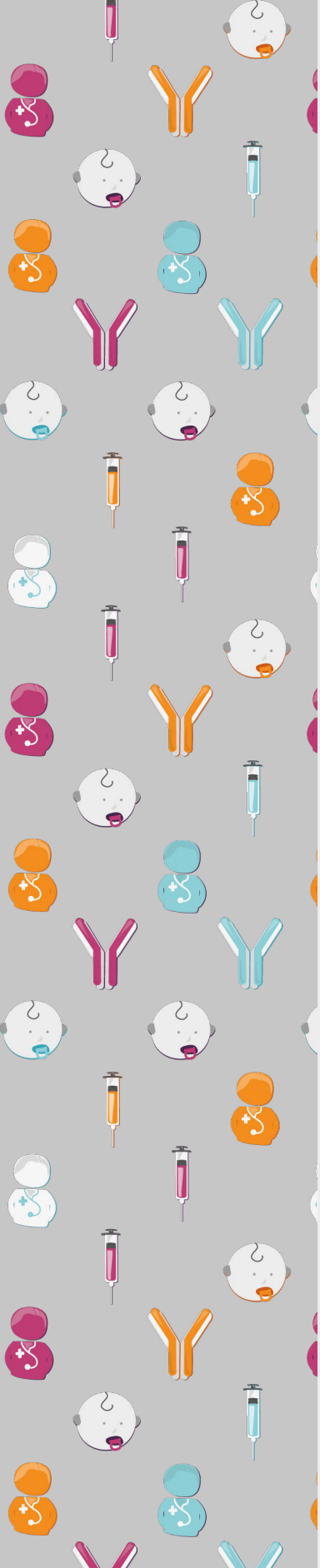

British Society for immunology

A guide to childhood vaccinations


Immunisation is the safest way to protect your child's health
Public Health England

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1

How vaccines work & why they're important

How do vaccines work?

You are given a small amount of a harmless form of a disease...

...Then your body makes antibodies to fight it off

Then if the real disease attacks...

...your body already has the antibodies, so you don't get sick. You are immune.

What is vaccination?

Vaccination is the safest way to protect your child against an infectious disease. Once your child has been vaccinated, they should have the ability to fight off the disease if they come into contact with it. They will have a level of protection, or **immunity**, against the disease.

How does vaccination work?

The immune system is a network of cells, tissues and organs that work together to help you fight off infection from harmful bacteria or viruses. When a disease-causing agent, such as a virus or bacteria, invades your body, your immune system recognises it as harmful and will trigger a response to destroy it. One of the ways your immune system fights off infection is by creating large proteins known as antibodies. These antibodies act as scouts, hunting down the infectious agent, and marking it for destruction by the immune system. Each antibody is specific to the bacteria or virus that it has detected and will trigger a specific immune response. These specific antibodies will remain in the immune system after the infection has gone. This means that if the same disease is encountered again, your immune system has a 'memory' of the disease and is ready to quickly destroy it before you get sick and any symptoms can develop. Sometimes, however, the immune system doesn't always win this initial battle against the harmful bacteria or virus and you can become very ill or – in extreme cases – die.

Vaccination is the safest and most common way to gain immunity against a bacteria or virus that your body has yet to encounter. Vaccines contain a harmless form of the bacteria or virus that causes the disease you are being immunised against. The bacteria or virus will be killed, greatly weakened, or broken down into small parts before use in the vaccine so that they can trigger an immune response without making you sick. Your immune system will still attack the harmless form of bacteria or virus from the vaccine and will produce antibodies to fight it off. The immune system then keeps a memory of the disease, so if a vaccinated person encounters the disease years later, their immune system is ready to fight it off and prevent an infection from developing.

Is it better for my child to get the disease naturally?

No. The only way to get the disease naturally would be through infection with the bacteria or virus that causes the disease. This would pose a serious risk to your child's health, potentially making them very ill and causing long-term effects. Some diseases, such as measles and meningitis, can also be fatal. Natural infection also enables the disease to spread from your child to those around them, increasing the risk of others getting ill. Vaccination allows your child to build up immunity in a safe and controlled environment without becoming ill with the disease and passing it to others.

How effective is vaccination?

