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Bridging Knowledge and the Economy

Vector

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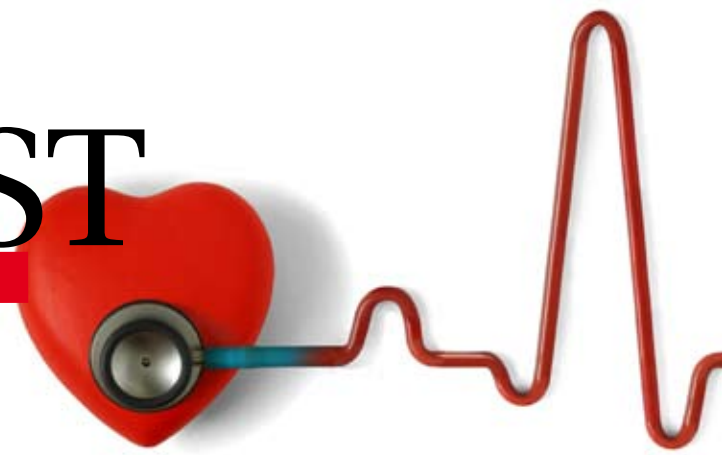
HEART TEST

A diagnostic test for acute coronary syndrome (ACS).



François Madore

When a patient arrives at a hospital emergency department with symptoms of acute thoracic pain, blood tests are done as rapidly as possible to determine the levels of creatine kinase (CK) and troponins. Unfortunately, increased serum levels of these biomarkers are not always very precise diagnostically. Furthermore, it often takes 8 to 12 hours to detect an increase in the serum levels.

The limitations of these diagnostic tests often result in longer hospital stays and a delay in appropriate therapy, which is very costly for the health care system. The ideal would be to have a marker which would give a reliable and rapid result, so that the appropriate treatment could be initiated within a few hours of the patient's arrival at the emergency department.

SIGN OF CELL DESTRUCTION

"We hope we have found such a marker in sFas," says Dr. François Madore, Director of the Université de Montréal's Nephrology Consortium, and Co-Director of Clinical Research at Sacré-Cœur Hospital in Montreal. This marker was previously identified as a result of basic research on cellular apoptosis.

A team consisting of Drs. Marie-Josée Hébert (CHUM), Héloïse Cardinal (CHUM), James Brophy (McGill) and Peter Bogaty (Laval University) was established in order to verify this hypothesis. Dr. Madore and his collaborators conducted a preliminary study using a bank of blood samples obtained from emergency patients showing acute thoracic pain.

"We realized that this marker could identify patients with acute coronary syndrome with great reliability, due to the presence of two- to three-fold higher levels of sFas in their blood."

Armed with these promising results, the team has been conducting for the past year a larger study of 500 patients admitted to the emergency departments at the Sacré-Coeur and Royal Victoria hospitals in Montreal. "To date, the results confirm our preliminary data. We indeed find a higher rate of sFas among people who have an infarction."

ALONE OR COMPLEMENTARY?

The work in progress will make it possible to determine the diagnostic reliability of measuring sFas. Can we count on sFas to predict the risk of a heart attack and to then determine the appropriate treatment? "We should have the definitive results within six months," predicts the researcher.

Will sFas be able to replace the other markers currently in use? That remains to be seen; however, Dr. Madore thinks that the test may be used in conjunction with the current tests, in order to significantly increase the precision and reliability of the diagnosis.

With such promising prospects – and without forgetting the international patent application – Univalor hopes to convince companies that develop and distribute diagnostic tests to partner in the development of this test. Potential partners have been found, and one of these is in discussion with Dr. Madore to obtain more specific proof of concept.

« The partner's expertise is of major importance for this research, emphasizes Véronique Bougie, Project Leader, Life Sciences, at Univalor. We have medical competence, of course. However, a partner can bring a great deal of complementary know-how. For example, how do we develop a simple and rapid test, as automated as possible, which can be done for several patients simultaneously in an emergency situation? »

A PERFECT IMAGE

A new method improves magnetic resonance images.

While crucial for diagnoses, the most recent magnetic resonance imaging (MRI) machines that have high magnetic fields also have problems with image quality, which leaves something to be desired in many cases: image regions with shadows, poor contrast, and bright spots.

