# How can oil technology help heart patients?

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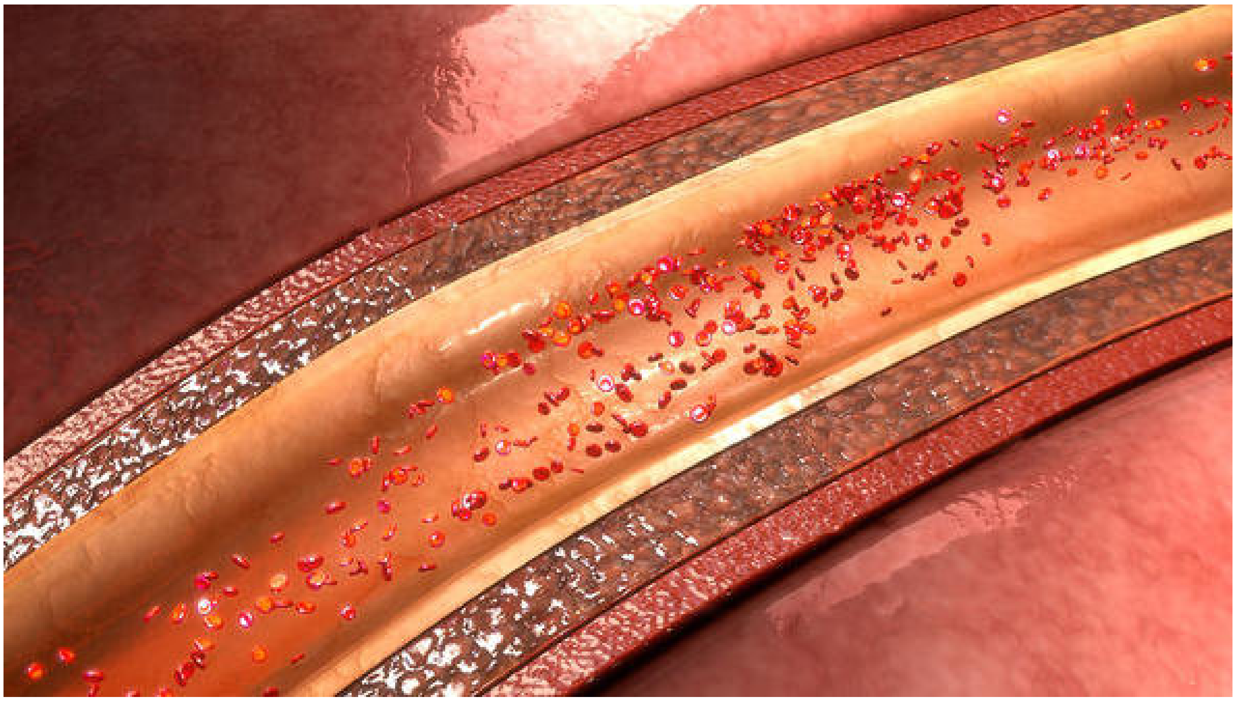

Here you can see a cut of a coronary artery. Petroleum researchers have spent decades developing flow models, and these are now tested on blood veins to help doctors investigate the severity of vessel narrowings using only non-invasive methods. Credit: University of Stavanger

Restricted blood flow in the coronary arteries can result in a heart attack. A narrowing in the arteries providing oxygen to the heart can therefore be deadly. Today, doctors examine patients using a catheter to determine whether an obstructive coronary artery disease is present or not. New technology can make it possible to evaluate the severity of blood vessel narrowings without inserting a catheter.

"Even though blood is different from oil, and blood vessels differ from pipes, there are several similarities," says Jan Ludvig Vinningland at IRIS (International research Institute of Stavanger) (Now NORCE after merger on 1 January 2018).

This means that blood supply to the heart can be calculated in much the same way as oil flowing through reservoirs and pipes.

"Mathematically it's very similar – more or less identical in fact" says Aksel Hiorth at the National IOR centre of Norway at the University of Stavanger.

Together with doctors from Stavanger University hospital, the two physicists are adapting oil technology to medicine.

## Risky examination

The coronary arteries provide critical blood and oxygen supply to the heart. If one or several coronary arteries are narrowed, the heart might not receive enough oxygen. These blockages develop to cause a heart attack.

Cardiologists use a catheter to investigate the narrowing of coronary artery. The catheter is inserted into an artery, usually in the patient's arm, and from there directed to the coronary artery supply of the heart. A sensor at the end of pressure measuring wire registers drop of pressure over the narrowing. This indicates how severe the narrowing is.

"The problem is that a catheter based measurement is potentially both risky and painful for the patient. For instance, the catheter might damage the arteries," explains interventional cardiologist Nigussie Bogale at a gathering of petroleum researchers and hospital doctors.

## From oil to blood

According to Vinningland and Hiorth, the human body can be compared to porous rock.

"In the same way as oil is spread in a network consisting of gaps and pores in porous rock, blood spreads through a very fine network of veins and arteries in our body," Hiorth explains.

Fluid dynamics describe the flow of liquids and gases. By applying the basic laws of fluid dynamics, physicists and other researchers are able to simulate several real-life situations.

For instance, this can be used to simulate airflow round the blades on a windmill. Or how water flows round a propeller. Or how oil, gas and water flow through a reservoir.

Petroleum researchers at UiS and IRIS have spent decades developing flow models, and these are now tested on blood veins.

## Images showing arteries

When adapting the model, Hiorth and Vinningland start with an image from a CT scan showing the patient's heart and the blood vessels of the coronary arteries. The three dimensional geometry of the vessels is obtained by extracting the internal geometry of the arteries as accurate as possible from the CT images. The model calculates velocity and pressure in the blood vessels, and predicts how vessel narrowings limit the blood supply. The result is a three dimensional image showing pressure and velocity .

At the start of the project, Siemens Healthcare provided the researchers with the necessary geometry. In the future, the researchers plan to use their own methods, developed at UiS and IRIS.

The goal is a software that efficiently and accurately determines the severity of vessel narrowings using only non-invasive methods. This will allow doctors to determine the best treatment, for instance whether stenting is necessary to widen a narrow artery.

## Better treatment in the future

"The new method is particularly useful when doctors face borderline cases. In some cases, with a minor blockage, the patient can have a good life without medical treatment. In cases of doubt, the method can give us information regarding pressure and flow. This makes it easier to make the right decision," says Bogale.

The method is not yet fully developed, but the potential for the patient is huge, believes Bogale.

"If we succeed in adopting the method, it could have a preventive effect. In the future we might be able to quickly examine people and give advice on how they can change their diet or lifestyle, or give them preventive drugs to avoid heart attack".

## Commercial solution

Vinningland points out that non-invasive characterization of stenosis severity is a very active area of research, and similar methods are being developed by researchers worldwide. As an example, HeartFlow in California offers a commercial service where hospitals can upload CT-images and get calculated flow values in return.

"However, building a local competence on computation-based health research enable us to bring knowledge gained over decades of oil related research to new areas of healthcare in close collaboration with local hospitals and patients," Vinningland says.

"This region has a long tradition in collaborating with industry to solve practical issues which has given us an advantage in providing commercial solutions," Hiorth adds.

Provided by University of Stavanger