis on target populations which are traditionally underrepresented in screening efforts. 'These physicians are trained, motivated, and connected to people who may never set foot in a pneumologist's office,' Revel noted. 'This is true public health outreach, and it costs nothing.'

Beyond its initial focus on lung cancer, the programme will identify coronary artery calcifications visible on low-dose CT scans, potentially preventing life-threatening cardiovascular events. Participants will also receive smoking cessation counselling, expanding the programme's preventive impact. 'We won't just save lives by finding cancer,' the expert said. 'We will also prevent heart attacks and help people quit smoking.'

'We can - and must - do better'

With its €10 million funding from the French National Cancer Institute (INCa), supported by social security and regional health authorities, the IMPULSION programme will initially include only five regions in 2025, with a national rollout envisioned for 2026.

Revel's team is exploring the potential of ultra-low dose scanning technology, testing whether radiation exposure equivalent to a chest X-ray can still yield actionable diagnostic data without compromising AI performance. 'The scanner is still an irradiating tool, but we can - and must - do better,' she emphasized.

For Revel, who lost her cousin to lung cancer, the new programme is also a very personal matter. She herself underwent screening and is constantly looking for new ways to reach wider audiences. 'Science matters,' she said. 'But if you want to change society, it's stories - not statistics - that move people.'

As Europe is redoubling its efforts for lung cancer screening, IMPUL-SION could become a model for implementing precision medicine while increasing health equity. And in the words of its creator, it is not just about saving lungs, but about saving lives.

Author: Mélisande Rouger



Marie-Pierre Revel

Marie-Pierre Revel is a professor of radiology at Université de Paris and Head of the Imaging Department at Cochin Hospital in Paris, France. She is a past president of the European Society of Thoracic Imaging (ESTI) and the deputy Vice-President of the European Society of Radiology.

Low-dose chest CT may detect more than just lung cancer

Pan-European lung cancer screening is challenged due to



In a study of 1486 patients ing causes of death: lung cancer screened for lung cancer between and coronary artery disease," the

the range of approaches in different countries. As attitudes towards smoking and smoking cessation programmes vary, experts are attempting to establish more unified lung cancer screening. The introduction of consistent pan-European lung cancer screening will be outlined at a special session during the online ECR 2021, with presentations highlighting the current position in several countries.

As new research in CMAJ (Canadian Medical Association Journal) shows, these CTs can identify coronary artery calcium, a strong risk factor for coronary artery disease (CAD), in patients without cardiac symptoms. "Lung cancer screening, although primarily geared towards reducing deaths from lung

Coronary artery calcification on low-dose chest CT.. Transaxial image of a lung cancer screening CT scan, showing coronary artery calcium in all 3 coronary arteries. LAD = left anterior descending artery, LCX = left circumflex artery, RCA = right coronary artery.

cancer, also has an opportunity to stratification of coronary atheroshelp tackle the second most common cause of premature death in middle-aged adults, through identification and risk the

clerosis," writes Dr. Gary Small, University of Ottawa Heart Institute.

March 2017 and November 2018 as part of the Ontario Health Lung Cancer Screening Pilot for People at High Risk, coronary artery calcium was detected in 83% (1232) of patients, with high levels in 30% (439). More than half of patients (52%) were male, mean age was 66 years, and 68% (1017) were current smokers.

As lung cancer is the leading cause of cancer deaths in Canada, screening programs across the country have introduced low-dose CT for people at risk of lung cancer. These CTs can also easily identify coronary calcification, a marker of coronary artery disease, the most common cause of cardiac death. "If appropriate therapeutic responses are instituted, lung CT findings could affect survival from two leadauthors write.

The success of this pilot program will be affected by how clinicians interpret and manage findings of coronary artery calcium. However, clinicians must be aware that there could be harms such as inappropriate investigation after coincidental detection.

The authors urge more research into how to manage patients with coincidentally detected coronary artery calcium but suggest "continued attention to cardiovascular disease prevention is warranted and could be amalgamated into lung cancer screening initiatives to promote health."

Source: Canadian Medical Association Journal

Implementation challenges of blood biomarkers for Alzheimer's disease

Blood-based biomarker (BBB) tests may represent the best weapon to combat the soaring rates of Alzheimer's disease (AD) throughout the world. Existing clinically validated tests are currently deployed to facilitate diagnosis, to monitor disease and effectiveness of treatments, to quantify progression, and to determine if a patient is appropriate for treatment or participation in a clinical trial.

