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The Independent Scientific Advisory Group for Emergencies (SAGE)

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Demystifying messenger RNA (mRNA) vaccines and debunking the myths

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The development of vaccines is one of the greatest ever achievements in public health. They have provided us with the ability to remove the threat posed by many once-common diseases, including those causing infant mortality and disease [1]. Vaccine design has become increasingly more sophisticated as scientific understanding has become more advanced. However, wider public understanding may not keep pace with such scientific and medical advances, which can lead to confusion and vaccine hesitancy. In turn, uncertainty can be further fuelled by misinformation (misunderstanding) and disinformation (deliberate spreading of incorrect information). The problem of mis-and dis-information has been especially severe in relation to the "messenger RNA" (mRNA) vaccines, exploiting that they use a technology that will be unfamiliar for many people, despite having been in use for decades.

The list of applications for mRNA vaccines is growing; this includes not just infectious disease, but also cancers, where they have the potential to change the treatment landscape for some types of cancer that are recalcitrant with respect to standard immunotherapy, such as pancreatic cancer. As such we believe it's important and timely to provide some clarity about mRNA vaccines. To this end, we have assembled some reliable information about how vaccines work and specifically what mRNA vaccines are. We discuss some applications for mRNA vaccine technology including vaccines for COVID (SARS-CoV-2), respiratory syncytial virus (RSV), Ebola, influenza, and cancers such as pancreatic adenocarcinoma, that are either already in use or in late-stage clinical trials. We hope that this will help people to understand these products better, and so make informed decisions about vaccination. Whether you choose to receive a vaccine, or to access one for your children, is a personal choice, but we hope to make it easier for that decision to be an informed one.

This report is organised into the following sections:

1. How does vaccination work?

When your immune system initially encounters a new infection like a virus, it takes time for it to fully respond by, for example, generating protective antibodies. You can become seriously ill or even die whilst your immune system is developing these responses that allow it to best fight off the infection. However, once your immune system has been trained by being exposed to the infection, special memory cells remember what to do and will respond much more quickly and robustly if they meet the same infection again. Most of the time this means you don't become anywhere near as unwell as previously- reducing the risk of severe disease and death, but it can sometimes mean that you don't become infected ever again, which we term "sterilising immunity".

Vaccination will similarly train your immune system for you to generate these robust immune "memories", but it bypasses that dangerous infection stage! All vaccines contain vital information about the pathogen, specifically parts of the pathogens (such as proteins) that are recognised by our immune system. Vaccines can take many forms, for instance a disabled or inactivated form of the pathogen that has been rendered unable to cause infection, or just a small piece of it, such as a single protein or part of a protein; that is all the immune systems needs to learn how to recognise the real thing. For example, COVID-19 vaccines target the spike protein of the virus - this is the spiky bit on the outside that both gives the virus its name (corona = crown), and which the virus uses to enter our cells; targeting this allows antibodies to be made that interfere with infection, as well as flagging up infected cells that are then killed by white blood cells known as T-cells. This is all the information our immune system needs to start making an immune memory. Vaccination means that we no longer need to become infected by a pathogen that can cause a life-threatening disease to obtain protection; that's not to say that vaccines are perfect, but the relative risk of harm is greatly diminished compared to the disease that the vaccine prevents. The benefits are genuinely staggering and transformational, with vaccines saving an estimated 154 million lives from childhood diseases between 1974 and 2024 [2]. In the case of SARS-CoV-2 rapidly emerging and causing the COVID-19 pandemic, one study estimated that almost 20 million deaths had been prevented through vaccination just during 2021, the first year they were rolled out [3]. The numbers saved since then and the impact upon many people's lives has been profound. For a fuller discussion, please see our report on childhood vaccination [1].