Vaccination is extremely effective with most childhood vaccines effective in 85% to 95% of children who receive them.[1] It is considered one of our greatest global health achievements and is estimated to save 2–3 million lives a year.[2]

Thanks to vaccines, life-threatening diseases that used to be common in young children in the UK, such as diphtheria, whooping cough and polio, are now relatively rare. Looking at the history of vaccine-preventable disease, there is a huge drop in the number of cases of a disease following the introduction of a vaccine against it. If smallpox had not been eradicated, it would cause 5 million deaths worldwide a year![3] Through vaccination, some diseases have even been eradicated completely, for example smallpox.

Have vaccines made a difference?

Year the vaccine was introduced		Cases per year in England and Wales before the vaccine	Cases per year now (post vaccine)
1942	Diphtheria vaccine	50,804	7
1957	Pertussis vaccine *(whooping cough)*	92,407	3,266
1968	Measles vaccine	460,407	1,034
1991	Hib vaccine	862	15
1998	MenC vaccine	883	28

Number of cases per year now represent most recent data from 2016-2018.[4]

If these diseases are so rare, why does my child need to be vaccinated?

All of the diseases that we vaccinate against exist in the world today. Therefore, if your child has not been vaccinated, there is still a risk that they could get the disease and become very sick. We know that decreases in vaccination uptake can result in outbreaks of diseases such as measles.[5] Regular vaccination is needed to keep our children healthy, prevent outbreaks from occurring and to eventually eradicate these diseases altogether.

Infectious diseases are easily passed from person to person and entire communities can rapidly become infected. If a high enough proportion of a community is protected by vaccination, it makes it difficult for the disease to spread because the number of people who can be infected is so small. This type of protection is known as **'herd immunity'** and is particularly crucial for some individuals who are unable to receive some vaccines. This may include those that are too young, undergoing certain medical treatment (such as for cancer) or have a health condition that impairs the function of their immune system (such as HIV). Declines in herd immunity caused by decreasing vaccination rates have recently caused outbreaks of measles and whooping cough in the UK.[6,7]

For herd immunity to work, a high percentage of the community needs to be vaccinated. Although average vaccination rates in the UK are relatively high, there are still pockets of the UK where rates fall significantly below what is required for herd immunity.[8] If the vaccination rates in your community are not high enough, it will leave the most vulnerable in your neighbourhood at a much greater risk of catching the disease. By vaccinating your child, you're not only protecting them, but you are also protecting the most vulnerable in your community.

What is ‘herd immunity’?

If only a few people are vaccinated...

...then one person is infected... the disease spreads very fast.

But if lots of people are vaccinated...

...then the disease can’t spread very far,
so the whole community stays safe.
This is ‘herd immunity’.

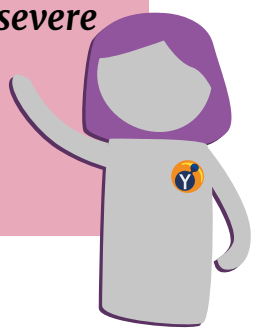
How do I know vaccines are safe?

Before a vaccine can be given to the population it must go through rigorous testing. Like all medicines, vaccines go through many clinical trials, where they are administered and monitored in groups of volunteers. In the UK, the results of trials are then assessed by the Medicines and Healthcare products Regulatory Agency (MHRA). Once licensed, the vaccine must then be further approved by the MHRA before it is added to the routine vaccination programme.

Even once a vaccine becomes part of the vaccination programme, it is continually monitored for safety and effectiveness by the MHRA. Any suspected side effects are reported by medical providers or patients to the MHRA using the yellow card scheme.

No medicine can ever be completely risk free or 100% effective. However, strong licensing processes and safety tests ensure that the health benefits of medicines being given through the NHS greatly outweigh any risks. As vaccines are given to healthy people, these regulatory measures are even stricter, meaning that the level of 'acceptable risk' for vaccines is much lower than it would be for other medicines.[9]

> ***Your immune system is there to protect you; by vaccinating your child, you give his/her immune system all the tools it needs to keep them safe from many severe diseases.***
>
> *Meike Heurich-Sevcenco, BSI Vaccine Champion*



What are vaccines made of?