Historically, diagnosis of AD has been based on clinical observations and apparent symptoms, and, for those with access and the funds to pay, lumbar spinal puncture for a cerebrospinal fluid (CSF) test or for a PET imaging scan.

With the proliferation of BBB tests in clinical development, and with increasing levels of accuracy attained, they are expected to become a global tool to fight this most common of dementias. However, there are many challenges to be overcome yet, both with the tests themselves and with their clinical implementation.

Test equipment challenges

The most accurate tests today use mass spectroscopy, which outperform immune-based methods of measuring plasma in accuracy and reliability. Korean researchers from Hanyang University College of Medicine in Seoul conducted an indepth review of current methodologies used in published research to measure Amyloid-beta (Aß) plasma. They discovered 'considerable

1. Kwon HS, Yu H-J, Koh S-H. Revolutionizing Alzheimer's Diagnosis and Management: The Dawn of Biomarker-Based Precision Medi-Neurocogn Dement Disord. 2024;23(4):188-201. doi.org/ 10.12779/dnd.2024.23.4.188.

variance in the diagnostic efficacy of plasma $A\beta$, contingent upon the measurement techniques employed. Ionization-mass spectroscopy exhibited superior performance, while single molecule array (SIMOA) technology did not yield comparable results,' wrote lead author Hyuk Sung Kwon,1

Mass spectrometry-based assays require specific expertise and infrastructure, are time consuming, and yield lower throughput with immunoassays. The equipment is expensive and not available in many hospital and clinic laboratories.²

However, immune-based methods are currently used for CSF analysis. In addition to immunoassays producing less accurate results of BBB tests they are also subject to batchto-batch variation, antibody reproducibility, and potential crossreactivity. They offer automated processing, lower cost, and can deliver rapid turnaround time for point-of-care testing capability. And equipment is in the lab. These factors make a strong case for the development of BBB tests specifically designed for immunoassays.

Standardisation challenges

Another challenge relates to collecting viable samples for processing in remote or low-economy geographic areas with inadequate laboratory infrastructure. Expansion of testing capability of more robust samples, such as dried blood spot, could help resolve such issues.

2. Schöll M, Verberk IMW, del Campo M, et al. Biomarkers of Neurodegeneration 2: Challenges in the practical implementation of blood biomarkers for Alzheimer's disease. Lancet Healthy Longev. 2024:S:100630. doi. org/10.1016/j.lanhl.2024.07.013.

When multiple tests are available from multiple vendors, the cost of blood biomarker analysis is expected to drop. While this is expected to make BBB testing more accessible throughout the world, standardisation for blood biomarker measurements is imperative. Reproducible, accurate, and consistent results are essential. The Global Biomarker Standardization Consortium of the Alzheimer's Association has been overseeing this critical issue as well as the development of certified reference material.

Both tasks are enormous in scope and scale, but essential for widespread global adoption.

Prof. Michel Schöll, Ph.D., of the University of Gothenburg and the Wallenberg Centre for Molecular and Translational Medicine, and colleagues, write: 'Standardisation challenges will vary greatly depending on the blood biomarker and analytic approaches used for its measurement.' They add, 'True standardisation will require the derival and validation of cutoffs that are translatable between methodological approaches for respective blood biomarkers.'

Standardisation reference values are made more complex by the fact that the requirements for the diagnostic performance of a biomarker are determined by the BBB test's context of use. As an example, a test to "rule in" AD needs a higher specificity cut point to minimise false positives, whereas a "rule out"

3. Hampel H, Hu Y, Cummings J, et al. Bloodbased biomarkers for Alzheimer's disease: Current state and future use in a transformed global healthcare landscape. Neuron. 2023;111(18):2781–2799. doi: 10.1016/j.neuron.2023.05.017.

test needs a high sensitivity cut point, to minimize false negatives.³

Challenges of population ethnic diversity, medical comorbidities, and confounding factors

Most BBB tests have been tested and validated in clinical trials with patient cohorts of non-Hispanic Caucasian people, who have few health-related comorbidities, and who live in developed economies in countries north of the Equator. Research is starting to reveal that co-morbidities, such as chronic kidney disease, hypertension, history of cancer and/or cardiac arrest, diabetes, and some prescription drugs, can each impact biomarker concentrations in the blood.