2. What are mRNA vaccines?

mRNA is a fundamental component of all life on this planet that acts to convey the information from our genes (made of DNA) to enable us to make the specific proteins we need to survive. Put simply, mRNA is like a recipe for a specific protein. mRNA vaccines therefore contain the genetic "recipe" corresponding to part of the pathogen or disease they target. Hence, when the vaccine is administered, specialised cells at the site of injection take up the mRNA and follow the instructions to make the target protein, just as they would if they had become infected with a pathogen. If it's a vaccine for SARS-CoV-2, for example, the mRNA will hold the information about how to make the spike protein. Our immune cells need this information to know how to respond. Essentially, this is like putting a USB stick into a computer and printing off the file stored on it, containing the protein recipe. The protein produced is then recognised by the immune system as something new or foreign and triggers the specific response to gear up to deal with it; again, this is just as if an otherwise dangerous infection was occurring. Importantly, the production of protein is temporary, just enough time to generate a response, as the mRNA from the vaccine is short-lived, like all mRNA, and is destroyed by the body using specialised, common enzymes in our bodies called RNAses, which recognise, chop up, and so destroy mRNA.

What else is in an mRNA vaccine?

Each vaccine formulation made by a different manufacturer will be made up of slightly different ingredients, depending on how the vaccine has been developed – this is because delivering mRNA into cells and ensuring that it exists long enough to do its job is challenging.

The active ingredient in an mRNA vaccine is, unsurprisingly, a very small amount of mRNA, just 30 or 50 micrograms; a microgram is just one millionth of a gram [4]. The paediatric COVID-19 vaccines (for u12's) have just a third of the adult dose of mRNA! To help deliver the mRNA into our cells it is usually packaged into something called a "lipid nanoparticle". Lipid is another word for fat and nano means microscopically small (one billionth of a metre!), so in essence the mRNA is held in microscopically small blobs of fat. This is needed to (a) help deliver the mRNA into the cell, which itself is contained within a layer of fat known as a cell membrane, and (b) to stop the mRNA being degraded too quickly (by RNAses as discussed above). The lipid nanoparticle itself is not harmful; it merely merges with our cell membranes upon delivering the mRNA inside the cell and is disposed of naturally.

Vaccines may also contain very small amounts of preservatives and stabilisers, such as sorbitol (a sugar often used as a sweetener in our foods) and citric acid (the zingy taste in a lemon or an orange), to maintain the high manufactured quality, and ensure the vaccine is safe to be transported and stored.

These ingredients can be found naturally in the body or in food, and at much higher levels than present within a vaccine. Preservatives are added to vaccines to prevent unwanted chemical changes that may cause degradation, much like they're used in food products to stop them from spoiling. Stabilisers are used to stop the vaccine components separating or sticking to the vial during transportation and storage. All of these individual components will have well evaluated safety profiles. All mRNA vaccines approved for use in the UK will not contain animal products and are therefore suitable for Halal, Kosher, vegetarian and vegan users.

Pros and cons of mRNA vaccine technology

mRNA vaccines have some big advantages or other types of vaccines. mRNA vaccines can be made in cell-free "bioreactors" by supplying the basic building blocks needed to create mRNA. This is just like the natural ways our own bodies make mRNA. Cell-free manufacture means that the quality, composition, and scale of the mRNA is readily achievable to the correct medical standards, and there is no risk of contamination from other biological material, such as when cell culture or eggs are used to make certain vaccines. Because the mRNA in the vaccine is built using the same building blocks as would be found in nature, our cells do not over-react to the vaccine mRNA itself..

mRNA vaccines are also relatively quick to manufacture meaning that they can be readily adapted if a pathogen changes – as for example is needed for some vaccine booster campaigns or if there is a new emergent infection. This has also been helpful for the development of cancer vaccines [5] (see section 3).

Another advantage of mRNA vaccines is that you can include more than mRNA in each inoculation, enabling you to target more than one bit of a pathogen. This is invaluable for pathogens that can mutate quickly, or to protect against more than one pathogen- for example targeting flu and Covid simultaneously. We call such vaccines bivalent (having two mRNA targets) or multivalent (having more than two mRNA targets) vaccines. Bivalent vaccines were used in the development of some of the COVID-19 vaccine campaigns to account for the virus changing, enabling the vaccine to target features of different SARS-CoV-2 variants [6, 7]. Multivalent vaccines are being investigated for the development of a universal flu vaccine [8] that would offer more robust protection against multiple flu types. Applications of mRNA vaccine technology for other diseases will be further discussed in section 3.