Each vaccine will be made up of slightly different ingredients depending on the disease it is targeting. The active ingredient in a vaccine is a very small amount of the killed, greatly weakened or broken-down parts of the bacteria or virus you are vaccinating against. Vaccines also contain small amounts of preservatives and stabilisers, such as sorbitol and citric acid. These can already be found in the body or in food – usually in much larger quantities than the amount used in a vaccine. However, the most abundant ingredient in a vaccine is water.

Some vaccines also contain aluminium – usually in the form of aluminium hydroxide. Aluminium is found naturally in nearly all food and drinking water and is used in vaccines to strengthen and prolong the immune response they generate.[10] The amount of aluminium in vaccines is extremely small and a recent study found that, in an infant's first year of life, the total amount of aluminium in both vaccines and food is less than the weekly safe intake level.[11] Aluminium is also found in many other medicines, such as heartburn medication.[12]

Formaldehyde is used in the manufacture of vaccines. It is an organic compound which is found in many living things and humans produce formaldehyde naturally as part of the metabolic process. While it is true that high levels of formaldehyde can be harmful to humans, the amount of formaldehyde present in any vaccine is fifty times smaller than that found in a pear.[10]

For a complete list of ingredients in each individual vaccine, you can refer to the Patient Information Leaflet (PIL) or Summary of Product Characteristics (SPC) sheet that comes with each vaccine. Both can be found online. Helpful information can also be found on the University of Oxford's Vaccine Knowledge Project webpages.

> ***Immunisation is a proven tool for controlling and eliminating life-threatening infectious diseases and is estimated to avert between 2 and 3 million deaths each year.***
>
> *World Health Organization*

2

Vaccine schedule recommended by the NHS and common questions

Many women question whether they should receive vaccines during pregnancy. Doctors recommend that pregnant women get vaccinated against flu and whooping cough to protect themselves and to share that protection with their baby.

Can I have vaccines when I am pregnant?

Yes. Some vaccines, such as the inactivated flu vaccine and the whooping cough vaccine, are offered to pregnant women to protect them and their unborn child.[13, 14] These vaccines are perfectly safe and are extremely effective at preventing serious illness from these infectious diseases. Inactivated vaccines do not contain any live version of the bacteria or virus they are protecting against.

During pregnancy, a woman's natural immune system is weakened. This may make it more difficult for them to fight infection and increase their risk of harm from common diseases, such as flu. Therefore, pregnant women are among a group that are especially vulnerable to flu complications, something which the vaccine can protect against.

Whooping cough, or pertussis, is a very serious infection and young babies are the most at risk. During pregnancy, vaccination against whooping cough will lead to the production of antibodies which will be passed on to the baby during the last three months of pregnancy through the placenta.[14]

Therefore, vaccines not only protect the mother during pregnancy, but also protect their unborn and newborn child.

If a vaccine is made up of a live, but weakened, version of the virus, pregnant women will usually be advised to wait until after birth to receive these. It is important that you speak to your midwife, practice nurse or GP if you are concerned about vaccines during pregnancy.

When and how many vaccines does my child need?

When?	What?
8 WEEKS	• **6-in-1 vaccine** *protects against diphtheria, tetanus, whooping cough, Hib, HepB and polio, first dose* • **Rotavirus vaccine** *first dose* • **Meningococcal group B (MenB) vaccine** *first dose*
12 WEEKS	• **6-in-1 vaccine** *second dose* • **Rotavirus vaccine** *second dose* • **Pneumococcal (PCV) vaccine** *first dose*
16 WEEKS	• **6-in-1 vaccine** *third dose* • **MenB vaccine** *second dose*
1 YEAR	• **Hib/MenC vaccine** *given as single vaccine against MenC (first dose) and Hib (fourth dose)* • **MMR vaccine** *protects against measles, mumps and rubella, first dose* • **PCV vaccine** *booster* • **MenB vaccine** *booster*
2–10 YEARS	• **Nasal flu vaccine** *yearly*
3 YEARS, 4 MONTHS	• **MMR vaccine** *second dose* • **4-in-1 pre-school booster** *given as single vaccine protects against diphtheria, tetanus, whooping cough and polio*

Correct as of February 2020. Always check the NHS website for the most up-to-date information.

Why are changes made to the immunisation schedule?

