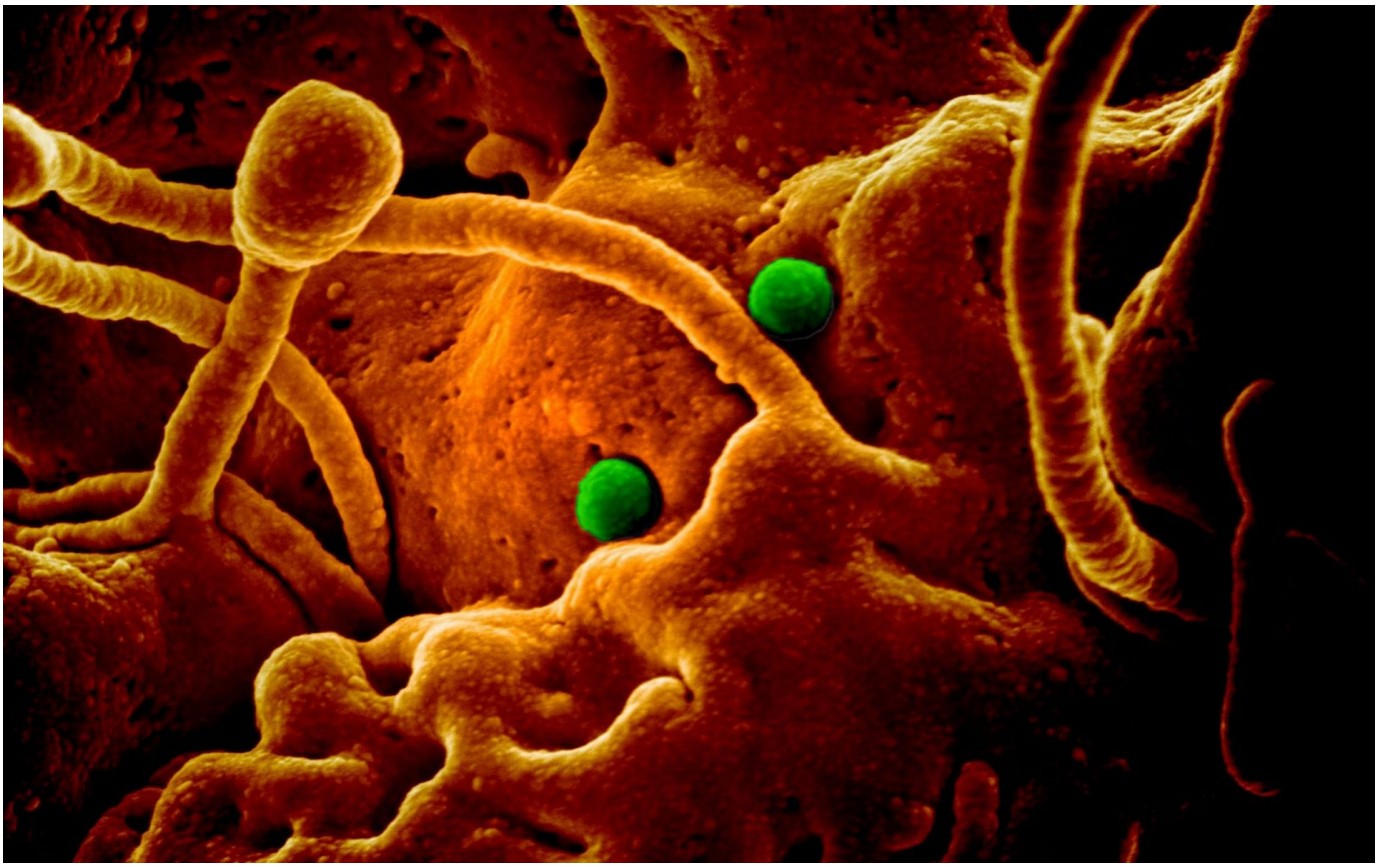
Could self-spreading vaccines stop a coronavirus pandemic?



The race is on to develop a vaccine that will help prevent the spread of the disease CREDIT: ALAMY/ALAMY

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The streets have emptied in Wuhan, the sprawling capital of China's Hubei province. Masked citizens, check points, and contamination zones have made the city seem more like a post-apocalyptic nightmare than a home to 11 million people.

Pictures of the gloomy ghost town have sparked fear across the globe as the fatalities attached to the new coronavirus (https://www.telegraph.co.uk/news/0/coronavirus-infection-everything-need-know-china-wuhan-outbreak/) continue to soar. The Chinese Government has set about building a 1,000-bed hospital in 10 days to deal with the increased pressure on the medical system.

A cure for the disease remains out of the hands of doctors and researchers to date. The race is on to develop a vaccine that will help prevent the spread of the disease. Authorities are determined to ensure the virus does not take hold in the same way SARS did in 2003 or worse the Spanish Flu at the turn of the 19th century.

However, if a cure is found, the pace at which it is distributed will be crucial. A range of technologies are being developed to quicken the delivery of vital medicines (https://www.telegraph.co.uk/technology/2020/01/21/ai-could-combat-spread-chinas-deadly-coronavirus/).

One such technology is self-spreading vaccines, whereby the cure spreads through the population in the same way a virus would.

Vaccines

The use of vaccines dates back to 1796, when Edward Jenner developed the smallpox cure.

At a top level, vaccines work by training the immune system to recognise and combat pathogens, be they viruses or bacteria. In order to do this, a small amount of the pathogen is introduced into the body, thus triggering a response. Should the virus appear again, the immune system will recognise it and attack it aggressively before it can spread.