During 2020, several approaches were being explored, developed and put through clinical trials for the desperately needed global COVID-19 vaccine campaigns. Compared to more traditional approaches tested (such as whole, inactivated virus), the mRNA vaccines by far outperformed the others. This was true both for lab measurements of immunity and for real-world efficacy, i.e. stopping the majority of people developing severe COVID-19 or dying.

mRNA vaccines do have some disadvantages too as they can require so called cold chain storage (long-term storage requires freezing at minus 80 degrees!). This makes some mRNA vaccines unsuitable for resource poor countries that may not have capacity to keep them cold in shipment and storage [9]. They can also be more expensive to manufacture, making them less accessible for some countries. Furthermore, some countries still lack the infrastructure or training that could enable them to manufacture such vaccines locally [10]. More work is needed to make mRNA vaccination manufacture and supply equitable.

Do mRNA vaccines have side-effects?

All medicines, including vaccines, can have side effects. In particular, as vaccines are designed to evoke our immune systems, most of the side-effects we see come from our immune response being triggered and how that can make us feel. The most important thing is *to consider how serious these side effects are compared with the risk of disease they are designed to target*.

The most common side effects experienced by mRNA vaccine recipients are mild-to-moderate pain at the injection site, fatigue, and headache, which resolve within a few days. These expected side effects happen shortly after vaccination and are not associated with serious or lasting illness; they also happen following other forms of vaccination. They are caused by the natural processes and chemicals released by our bodies as they mount their initial immune response to a foreign body – akin to when we feel poorly when we get an infection, which is the same process.

One of the side effects of COVID-19 mRNA vaccines that has attracted particular attention is rare cases of myocarditis and pericarditis (1 event per million doses, overall), seen particularly in younger males between 16-29 years of age. Myocarditis is inflammation of the heart muscle and pericarditis is inflammation of the lining outside of the heart, so again this is linked to our immune systems misfiring. In younger males (aged 12-15) the risk is less than 0.5 events per million vaccines administered. The risks in other age groups and females are much, much lower than this, with the risk in younger children (under 12s) virtually zero because of the reduced mRNA dose.

These conditions may sound scary, and of course it is concerning for those who experience them. However, the virus itself can cause myocarditis, and this happens far more often and more severely than following the vaccine. The risk is 11-fold higher (irrespective of age group) in the 28 days following a SARS-CoV-2 positive test [11]. Other heart problems such as pericarditis and cardiac arrhythmias are also much more likely following a positive SARS-CoV-2 test. Not only is myocarditis more common **after** SARS-CoV-2, but it is also usually far more severe. Studies report that COVID patients with myocarditis had significantly higher in-hospital mortality compared to those without (30.5% vs. 13.1%)[12]. By contrast, myocarditis after the vaccine is relatively mild, often requiring no treatment, bed rest, or merely non-steroidal anti-inflammatories (e.g. ibuprofen): only 2% of the already-small proportion of people who develop mRNA vaccine myocarditis may need to go to hospital, and nearly all people fully recover within a week, perhaps two. Myocarditis, like any disease, is not all or nothing, ranging from no symptoms (asymptomatic) to severe, but there is now a vast amount of data comparing billions of doses versus billions of SARS-CoV-2 infections that support the risk of infection easily outstripping that of mRNA vaccines.

A very small fraction of the population has reported a chronic condition following immunisation with COVID-19 vaccines, – which shares overlapping symptoms with long COVID and has been dubbed post-vaccination syndrome (PVS). The incidence of PVS is extremely low [13], even compared to other rare adverse vaccine reactions, which has made it difficult to study [14]. For example, one study assessed just 3 patients with other reports involving single case studies. As such, the mechanisms underpinning why some responses lead to PVS are not well understood and there is a lack of clarity as to whether some people had prior infections that may have contributed to this. There does, however, seem to be many similarities between the self-reported symptoms of long COVID and PVS [14]. This may include, for example, clusters of symptoms spanning extreme fatigue, breathlessness, brain fog, neurological problems, cardiovascular issues, and joint pain, persisting for 12 weeks, or more. Logically, given that both infection and vaccination “programme” our immunity in similar ways, this may not be as surprising as it first sounds. Importantly, the phenomenon of PVS has been observed for both mRNA vaccines and other vaccine types, which further supports that it is to do with the immune system misfiring rather than a particular issue specific to one type of vaccine.