Dr. Gilles Beaudoin and Jean-Charles Côté, a former PhD student, developed a novel MRI method, now patented, to reduce these problems. "In order to use our new method, all that is needed is to integrate the software that we developed into any existing MRI machine," emphasizes Dr. Beaudoin, Assistant Head of the Physics and Biomedical Engineering service at CHUM.

Old Wave, New Trick

This research advance is based on pseudo-adiabatic radio frequency (RF) waves, an invention that they originally developed for quantitative MRI analysis, useful for research purposes. Adiabatic waves have been known for a long time and are used widely in chemistry to characterize materials. Compared with the basic RF waves used in clinical MRI, adiabatic waves have the advantage of providing very homogeneous and clear images of matter subject to their excitation. If they were used in the clinic, however, "they would have a net disadvantage, subjecting the human body to too high an energy level," explains Dr. Beaudoin.

The solution? To develop a type of pseudo-adiabatic wave which combines the low power emitted during excitation by the current RF waves used in MRI with the high homogeneity of the excitations from adiabatic waves. "It would give us ten times less power deposited, but it would provide much greater image spatial homogeneity than the standard excitation," emphasizes the researcher.

Pseudo-adiabatic waves are produced by inserting the software created by the two researchers into any MRI machine made by the large manufacturers. This very convenient software offers the specialist a new analysis method, one that uses pseudo-adiabatic waves to parameterize the process of image acquisition in order to obtain contrast homogeneity over the entire volume studied.

Gilles Beaudoin

Applications that Work

Manufacturers such as Siemens, Philips and General Electric when examining this invention will obviously first ask: Does it work? Dr. Beaudoin is preparing an applications portfolio to answer this question and show how his method is clearly superior to the traditional approach.

For example, he has developed an imaging method for the abdomen, a part of the body where the traditional approach usually gives a shadowy image, particularly at the level of the liver. These zones are more intense with the new generation of 3 Tesla MRI machines. The use of pseudo-adiabatic excitation produces a homogeneous image over the entire volume.

This homogeneous result is also obtained in many other zones of the body where the traditional approach is deficient, particularly for the breast and, at a higher field intensity, for the brain. Another possible application is for imaging arteries with stents, which normally are shadowed using RF waves, so that the image inside the stents is dark. "Our approach provides an image where the contrast is homogeneous in spite of the stents," says the researcher.

To date, "Dr. Gilles Beaudoin and Jean-Charles Côté's patented method is being used for research with machines from two different companies, and it fulfills its promise, announces Anne-Marie Larose, Manager, Business Development, Life Sciences, at Univalor. We only need to convince one of the MRI machine manufacturers that our method provides an advantageous solution to the problems of image non-homogeneity, by offering a 'software' approach, which is much simpler than a 'hardware' one, and that is ready for clinical use."

DEFICIENCY GENE

An important gene for non-syndromic mental retardation has been identified.

Jacques Michaud

Fadi Hamdan

While studying 300 genes related to non-syndromic mental retardation (NSMR), Drs. Jacques Michaud and Fadi Hamdan discovered that three infants in a group of 94 had one mutation that affected the same gene, SYNGAP1[1]. Not very significant you might think?

On the contrary, an incidence of 3% is "enormous!" exclaims Dr. Michaud, Associate Professor in Pediatrics and a physician geneticist who works at the Department of Medical Genetics at CHU Saint-Justine Research Center, also a researcher at the Centre of Excellence in Neuromics at the Université de Montréal. The only other gene that we can associate with NSMR at a similar prevalence is that of the fragile X syndrome, which is present in 2% of affected boys.

Certainly, acknowledges the researcher, "we cannot explain everything with this single gene." NSMR no doubt involves many genes, but it seems no one has found a mutation in a candidate gene present at such a high frequency. It should be noted that this involves a *de novo* mutation, one that is not transmitted by the parents.

SYNAPTIC CEMENT >>

Other research has shown that the SYNGAP1 gene, expressed only in the brain, plays a crucial role in remodelling of synapses during learning, by contributing to their plasticity and their reorganization, according to Dr. Fadi Hamdan, a researcher with Dr. Michaud's team.

In the United States, mental retardation affects between 3 and 9 million citizens. Within this group, we find about 50% of cases where the deficiency is non-syndromic, and it manifests without any defects in body morphology or metabolism, for example, affecting height or brain conformation.