Alzheimer's BBB research of the diverse ethnic, genetic, cultural and demographic factors, and socioeconomic different populations of Africa, South Asia, Central America and South America has just begun, and is sparse compared to research in Europe, North America, China, Korea and Japan. Yet, approximately 60% of people living with dementia are estimated to be from low-income and middleincome countries in these underresearched areas.4

This is a massive and complex challenge. 'The unavailability of reliable reference intervals for highly diverse populations could lead to the misinterpretation of laboratory test results and contribute to misdiagnosis and inappropriate clinical intervention in a diverse real-

4. McGlinchey E, Duran-Aniotz C, Akinyemi R, et al. Biomarkers of Neurodegeneration 5: Biomarkers of neurodegeneration across the Global South. Lancet Healthy Longev. 2024 Oct;5(10):100616. doi: 10.1016/S2666-7568(24)00132-6.

world setting with greater heterogeneity among individuals,' writes Schöll and his multi-national team of co-authors.

5

Harald Hampel, MD, PhD, Chief Medical Officer and Senior Vice President, Neurology from Japanbased pharmaceutical company Eisai, and co-authors are more blunt: 'While the performance of BBBs in highly selective populations provides initial information, a broader understanding of how these biomarkers behave within the global community at large is needed to provide clinical guidance. It is imperative to conduct rigorous validation studies in more representative, real-world populations to determine which measures perform most consistently and to establish cutoffs and reference intervals that perform reliably across all patient groups.'

BBB tests in current clinical use are making diagnoses and AD monitoring more precise, and are facilitating AD research through better selection of patient cohorts for clinical trials. Still, it is going to take years before BBB testing can reach the lofty but much needed goal of stemming the epidemic of AD.

Report: Cynthia Keen

New disovery could prevent memory loss in Alzheimer's patients

A gene once believed to fight only viral infections could also



also plays a pivotal role in Alz- decrease, but their ability to clear attack the brain's nerve cells.

Center, discovered that this gene only did microglial inflammation suspicions that it might mistakenly

hold the key to preventing memory loss in Alzheimer's patients. **Researchers from National Yang** Ming Chiao Tung University (NYCU) and Taiwan's National Health **Research** Institutes (NHRI) have revealed that the immune gene CLEC5A plays a critical role in the progression of Alzheimer's disease, rewriting the scientific community's longheld understanding of dementia. Published in the Journal of Neuroinflammation, their results offer new insights into Alzheimer's disease mechanisms and pave the way for new drug development.

Traditionally, CLEC5A has been associated with viral defense, activating the immune system in response to diseases like dengue fever, JapThe research team (from right): NHRI Director Dr. Shie-Liang Hsieh, NYCU Institute of Brain Science Associate Professor Han-Juo Cheng, and Ph.D. student Yu-Yi Lin.

anese encephalitis, influenza, and Covid-19. It has also been linked to the deadly "cytokine storm" phenomenon. However, in a surprising twist, a research team led by Associate Professor Han-Juo Cheng of NYCU's Institute of Brain Science and Dr. Shie-Liang Hsieh, Director of NHRI's Immunology Research heimer's disease.

Using genetic engineering techniques, the team bred Alzheimer's

model mice that lacked the CLEC5A gene and compared them with normal Alzheimer's mice. The results were astonishing: mice without the CLEC5A gene performed significantly better in memory and learning tests. They showed a marked reduction in harmful β-amyloid plaque accumulation—a hallmark of Alzheimer's pathology.

Professor Cheng explained that microglia-the brain's resident immune cells-become hyperactive in response to abnormal β -amyloid buildup, mistakenly attacking healthy neurons and accelerating disease progression. However, when CLEC5A was removed, not

 β -amyloid improved dramatically, slowing the progression of brain degeneration.