What about long-term effects of mRNA vaccines that we can’t know about yet?

The vaccine constituents - the mRNA, lipid nanoparticles and any protein made by the cells in our body that become programmed by the vaccine - exist only for a short time in any measurable quantities and will therefore not stay in the body very long. That means that long term effects are very unlikely for these, or indeed other vaccines.

We might not, so far, have long term data on COVID vaccines (just over four years to date), but we do for many other vaccines. Vaccination has been used regularly as a tool to protect our health since the 18th century. Importantly, without exception, adverse reactions to vaccines *tend to occur a maximum of twelve or so weeks post inoculation – mostly much earlier*. Whilst the effects may rarely be long-lasting, *"latent" (very late) vaccine reactions have never been observed* i.e. random effects arising many months or even years later after the inoculation. Now that vast numbers of people have been vaccinated using mRNA vaccines (many billions), it is almost vanishingly unlikely that we might see any further rare reactions to the vaccine in addition to those we already know about. By contrast, multiple latent events have been associated with SARS-CoV2 infection, including cardiovascular and autoimmune conditions.

3. Diseases for which mRNA vaccines are currently in use/in development

The huge success in trials and implementation of highly effective mRNA vaccines for COVID-19 has helped to catalyse new activity for many serious diseases for which either there have been no licensed vaccines, or vaccine programmes had been experimental or preliminary.

Flu

Annual vaccine programmes for 'winter flu' have long been a subject of concern among healthcare planners: they're urgently needed as winter figures for the UK can be around 5,000 hospitalised per day, with around 20,000 deaths per annum. The problems are that vaccine uptake is often patchy, and the effectiveness of traditional flu vaccine programmes can vary. This is largely because there are virus strain differences from year to year, so the immunity induced by those previously selected for vaccines may sometimes offer incomplete protection. With these problems in mind, there has been a lot of interest – with well-advanced clinical trials – to learn from the successes of COVID-19 mRNA vaccines [15-18].

There are huge benefits from Winter programmes that target both COVID-19 and flu vaccination in a single visit, for all those who are eligible. This is already happening, giving the two vaccines at the same time. The next idea is to make 'multicomponent' mRNA vaccines, so that a single injection of an mRNA vaccine can give protection against both viruses, by programming immunity to proteins from flu and SARS-CoV-2. This has been successfully achieved in clinical trials with immune responses to SARS-CoV-2 that were comparable with other vaccines and enhanced responses to influenza A. However, the responses to influenza B were not as good, so the companies are redeveloping the design for the influenza B target. Nonetheless this is very promising data and indicative of the potential and likely future use [19].

As mRNA vaccine design is so much more adaptable than traditional approaches, trials are already starting to look at including proteins from more parts of the virus that could offer a more universal flu vaccine that might supply protection to different strains from year to year. At a time of continuing concern about the potential of avian flu to cause a pandemic, this approach is ready to go in terms of protective programmes [20, 21].

Ebola

Ebola is a type of virus called a Filovirus (Filo = thread, reflecting their characteristic shape) that cause severe, often fatal, haemorrhagic disease when they cross from animals, usually bats, into humans, and are able to spread between humans thereafter by close contact. The Filovirus family includes eight groups (or genera), of which only three species have been generally associated with human infections. Of the classical group (*Orthoebolavirus*) *Zaire Ebolavirus* caused a large epidemic in West Africa between 2013 and 2016, and *Sudan Ebolavirus* caused an outbreak in Uganda in 2022. Marburg viruses (*Orthomarburgvirus*) were first identified in Germany when infected animals passed disease into humans during the 1960s, but have caused multiple, highly lethal outbreaks since.