At this stage, the researcher is involved in conducting studies with a larger sample size of infants, to see if the initial results will be confirmed. "Did we simply get lucky?" asks the researcher. "In a sample of 1000 infants, will the proportion still be 3%? Or will it drop to 2% or increase to 5%?"

"It seems that Dr. Michaud's discovery is already extremely attractive for potential partners," affirms Louis Provencher, Manager, Business Development, Life Sciences, at Univalor. The first level of interest concerns the development of short term genetic tests to detect mental retardation.

UPSET PARENTS >>

"There is a major demand from parents to understand what is happening with their child," says Dr. Michaud. "Is what looks like a deficiency caused by a genetic deficiency, or does it simply involve a slight delay in learning? Some of them ask whether the next child will also have the same deficiency." A test would give us an immediate answer for the 3% of cases that involve the SYNGAP1 gene.

The genetic tests also have long term interest. "Genetic therapies, because they are very specific, will only be effective if they target the correct patients," says Dr. Hamdan.

Even more long term, Dr. Jaques Michaud's work will contribute to the development of pharmacological therapies capable of reducing or neutralizing certain deficiencies. In several mouse models, they were able to improve memory and learning. "It is thus not impossible to think that we could develop a similar approach to target SINGAP1," says the researcher, "even if we are still far from a pharmacological application."

While it is still early, Univalor has already succeeded in interesting a diagnostic company among a dozen others possibly interested in the development of a genetic test. And things could move ahead rapidly, notes Louis Provencher. "During 2010, he says, we have high hopes of signing a licensing agreement with a partner, which will satisfy all of the participants involved."

[1] This study was published in February 2009 in the *New England Journal of Medicine.*

COMPLETE SECURITY

A quantum network with complete confidentiality.

Félix Bussières

Nicolas Godbout and Suzanne Lacroix

In the traditional universe of communications safety, the symbolic characters Alice and Bob have always good reason to be wary of Eve, the spy. None of the encryption methods currently used on a large scale in telecommunications networks guaranty that Eve can be ignored. Quantum cryptography is providing a new solution for this problem.

Currently, most of the encryption algorithms that are used on the internet can be "cracked" by a determined group that invests sufficient computing power and the necessary time. Quantum cryptography provides an additional level of complexity.

"Quantum security is ensured by the laws of physics," explains Dr. Félix Bussières, PhD graduate in Physical Engineering of the École Polytechnique de Montréal, and whose work originated the ongoing research.

A Measurement That Destroys

Everything is due to the nature of a quantum particle, in this case the photon, which makes it possible to establish the key for encoding a message. "As soon as we make a measurement on a photon, we destroy its quantum state," points out Dr. Suzanne Lacroix, Professor of Physical Engineering at École Polytechnique de Montréal. "If Alice sends a photon to Bob and if Eve tries to measure it, this will destroy the state of the photon immediately. Alice and Bob will thus know that there is a spy in the loop."

A network must be constructed on which to circulate the quantum cryptographic keys. For the moment, only two companies in the world build this type of system; however, they are handicapped because they only operate point-to-point.

The research team from École Polytechnique and Université de Montréal has invented a quantum cryptography system which can function on a multipoint network, which corresponds much better to user reality.

"Our invention provides a way of using an optical fiber network architecture with quantum cryptography, where a large number of participants can share the keys," explains Dr. Nicolas Godbout, Professor at Polytechnique.

One of the beauties of this system is that it makes use of components already manufactured in the telecommunications world, by using their multiplexing resources, in order to exploit various wavelengths inside the same optical fiber.

We can understand that this type of network would interest many prospective customers for whom safety is of the highest importance: national defense, banking networks, diplomatic communications, etc.

Build a Prototype and Network

The researchers' concept can already be set up in its simplest form. However, its more advanced aspects are ahead of the technologies available commercially, so that some equipment is missing for doing the work well, particularly single source photons and intricate pairs of photons.

To obtain this type of equipment, the researchers will need to make it themselves. This is the prototype that they plan to construct once the search for financing is completed.

"A point of leverage that strengthens their project is the fact that they will soon be granted a patent that was initially filed in 2003," points out Thomas Martinuzzo, Project Manager, Business Development, Science and Engineering, at Univalor. "We are completing this project, he continues, with the research team at Polytechnique in order to propose in the next few months a complete system which will allow us to quickly find a licensee, and thus to provide a new security tool for networks."

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