This discovery positions CLEC5A as a promising new therapeutic target for Alzheimer's. By designing drugs to block this gene's protein function, scientists believe they may open a new front in the battle against dementia. "It started as a hunch without solid evidence," admitted Dr. Hsieh, who previously identified CLEC5A as a key factor in severe dengue and Japanese encephalitis cases. Initially, the team was uncertain whether this virusrelated gene could also be implicated in Alzheimer's. However, further research revealed that CLEC5A doesn't just recognize viruses-it's also involved in autoimmune diseases like lupus, raising

This study also credits NYCU doctoral students Yu-Yi Lin and Wen-Han Chang for their critical contributions. The findings have drawn significant attention from the international scientific community.

As Alzheimer's cases rise globally, this breakthrough led by Taiwan's scientific teams not only offers a fresh perspective on the disease's origins but also points to an entirely new direction for drug development, the research team hopes. Shortly, targeted therapies against CLEC5A could offer countless families a new beacon of hope in the fight against memory loss.

> Source: National Yang Ming Chiao Tung University

How to teach an LLM to think like a clinician

While generative AI shows immense potential for healthcare, a critical reliability issue lurks beneath the surface: LLMs don't think like doctors do, a data science expert explained at the **Emerging Technologies in Medi**cine (ETIM) congress in Essen. This potentially fatal flaw, however, may be fixable.

From patient communication to clinical decision support and automated reporting - Prof. Michael Gertz pointed out how LLMs show great promise to help clinicians at almost every task across the patient journey.1 However, the models suffer from fluctuating performance and therefore lack the reliability needed for sensitive healthcare applications, explained the Head of the Data Science Group at Heidelberg University.²

To understand the frequent inaccuracies within the AI output, 'it is important to keep in mind that an LLM is basically just a machine for next word prediction', Gertz said. While this may be useful for tasks requiring a certain degree of creativity, it can lead to potentially severe errors in a medical context (see article below).

'LLMs demonstrate remarkable language generation skills, which can easily be mistaken for genuine reasoning,' the expert cautioned. 'In high-stakes domains like medicine, this illusion can lead to real harm. This is why, despite their promise, these models must be integrated carefully, with human oversight and robust methods for verifying correctness and sources.'

Taking it one step at a time Efforts to improve the reliability of

Misleading medical analyses



LLM output include careful prompt engineering, using advanced techniques such as retrieval-augmented generation (RAG) and thorough fine-tuning of results in safe testing environments. Using these methods, it is possible to guide the AI models towards an approximation of clinical reasoning, Gertz suggested. This includes concepts such as evidence-based decision-making, pattern recognition, and probabilistic thinking.

A suitable way to introduce an LLM to this line of reasoning can be through chain-of-thought (CoT) - a method derived from the structured interviews performed in psychotherapy, the expert explained. Basically, this replaces the LLM's associative default mode of operation with a more thorough stepby-step approach. Adopting this format, an LLM can be trained to follow decision trees, eventually leading to a way of reasoning closer to that of a clinician using causal chains before coming to a diagnosis.3

Transparent attribution is key

aforementioned While the measures reduce the likelihood of AI-generated "hallucinations", several challenges with current LLMs must be addressed before safe adoption in a medical setting, Gertz said. For one, the models are often trained on huge, uncurated datasets. This makes pinpointing the origin of a single statement nearly impossible. 'In healthcare, trust and accountability hinge on

traceability,' the expert stressed. 'Clinicians and patients want to know where a given piece of information is coming from - from a peer-reviewed study, a reputable guideline, or just online chatter?' Consequently, thorough and transparent attribution of sources is vital - especially so considering that current models tend to simply invent citations to support statements, thus posing a serious ethical and practical problem in medical contexts, Gertz added.

Further issues include significant drops in LLM reliability when the models are confronted with novel or complex circumstances and the as-of-yet unclear legal responsibility in case of faulty medical advice. 'For the foreseeable future, there

will always have to be a human in the loop', Gertz concluded - 'a medical professional to interpret and validate outputs before any critical decision-making.'

Author: Wolfgang Behrends



Michael Gertz

Michael Gertz is a full professor at Heidelberg University where he heads the Data Science Group at the faculty of Mathematics and Computer Science. From 1997 until 2008 he was a faculty at Department of Computer Science at the University of California at Davis. His interdisciplinary research interests include natural language processing, AI, complex networks, and scientific data management, with applications in the medical sciences, law, physics, political sciences, and economics.

Sources.