Currently developed vaccines primarily target the *Zaire Ebolavirus,* and a 2017, a study showed that two mRNA vaccine formulations produced protective immune responses to Ebola in guinea pigs [22]. Given the severity of Filovirus infections and the fact they often occur in resource poor areas, it would be ideal if vaccine candidates offered broad protection against multiple Filoviruses —rather than having many separate vaccines. Moderna were developing a vaccine candidate using mRNA technology that may have had broader specificity. However, whilst funding for this programme was announced in 2023 [23], it is unclear what the future of this will be given that current US health policies are more averse to supporting vaccine development, infectious disease research, and partnership with developing countries on infection control.

RSV

Respiratory syncytial virus (RSV) disease, as it names suggests, is a virus that causes respiratory conditions that range from mild upper respiratory symptoms to severe lower respiratory tract disease. Older adults, pregnant women and young infants are at increased risk for RSV-related complications. An mRNA vaccine that targets RSV has been clinically evaluated, showing good safety and efficacy in older adults. It has now been approved for use in older adults in the UK, Europe and US with a rollout that started in Autumn 2024 [24, 25]}. The vaccine has also been successfully trialled on pregnant women (to protect the mother and the infant until around 6m of age) and is now being offered in countries including the UK. Following on from the trials of 'multicomponent' respiratory mRNA vaccines to give protection against both COVID-19 and flu, there are plans to incorporate RSV as well. This has potential to be a real game-changer for the annual so-called triple-demic of COVID-19, flu and RSV which overstretches health services such as the NHS every Winter, with tens of thousands of associated deaths.

Cancers

The rapid development of mRNA vaccines during the COVID-19 pandemic has brought an unexpected bonus: the same technology is now being adapted to fight cancer. The progress made during the pandemic has rapidly spread to other areas of medicine, especially cancer treatment. The fact that the mRNA vaccine platform is so flexible means that it can be tailored to enable the development of **personalised cancer vaccines.** These vaccines train the immune system to recognise and attack a patient's own cancer cells, helping to prevent the disease from coming back. This has the potential to revolutionise cancer care, especially with cancers that are difficult to target with targeted/chemotherapies, radiotherapy, or more standard immunotherapy. In the UK, a national cancer vaccine advance was announced in 2023, sparking major excitement across the world [26]. One promising product, V940 [27] —a personalised cancer vaccine—is nearing approval after completing phase 3 trials [28]. This breakthrough could give patients hope for long-lasting protection against cancer.

Research in this area is moving fast, driven by the success of mRNA technology. Companies that were at the forefront of pandemic vaccines, like Moderna and BioNTech, are now reinvesting in cancer vaccines. They are joined by many start-ups that see the potential of using mRNA to create tailored treatments for cancer patients. Healthcare systems are also recognising the benefits, as these vaccines tend to have fewer side effects than standard cancer therapies, are easy to administer, and fit well within existing vaccine infrastructure. The goal is to use these vaccines to teach the immune system to fight cancer by targeting proteins called "neoantigens", which are unique to cancer cells. The hope is that these vaccines could eventually provide long-term immunity. Some of the cancer types currently being tested include lung cancer [29], pancreatic cancer [30] head and neck cancers [31] and melanomas, among many others.

Right now, these vaccines are being developed for people who already have cancer, and the clinical trials are being closely monitored to ensure safety and effectiveness. Because each cancer can be different, the vaccines are designed to be **personalised to the individual patient's tumour**, making the treatment as precise as possible. Whilst the journey is still ongoing, the progress being made offers real hope for a future where mRNA vaccines can stop cancer from coming back, giving patients the chance to live cancer-free.

4. Debunking common myths about mRNA vaccines

"The trials, approvals, and rollout of the COVID vaccines were rushed and not done safely"

Whilst mRNA vaccines may seem quite a new idea to many, the SARS-CoV-2 mRNA vaccines were made possible by many, many years of research and clinical development. For example, the first human clinical trial for an mRNA vaccine against rabies virus took place in 2013 [32], an influenza trial followed in 2015 incorporating lipid nanoparticles [33], and multiple other vaccines targeting other infections [22] and cancers were in human clinical trials before the peak of the COVID-19 pandemic, with promising results and no major safety concerns.

