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What makes a cancer test?

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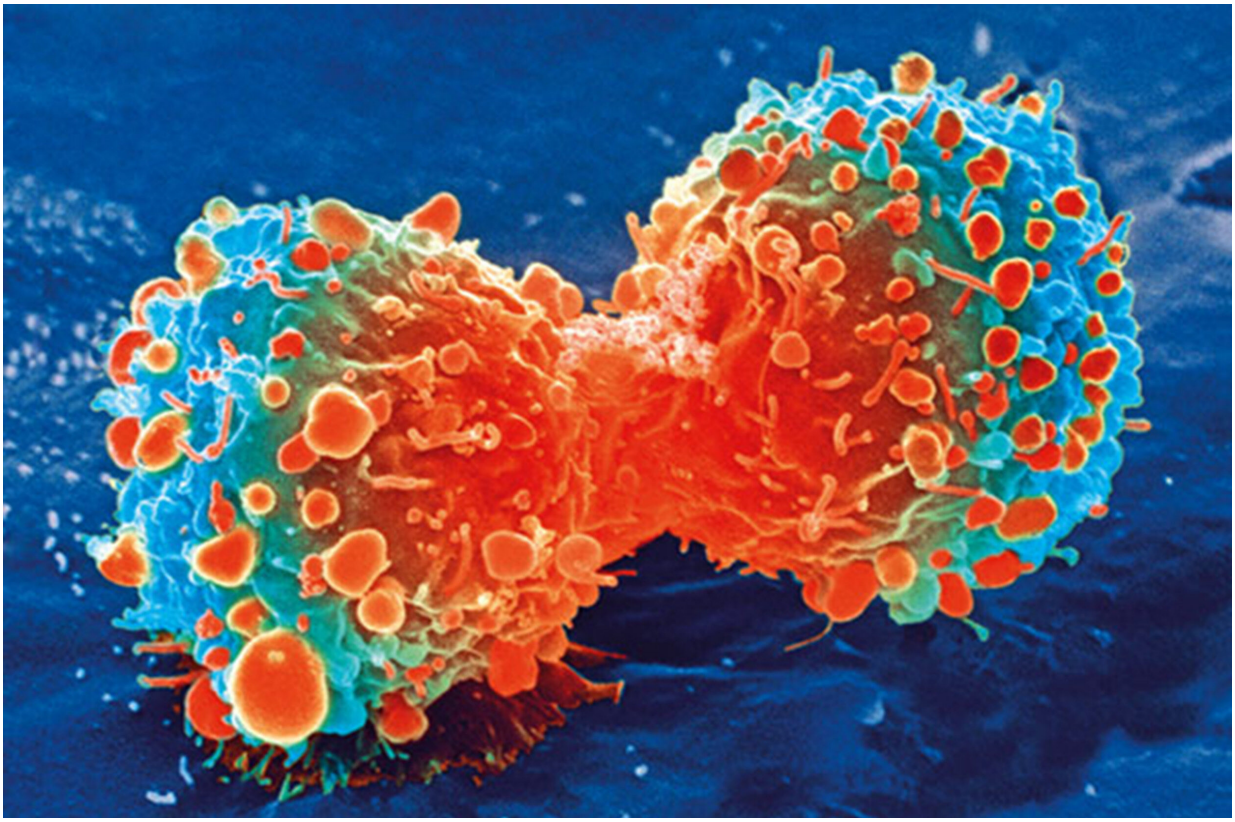

Cancer cell during cell division. Credit: National Institutes of Health

The earlier a cancer is picked up, the more likely a person is to survive. And if we can't stop cancers starting then, detecting them before they cause trouble is the next best thing.

But detecting the almost undetectable comes with significant challenges

as these tiny, newly formed cancers are hiding from scientists and doctors amongst a smokescreen of trillions of healthy cells.

Detecting the almost undetectable

To find cancer in the body, first you need something to look for.

A successful cancer test will be able to detect 'red-flag' molecules produced by the cancer, revealing its presence. And to pick up disease at a stage where it can be cured with treatment such as surgery, the cancer needs to be compact and contained. Unfortunately, in most cases, this means it's small enough to lay low. So, to locate these tiny cancers and successfully pick up the small number of 'red flag' molecules they're making, scientists have to get creative.