¹ Bhayana R: Chatbots and Large Language Models in Radiology: A Practical Primer for Clinical and Research Applications; Radiol-2024; https://doi.org/ ogy 10.1148/radiol.232756

² Gupta M, Virostko J, Kaufmann C: Large language models in radiology: Fluctuating performance and decreasing discordance over time; European Journal of Radiology 2025; https://doi.org/10.1016/j.ejrad.2024.111842 ³ Liévin V, Hother CE, Motzfeldt AG, Winther O: Can large language models reason about medical questions?; arXiv preprint 2023; https://doi.org/10.48550/arXiv.2207.08143

Al "predicts" beer drinking based on knee X-rays

Where a radiologist can identify fractures and other abnormalities from an X-ray, AI



differences in X-ray equipment or danger can lead to some really clinical site markers-to make dodgy claims, and researchers

on confounding variables—such as another it previously ignored. This need to be aware of how readily this happens when using this technique." "The burden of proof just goes way up when it comes to using models for the discovery of new patterns in medicine," Hill continued. "Part of the problem is our own bias. It is incredibly easy to fall into the trap of presuming that the model 'sees' the same way we do. In the end, it doesn't. It is almost like dealing with an alien intelligence. You want to say the model is 'cheating,' but that anthropomorphizes the technology. It learned a way to solve the task given to it, but not necessarily how a person would. It doesn't have logic or reasoning as we typically understand it."

models can see patterns humans cannot, offering the opportunity to expand the effectiveness of medical imaging. A study led by Dartmouth Health researchers, in collaboration with the Veterans Affairs Medical Center in White River Junction, VT, and published in Nature's Scientific Reports, highlights the hidden challenges of using AI in medical imaging research. The study examined highly accurate yet potentially misleading results-a phenomenon known as "shortcut learning."

Using knee X-rays from the National Institutes of Healthfunded Osteoarthritis Initiative, researchers demonstrated that AI models could "predict" unrelated and implausible traits, such as

Using knee X-rays from the Osteoarthritis Initiative, researchers demonstrated that Al models could "predict" unrelated and implausible traits, such as whether patients abstained from drinking beer or, as shown here, eating refried beans.

whether patients abstained from eating refried beans or drinking beer. While these predictions have no medical basis, the models achieved surprising levels of accuracy, revealing their ability to exploit subtle and unintended patterns in the data.

"While AI has the potential to transform medical imaging, we must be cautious," said Peter L. Schilling, MD, MS, an orthopaedic surgeon at Dartmouth Health's Dartmouth Hitchcock Medical Center (DHMC), who served as senior author on the study. "These models can see patterns humans cannot, but not all patterns they identify are meaningful or reliable. It's crucial to recognize these risks to prevent misleading conclusions and ensure scientific integrity."

Schilling and his colleagues examined how AI algorithms often rely

predictions rather than medically meaningful features. Attempts to eliminate these biases were only marginally successful-the AI models would just "learn" other hidden data patterns. The research team's findings underscore the need for rigorous evaluation standards in AI-based medical research. Over-reliance on standard algorithms without deeper scrutiny could lead to erroneous clinical insights and treatment pathways. "This goes beyond bias from clues of race or gender," said Brandon G. Hill, a machine learning scientist at DHMC and one of Schilling's co-authors. "We found the algorithm could even learn to predict the year an X-ray was taken. It's pernicious; when you prevent it from learning one of these elements, it will instead learn

Source: Dartmouth Health

Digital resilience

Healthcare cybersecurity: from basics to best practices

Building resilience for digitally driven healthcare: At the HETT (Healthcare Excellence Through Technology) North conference in Manchester, leading IT specialists highlighted the need for high levels of education, awareness and vigilance among healthcare staff in the fight to protect systems against cyberattack.

With the healthcare sector increasingly reliant on technology to deliver services, and the NHS in the UK along with other major public organisations having seen a number of cyberattacks in recent years, experts are placing the emphasis on getting the basics right as a critical step in protecting against, or minimising, future attacks and keeping patients safe.

Nasser Arif, Cyber Security Manager at London North West University Healthcare NHS Trust, chaired the panel at HETT North and opened the session by emphasizing the importance of finding "the right balance" between optimal use of technology, patient access and protection against cyberattack.