Before any vaccine can be given to people it must go through rigorous testing, which usually takes considerable time. As such, like all medicines, vaccines undergo extensive clinical trials, where they are administered and monitored in groups of volunteers. Although, vaccines for COVID-19 were developed at a much faster pace than normal, no stages of vaccine development and safety were omitted. To understand why it seemed so fast you need to understand why vaccine production is usually slow.

Clinical trials typically operate through 4 stages. Phase 1 trials are typically small (often about 10-20 people) assessing safety, dosage and whether there is an appropriate immune response (measurable antibodies in the serum). Phase 1 trials come in 2 stages- a phase 1a in healthy adults and a phase 1b in healthy adults that are more likely to be infected e.g. live in an area where the pathogen is common. Phase 2 involves more people (up to 100) and looks at safety and immunogenicity (the immune responses). The recruits will typically be from the group from which the vaccine is intended to be used by e.g. older adults or children. The trials will assess safety and how effective the vaccine is by comparing the percentage of reduction of disease in vaccinated versus unvaccinated people. Phase three trials are much larger involving hundreds up to tens of thousands of people. Again they look at the level of immunity that can protect against disease and provide evidence that the vaccine can reduce infection in a given population. The phase IV trials are also called post-marketing surveillance which happen after the vaccines are approved for rollout. These monitor the long-term safety by, for example, looking for rare adverse effects that may only be apparent when a large population is vaccinated as well as long term efficacy- e.g. will the vaccine provide sterilising protection or require boosters.

All three phases (Phase I-III) of pre-vaccine rollout were able to be done at a much swifter speed than normal because we were in an unprecedented emergency. The entire world had essentially no immunity to the emergent SARS-CoV-2 with devastating results, meaning swift action was needed. A major hurdle for vaccine development is funding. Ordinarily, it takes a long time to apply for funding and obtain it, and this causes delays between each phase of vaccine testing. However, the emergency meant that abundant resource was made available by Governments and pharmaceutical companies alike, including new unprecedented partnerships between academia, governments and industry. Further delays in vaccine development can ensue whilst researchers negotiate with manufacturers to scale up production of vaccines products, but these were circumvented because of massive international cooperation. Moreover, mRNA vaccines are generally quicker to make at scale compared with other platforms.

Defining appropriate vaccine targets (which bits of a pathogen to target a vaccine to) can take some time but the pace of research into the virology and immunology of SARS-CoV-2 was massively accelerated. This was partly because many of the basic principles were in place and ready to go following the earlier programmes developing vaccines against the related SARS and MERS viruses. Furthermore, scientists shared knowledge openly and promptly during the pandemic, meaning vaccine targets were identified extremely quickly. Huge effort was also made to speed up the administrative pipelines by the scientists, doctors, ethics approval boards, manufacturers and regulatory agencies, all coming together to work harder and faster on things like ethical approvals (for each stage of the clinical trials) and safety assessments of data from each stage of the clinical trial. This cooperation accelerated each step of the vaccine development.

The principal bottleneck in most vaccine development is the ability to recruit sufficient appropriate patients for clinical trials as well as the infrastructure to run the trials. There was an enormous public response to the various COVID trials. As a consequence of all this unprecedented cooperation, the trials were moved seamlessly from one phase to the next. As a result, the conclusive large "phase three" trials were much larger than the majority of studies for other diseases – often with more than 40,000 people per group -and they reported data promptly and quickly due to unprecedented need. Thus, regulatory bodies had vast amounts of data to support their assessments within mere months during 2020/21.