The issue with the coronavirus (https://www.telegraph.co.uk/news/2020/01/31/two-people-england-have-testedpositive-coronavirus/) is there is no vaccine, yet. If and when it does arrive a rapid distribution may be required to stem its spread. Distributing the cure like a virus may hold the key.

In 2018, researchers at Johns Hopkins Center for Global Security published a report (https://www.telegraph.co.uk/global-health/science-and-disease/self-spreading-vaccines-3d-drugs-tech-will-stop-pandemic/) into the technologies that are already available but have yet to be applied to an emergency situation.

Self-spreading vaccines were among the most eye-catching technologies outlined by the research. Using this method, a small number of individuals are targeted so that an entire population could be protected. The report stated the vaccines could "dramatically increase" the protection of both human and animal populations.

"For human use, targeted release of a weakly transmissible self-spreading vaccine early in an outbreak could create herd immunity in communities and prevent an outbreak from becoming a pandemic," the report says.

It also says that even when introduced after an outbreak has become widespread, self-spreading vaccines could "protect susceptible individuals and limit the number of new cases".

Dr Amesh Adalja, a senior scholar at Johns Hopkins University, says the outbreak of the coronavirus may have come too soon for the technology.

"I don't expect anything like that in the near future for this coronavirus outbreak," he says.

"More than likely it will be for an established seasonal infectious disease where they can do clinical trials to test efficacy. When we do get a vaccine for the coronavirus I suspect it will be more like the traditional syringe vaccine."

However, Dr Adalja says that he sees "no reason" why self-spreading vaccines could not be used in the future to tackle similar outbreaks.

"My suspicion is that the first self-spreading vaccine will be for common types of infections as a proof of concept, before they move to infectious diseases and outbreaks,"

he says.

Such a programme of vaccination comes with significant challenges, particularly around consent and the near impossibility of getting everyone to sign up.

Dr Adalja says the method of vaccination will throw serious medical ethics questions. His view is endorsed by the Department of Health, which explored the technology in a presentation late last year.

In a study from November, the department stated that self-spreading techniques could eliminate "vaccine delay".

The presentation also stated that such vaccines did "very little harm" in comparison to a pandemic.

However, the department highlighted a number of ethical issues that arise with self-spreading vaccines. One of which is that it is "less lethal" not "non-lethal"meaning it can still kill.

"Some people will die who otherwise would have lived, even though fewer people die overall," it stated.

Killing it at source

Human transmission of vaccines is just one strain of thinking for self-spreading technologies. Dr Michael Jarvis, Plymoth associate professor in virology, is heading up efforts to vaccinate the animal population first, ensuring that an outbreak never reaches the human population.

While Jarvis says it's too early to tell if the new coronavirus has emerged from the animal population, many of the previous pandemics have done so.

"If you look at the other coronaviruses that came out like SARS in 2003, that was through human contacts with civet cats that were infected," he says.

"It was the same with Ebola, once it gets into the human population, now it's going to be fuelled by human to human transmission. For a disseminating vaccine the horse has already bolted."

Jarvis founded university spinout The Vaccine Group to explore the method. In January of last year, the group received over £700,000 to combat an antibiotic resistant disease able to jump from pigs to humans with potentially fatal consequences.

He says the group is looking at developing vaccines for cases where conventional vaccination won't work.

“We're looking at methods where you can’t get access to every individual animal to get high enough coverage,” he says.

“We’re using the capacity of the vaccine to spread through populations to get high enough coverage in the animal population to prevent the pathogenic virus moving out into the human population.”

Jarvis also maintains that disseminating the cure through humans causes more significant headaches, with consent among the most-prominent issues.

Previous cases

Self-spreading vaccines have actually been used in the past, however they weren't intentionally meant to.

In the US, a vaccine that was developed to battle polio, which carries a live-but-weakened version of the virus spread briefly to other people before dying off. (https://www.telegraph.co.uk/global-health/science-and-disease/war-polio-two-three-strains-eliminated-hotspots-persist/) It was uncovered by the World Health Organisation, which uses the vaccine to tackle the disease.

However, in the case of the orally-admitted polio vaccine it can mutate and revert back to a virulent form.

"On rare occasions, if a population is seriously under-immunised, an excreted vaccine-virus can continue to circulate," the WHO says.

"The longer it is allowed to survive, the more genetic changes it undergoes. In very rare instances, the vaccine-virus can genetically change into a form that can paralyse."

Much of these rare cases are caused by a strain of polio that no longer exists in the wild. The WHO has also since removed the strain from its vaccine.

The WHO said the risks posed by the vaccine "pales in significance" to the significant public health benefits. It maintains that in excess of 10 million cases have been averted since it began distributing the vaccine 20 years ago.

Developing a vaccine often takes years rather than months and weeks. Oftentimes in the event of a spreading epidemic, public health campaigns such as the ones introduced during foot and mouth and SARS, are implemented. The campaigns have been extremely effective in the past and will be utilised to tackle the new coronavirus.

However, the length of time it takes to develop a virus have not turned off the likes of US-based Moderna Therapeutics and Inovio Pharmaceuticals. The two pharma firms

have received millions from the Coalition for Epidemic Preparedness Innovations.

The coalition has an ambitious goal, which is to have a vaccine ready for human testing within 16 months.

Should the coalition be successful, the Department of Health may have to face up to the ethical concerns of self-spreading vaccines and make a decision.