MFA, passwords, patching: getting the basics right

Catherine O'Keeffe, Deputy Director of Cyber Operations (Delivery) and Head of the Cyber Profession within the Cyber Operations Team at NHS England, underlined the importance of multi-factor authentication (MFA), robust password management and patching (software changes to resolve a security vulnerability). 'MFA will stop 90% of cyberattacks,' she said, 'and if you get the patching right, you will take away some of the critical vulnerabilities.'

She said password management should also extend to clients and suppliers, where passwords may often not have been regularly updated. 'Back to basics is absolutely where you should be. Get all the basics right and not only are you decreasing the risk, you are increasing resilience, and the ability to recover from cyberattack.'



The Cyber Security panel (from left) - NasserArif, Mohammad Waqas, Daniel O'Shaughnessy, Catherine O'Keeffe, Daniel Hallen.

highlighted impactful awareness and communication strategies, including phishing exercises; reinforcing cybersecurity messages; simulations and cyber training; testing security plans; and campaigns such as Cyber Security Month in October. This education approach, the experts said, must also apply when devices were being used by patients from their own homes.

Cybersecurity as a team effort

According to Mohammad Waqas, CTO Healthcare at cybersecurity company Armis, identifying vulnerabilities, understanding associated risks, and developing appropriate responses is essential. Healthcare professionals need to be aware of the different entry points and identify the most critical elements of patient care service delivery, he said, adding that 'systems are never going to be 100% secure.' However, even when a cyber-incident leads to inevitable downtime, it is crucial to maintain continuity when services are compromised.

Waqas further pointed to the benefits of cross-organizational collaboration to work through issues and pool resources in a financially constrained environment. The discussion also highlighted the importance of interdisciplinary teamwork, emphasizing the value of integrating perspectives from both clinical teams and cybersecurity experts. 'Once there is that understanding,' said Waqas, 'people can work together to secure the environment.'

These solutions provide muchneeded visibility into IT infrastructure, allowing for earlier intervention to prevent threats from escalating, said O'Keeffe, who pointed out the Cyber Associates Network as an invaluable resource for problem sharing and solving. That collaboration also extends to suppliers, partners and vendors and can lead to greater accountability while leveraging their specialized expertise to enhance cybersecurity measures.

Offering an external perspective, Daniel O'Shaughnessy, Head of Programme Delivery for Digital Care Hub, observed that organisations often cite limited resources as a barrier to addressing cybersecurity issues. 'It is often siloed solutions but the same threat actors are targeting the same groups in the same way, so there are economies of scale here to share across the system of when and where it is happening.'

While concerns regarding Artificial Intelligence (AI) were discussed, panellists characterized it as an "emerging technology" that should be approached similarly to other innovations like smartphones or social media, noting that AI is also being deployed defensively in cybersecurity applications.

Daniel O'Shaughnessy is the Head of Programme Delivery for Digital Care Hub's Better Security, Better Care Programme – a nationwide programme that supports the Adult Social Care sector with data protection and cyber security.

Mohammad Waqas is CTO Healthcare at Armis with an interest in cyber security and IT/Digital Leadership. Nasser Arif is Cyber Security Manager with London North West University Healthcare NHS Trust and Hillingdon Hospitals NHS Foundation Trust and a cyber security professional with an interest in transformation, wellbeing and the human element of cyber security.

Daniel Hallen is the Director of Data & Digital (CIO) at East Lancashire Hospitals, and with a background in digital programme leadership and transformation, has worked in the NHS, local government, and the private sector.



Education and awareness

Daniel Hallen, Director of Data & Digital (CIO) at East Lancashire Hospitals, pointed to the importance of education and awareness among all tiers of healthcare staff. Critical cybersecurity issues, he argued, are rooted in user behaviour, such as posting details of themselves on social media via smartphones or adopting their at-home approaches at the workplace. 'We have to educate people at all levels about security,' he said. The expert placed an emphasis on senior leaders within an organisation with visible an "googleable" profile, who also need to protect themselves in a personal capacity.

To educate healthcare staff against the threat of cyberattacks, Hallen

Protective technologies

While the importance of collaboration and partnerships in managing staff awareness and cyber risks was emphasized, the experts also addressed the necessity of implementing protective technologies such as Microsoft Defender and similar security tools. Author: Mark Nicholls

Catherine O'Keeffe is the Deputy Director of Cyber Operations (Delivery) & Head of the Cyber Profession within the Cyber Operations Team at NHS England and has a wealth of experience in clinical practice, IT, Information Governance and Cyber Security, having worked in the NHS for over 35 years.