In the UK, the results of clinical trials (including the trials for the mRNA vaccines) are assessed by the Medicines and Healthcare products Regulatory Agency (MHRA). Stringent licencing processes and safety tests ensure that the health benefits of all medicines and vaccines that are provided via the NHS are safe. As vaccines are given to prevent rather than treat disease they are given to healthy people. As such, these regulatory measures are even stricter than with conventional medicines, meaning that the level of 'acceptable risk' for vaccines is much lower than it would be for other medicines. The UK was the first country to grant an "emergency use authorisation" for the Pfizer mRNA vaccine, enabling rapid data evaluation rather than waiting for scheduled meetings to assess the data (that usually happen at pre-determined times of the year). As such, this emergency authorisation served to cut the time and red-tape necessary to physically get the vaccines into arms. The UK was joined by virtually every country and bloc in the world by initially, and subsequently fully approving mRNA COVID vaccines.

Like all vaccines, the safety of the mRNA vaccines has continued to be monitored by regulatory authorities (as part of usual phase IV practice) and there are robust reporting systems for adverse events associated with the injections.

"mRNA vaccines will alter my DNA"

No. The mRNA delivered by the vaccine cannot enter the nucleus of your cells, where your DNA is stored, and will degrade naturally within hours as per what happens to natural mRNA. At no point is your DNA interfered with. Put simply, cells have no machinery that could ever incorporate mRNA vaccines into your genes.

"mRNA vaccines are causing turbo cancers"

There is zero evidence linking the vaccines with cancer or so-called turbo cancers. Remember vaccines (and all drugs) are monitored once they have been approved as part of ongoing phase IV evaluation.

The claims appear to centre on ideas that either the inflammatory response to the vaccines, or that "long-lived spike protein" is somehow oncogenic, or "cancer causing". Whilst certain types of chronic inflammation can indeed contribute to cancer causation over prolonged periods (usually a decade or more), there is no evidence that vaccines cause such long-term inflammation and therefore this logic is flawed. Although sadly, there has been a long-term trend for cancers beginning to affect more and younger people, this has been ongoing for many years, predating the pandemic as well as the development of COVID vaccines, and the reasons for this are a complex interplay between lifestyle changes, environmental factors and genetics. Crucially, NO reputable peer reviewed studies have been undertaken that have linked vaccines to the development of cancer. There has been some popular coverage of anecdotes that 'more cancers seem to be popping up since the pandemic and vaccine programmes', but this is likely explained by the backlog of people who were delayed in getting a diagnosis and seeking treatment during the first two years of the pandemic.

"People, including young people, taking mRNA vaccines have "died suddenly" from heart problems"

No, this is not true. It seems to stem from claims by some bad actors that mRNA vaccines have caused widespread cardiovascular disease, including myocardial infarction (aka a heart attack), embolisms (blockage of the arteries by blood clots), abundant myo/pericarditis, and other rarer causes of sudden heart failure. As discussed in section two, rare myocardial events have been linked to the mRNA vaccines this was much less severe than those caused by COVID-19, in unvaccinated individuals. Importantly rare myocardial events occur soon after vaccination and not months or years later. Often these accusations of people who died suddenly are actually found to have died of unrelated causes such as accidents. Importantly, the Office of National Statistics (ONS) assessed all data in the UK and showed conclusively that people that had been vaccinated had significantly improved life expectancy compared with unvaccinated people during the first three years of the pandemic [34].

"mRNA vaccines contain microchips, nano-devices, graphene oxide, or other things that detect 5G signals, and they induce magnetism in the skin following injection."

These claims are, unsurprisingly, demonstrably false – for a fuller discussion of vaccine ingredients see section two. Microscopy studies claiming to show objects within vaccine preparations are disingenuous, showing high magnification images of contaminants present such as bits of fluff on a microscope slides because of poor scientific practice. They are most certainly not capable of receiving or transferring messages from a 5G mast.

Key messages

Vaccines, like clean water and antibiotics, have been amongst the great advances in the history of medicine. Killer diseases of the past, especially childhood diseases, have been controlled globally by routine vaccination programmes. There are different ways of formulating a vaccine to stimulate immunity, with mRNA vaccines having come to public attention due to their huge success in reducing the severity of infection during the ongoing COVID-19 pandemic. More than 20,000 peer-reviewed papers have been written in medical journals on their use and safety. They generally out-perform other vaccine approaches in their efficacy, a property that puts them in a strong position to impact healthcare across infectious diseases, cancer prevention, and possibly other illnesses in the future.

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