One type of test that's seen a lot of investment are those looking for floating bits of cancer cell DNA in the blood.

Professor Paul Pharoah, from the Cancer Research UK Cambridge Centre, says "a very small part of the blood is made up of cell free DNA that's come from all sorts of places in your body." Cancer cells can also release DNA into the bloodstream when they die, which could be picked up by testing the blood. But it's no mean feat.

"The proportion of DNA from cancer is even smaller and therefore your test has to be incredibly sensitive to look beyond all of these extra DNA pieces," says Pharoah, adding that urine, poo and breath may also contain signs of cancer.

The secret to a good cancer test

A good cancer test needs to be suitable to use in entire populations of

people who are likely healthy. If getting tested is a nasty experience, then no one is going to choose to do it.

"If you're going to test people without symptoms, the test needs to be acceptable," says Pharoah.

The sample that you're looking for cancer in must also be readily available. "That could be blood, urine, faeces. Basically, anything that you can find evidence of cancer in and acquire easily."

It also needs to be reliable, so it doesn't lead doctors on a wild-goose chase.

"The test needs to be fairly sensitive, because you want it to be able to pick up most of the people who've got the cancer," says Pharoah.

But you also need to be confident that the positive results are correct, so doctors don't follow the wrong lines of investigation with too many people.

"It needs to be reasonably specific so that if the test is positive it's not detecting all sorts of other conditions."

Lastly, useful cancer tests must be cheap so it can be used on thousands of people without financially crippling healthcare providers.

Why haven't more cancer tests been developed?

Despite Pharoah saying that a screening test "doesn't have to be perfect" because it's not designed to diagnose someone with cancer, but rather highlight those who may need more investigation, even getting to the stage where a test works fairly well is troublesome. As it turns out, finding the perfect 'red flag' or marker of cancer for the test to pick up is

incredibly hard.

Pharoah says researchers have spent a considerable amount of time following promising but ultimately unsuccessful leads—molecules that at first seem to be a good indicator of cancer but, after more research, turn out to be unsuitable. Often this is because the molecules aren't just made by the tumour, they're also produced by healthy cells. Or they're made in too small quantities for a cancer test to detect.

And once you've found a suitable cancer 'red flag', you need to make sure it's fit for purpose. The next step is often to use the test on people who already have cancer, where there are likely to be a lot more 'red flag' molecules floating around. It's a sensible start—if a test can't pick up cancer that's already been diagnosed then it's unlikely to be able to detect smaller cancers—but positive results at this stage aren't as 'game-changing' as many headlines suggest.

For a test to really work, it needs to pick up tiny amounts of disease in people who don't even know they have it.

"To show that screening with a given test is a useful intervention you need to do a randomised control trial." These trials are very costly and difficult to organise because they need to include very large numbers of people.

Overcoming overdiagnosis

Finally, when you go looking for something you can usually find it. With every cancer test you also run the risk of identifying tiny tumours that may not have gone on to cause harm. We have not yet developed a way to distinguish between cancers that are dangerous and need treatment, and those which aren't and could be safely left alone.

"There are lots of cancers that are called 'cancer' if you look at them under the microscope but actually, they were never destined to kill that person because they're slow growing," says Pharaoh.

And so naturally some of these cancers are treated, which could lead to unnecessary side effects.

Research to clear muddied waters

There are currently three national cancer screening programmes available in the UK for cervical, breast and bowel cancers. But, due to difficulties in developing useful cancer tests, these life-saving programmes have been decades in the making.

False clues make detecting cancer at an early stage very hard. But thanks to research, scientists are getting better at identifying red herrings. And learning more about cancer biology will get us closer to knowing how to set dangerous cancers apart from the mass of other molecules clouding our bodily fluids.

Although hard work, early detection is an investment that will really pay off. Developing these types of tests which meet the criteria above and promptly putting them into practice, will give people the best possible chance of treatment being successful and maybe even cure.

Follow our series to find out all the different ways—and types of bodily fluid—our scientists are investigating to find cancer early and boost the number of people who survive.

Provided by Cancer Research UK