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Realising the potential of Smart Hospitals

Digital technology to optimize use of hospital space

From identifying under-utilized rooms to tracking spare mobile equipment like wheelchairs, spatial awareness technology is evolving to improve day-to-day operations on healthcare sites. The technology, which is already being deployed in airports, universities and industrial premises, is now seeing growing applications within hospitals. At the HETT (Healthcare Excellence Through Technology) North conference in Manchester, an expert explained how geospatial technology enables hospitals to make more efficient use of their space and assets.

At the core of this technology are so-called Geographic Information Systems (GIS), which acquire and integrate data from various sources. Duncan Booth, Head of Health and Social Care at the GIS software company Esri UK, explained: 'We transform data using geography to help people look at data through a different lens. By doing that, they unlock different insights.' Such as identifying the location of an asset such as a bed, scanner or wheelchair, or help a hospital monitor its infrastructure.

Digital twins visualize unused hospital space

A first step is integrating data from CAD (computer-aided design) drawings or building plans. That information is then converted into an "indoors model", where the interior can be seen in the context of its surroundings geographically. 'Once we have created an indoor model we can engage and interact with it and integrate it with a space management systems to see how space is being used,' added Booth.

This also offers an interactive dashboard from which it is possible to track hospital assets, though each must give off a signal such as via an RFID (radio-frequency identification) tag. The Esri system can consume the signatures emitted with real-time information accessed by staff to take asset or space management decisions.

To assess how spaces such as and administrative area. 'Essenwards or meetings rooms are being tially, we are creating an intelligent



The asset tracking dashboard.

utilized requires a Bluetooth "beacon" system that can detect how many assets are in certain rooms, for example. Booth said: 'Once all of that is in place it is a case of bringing data into the system and because we have the indoors model, we can see physically where things are in real time.' This technology addresses the common issue of hospitals not using available space efficiently.

Data set visualisation and asset tracking

While the concept is relatively new for healthcare, this technology has been implemented at two pioneering hospitals where Esri is involved: Airedale General Hospital in Keighley, Yorkshire, and Manchester University NHS Foundation Trust.

At Manchester, developers have incorporated an indoor spatial model into the hospital's existing management infrastructure, creating a dashboard that monitors space utilization across both clinical wards and administrative area. 'Essentially, we are creating an intelligent map of the entire estate,' the expert said. 'Using floor plans and room information, we are building a floor aware information model where we can overlay and visualise different data sets.' Additionally, ESRI is piloting advanced asset tracking capabilities throughout the facility.

At Airedale, the technology has been implemented to address critical structural integrity concerns – specifically monitoring degradation patterns in Reinforced Autoclaved Aerated Concrete (RAAC) panels. Staff equipped with iPadbased tools to survey areas and capture information to create a visual map covering 50,000 panels. Booth said: 'From that, the project manager can see which of the RAAC concrete panels are high-risk and how they are deteriorating over time.'

The acquired data is constantly being built upon and gradually used for expanded applications. Esri advocates this incremental approach to health, beginning with targeted implementations that can scale organically as institutional needs evolve. 'With Manchester, for example, they approached this by firstly looking at space management, getting CAD drawings into the system and helping manage space better. That then led us on to asset tracking.'

'Unlocking efficiencies'

Outlining the concept at HETT North in February, Booth said: 'Our focus is on transforming data into actionable insights. We use location as a predominant thread, collecting siloed disparate data to create an integrated operational picture. Geospatial technology is unlocking efficiencies that can help better decision making and ultimately improve patient care.'

While the solutions can integrate with existing hospital systems, Esri UK recognise that the process can require upskilling and that clients also have to consider their digital strategy and the resources and capability within their teams.

Author: Mark Nicholls



Duncan Booth

Duncan Booth is Head of Health and Social Care at Esri UK and an expert in leveraging technology to drive digital transformation across health and social care. With nearly two decades of experience in technology, data and strategic planning, he works to empower organisations to unlock actionable insights that enhance service delivery, resource allocation, and long-term sustainability.



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