A4I Analysis for Innovators

NPL validates new MRI standard, advancing potential technique for Alzheimer's diagnosis

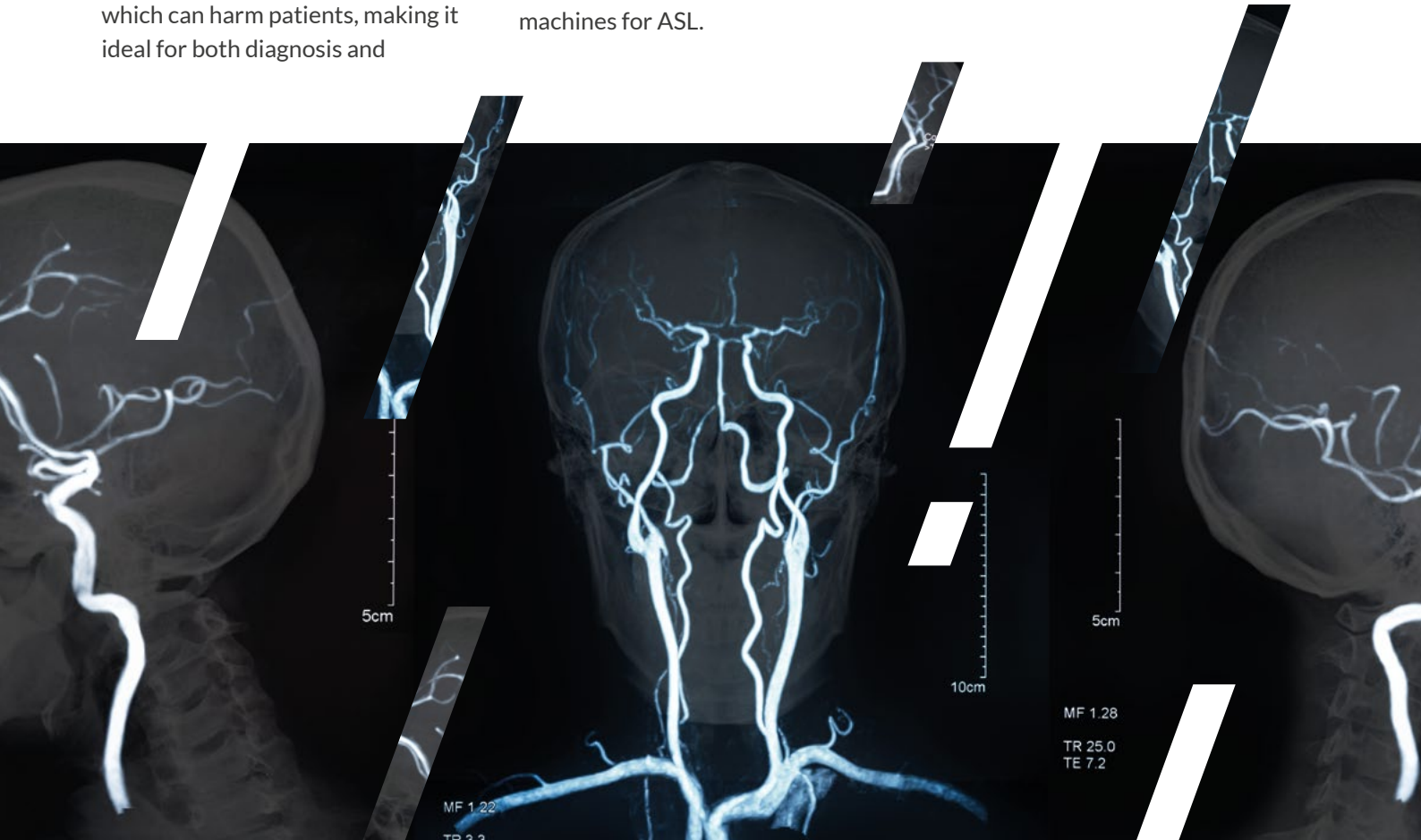
MRI scanners are pivotal to diagnosing a wide range of conditions, but with new measurement approaches, they could be used to diagnose many more.

A promising new application of MRI is Arterial Spin Labelling (ASL), which provides measures of perfusion, the rate of blood flow to an organ. Changes to perfusion can indicate disease in the liver, heart, kidney, and brain, including Alzheimer's.

Unlike other perfusion measurement techniques, it does not require injected contrast agents which can harm patients, making it ideal for both diagnosis and long-term monitoring, saving lives and improving quality of life for the terminally ill.

Over the past few years there has been a huge effort by the research community on ASL, culminating in a 2015 medical white paper recommending a standardised methodology for clinical practice. However, despite clear benefits, it is held back by the absence of a reliable way to calibrate MRI machines for ASL.

London-based Gold Standard Phantoms is addressing this with the world's first perfusion standard – also known as a 'phantom'. It is working with NPL, through the Analysis for Innovators (A4I) Programme, to ensure the standard is accurate and trustworthy. This will give GSP a unique competitive edge in the healthcare market, whilst opening up a valuable new diagnosis technique.



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Innovate UK

Challenge

Gold Standard Phantoms' innovative standard simulates a fixed rate of perfusion, allowing MRI scanners to be calibrated against known values. It is roughly the shape of the upper body and head, and contains a simulated capillary bed through which fluid is pumped at a highly controlled rate.

Gold Standard Phantoms needed to know the flow rate within the phantom to provide a defined value against which MRI measurements could be compared. They built a computational fluid dynamics model which relates flow in the phantom to MRI images. But this model was complex and included many assumptions and uncertainties. They needed to validate the inputs into their model, to ensure the outputs could be relied upon.

Solution

Gold Standard Phantoms worked with NPL and NEL, to validate key aspects of their model. They assessed and refined areas of systematic error, identified sources of uncertainty which could be reduced, and made measurements of key parameters and their uncertainties which were used to improve the data going into the model.

> NEL validated Gold Standard Phantoms' model against their own in-house simulation, concluding that the model worked as intended, and NPL has ensured that all work was performed in accordance with best measurement practice.

In particular, NPL was involved in assessing the precision which both mathematical model and phantom could provide, thereby creating a standard against which ASL MRI measurements can be compared.

A4I

A4I is a programme that gives UK businesses, of any size, access to cutting-edge R&D expertise and facilities to help solve problems that they have been unable to tackle using standard techniques. The focus is on solving issues affecting product cost, reliability or lifetime and production problems.

NPL nel flow measurement services NMML

Science & Technology Facilities Council

Innovate UK Knowledge Transfer Network

Impact

Through the project, Gold Standard Phantoms improved, simplified and validated many aspects of their model, and identified parameters and sources of uncertainty. The result is an improved model, with an independent validation. Gold Standard Phantoms can now provide confidence to customers that the phantom can be relied on to accurately calibrate MRI scanners for ASL measurements.

One of the most important benefits was the learning acquired on the best principles of measurement, such as calculating uncertainties. Gold Standard Phantoms can now apply this learning as they continue to refine their model.

Gold Standard Phantoms had already sold phantoms to researchers, and NPL's validation now allows them to sell to a much larger medical market. This will allow MRI to be accurately calibrated in hospitals for ASL, opening up the technique for diagnosis and monitoring of a wide range of debilitating diseases, ranging from dementia and stroke, to cancer.

"Having the validation of NPL shows customers our phantoms meet the very highest measurement standards, which gives them confidence, and sets the bar very high for our competitors. In an industry where scans are relied on to make life or death decisions, accuracy and trust are everything. Beyond the immediate value, it also gives us new skills in-house to develop the product further and which can be applied to new challenges, putting the business in a strong long-term competitive position."

Aaron Oliver-Taylor
Chief Technical Officer at Gold Standard Phantoms

GOLD STANDARD PHANTOMS

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