The immunisation schedule is continually monitored to ensure that the timing and type of vaccination is as beneficial to your child as possible. Improvements to the schedule may involve changing the recommended age a vaccine is given at, the number of doses required, or introducing a new vaccine combination. Following extensive research, trials and analysis, new vaccines will also be added to the schedule to increase the number of diseases that your child can be protected from.

The most important thing to remember is that any change to the immunisation schedule is there to help keep your child as safe as possible, by protecting them from more diseases and ensuring a vaccine is as effective as possible.

> ***There is so much information out there about vaccines. Engaging with parents/carers on immunisations is a great way to help them make an informed decision about the best start to a healthy life for their child.***
>
> *Shannon Lacombe,*
> *BSI Public Engagement and Vaccine Champion*

Can receiving multiple vaccinations overload the immune system?

No. Your child's immune system fights off millions of germs every day. The amount of bacteria or virus in a vaccine is very small in comparison and will put no extra strain on your child's immune system. Even if your child received a number of different vaccines at once, they would still only be using less than a thousandth of their immune system's capacity.[15]

Why do I have to vaccinate my child at specific times? Can I wait until they're older?

The immunisation schedule has been designed so that your child can be vaccinated as soon as possible, at a time when each vaccine will be the most effective.

It is important to vaccinate your child at the age advised to make sure that they are protected from an early age. Babies and young children are the most vulnerable to disease and the longer you wait to vaccinate your child, the greater the possibility of them catching the disease and becoming ill.

If you miss an appointment you can still get your child vaccinated after the recommended age. However, keep in mind that the longer you wait, the longer you leave your child unprotected and vulnerable to disease. Please speak to your health visitor, practice nurse or GP for further information about vaccinating your child outside of the recommended times.

Is there a situation when a child shouldn't be vaccinated?

If a child is unwell with a fever, then vaccination will usually be postponed until they are better. Otherwise, it is very rare that a child is unable to be vaccinated. Only children with a weakened immune system, caused by a medical treatment such as chemotherapy, an allergy to the vaccine or its components, or certain medical conditions affecting the function of their immune systems are unable to receive all the vaccines recommended in the immunisation schedule. Please speak to your health visitor, practice nurse or GP if you are concerned about whether your child is able to receive all the vaccines on the immunisation schedule.

What is a booster vaccine and why does my child need one?

Booster vaccines do exactly what they say on the tin – they give your immune system a boost against the disease! For some vaccines a further round of exposure to the vaccine is required to increase immunity against the disease. Immunity against some diseases can fade over time and it is important to keep up to date with your child's booster vaccines to ensure that they are as protected as possible.

Why do some children still get the disease even after they've been vaccinated?

Most vaccines produce immunity in 85% to 95% of children who receive them, making them the most effective medical intervention we have for preventing disease. However, no medicine can ever be 100% effective and the effectiveness of the vaccine will differ depending on how it is made and the disease it is protecting you from.[16]

Variations in individual immune systems mean that the protective capacity of the vaccine will vary between different people, and in a very small number of cases, immunity against the disease will not fully develop. However, vaccination is extremely effective for the majority of the population, and if a high enough proportion of people are immunised, those who have not developed immunity from the vaccine will be protected by herd immunity.[17] Even if your child does catch the disease after they have been immunised, their symptoms are likely to be much milder in comparison to those in children who have not received the vaccine.[16]

3

Vaccine myths

Concerns over vaccine safety have allowed myths and misconceptions about vaccination to spread among parents, despite there being little, if any, evidence to back them up. However, the large amount of unverified information available on the internet about vaccination can make it difficult to distinguish the facts from the myths. Here are some of the most common myths about vaccines and the truth behind them.

Does the MMR vaccine cause autism?

In 1998, a former and now discredited doctor published a paper to suggest a link between the MMR (measles, mumps and rubella) vaccine and development of autism. The actual paper showed no such link and it was subsequently removed from publication due to ethical violations, financial conflicts and serious errors in data collection.[18] The doctor was also struck off the General Medical Council. The excessive amount of media coverage of the report and these statements caused panic among parents and a fall in vaccination rates, which ultimately resulted in dangerous measles outbreaks around the country.

Multiple studies have since been carried out, studying a large number of participants, to investigate if there is any relationship between MMR vaccine and autism. None of these studies has identified any links between the MMR vaccine and autism.[19,20,21] If you want to read more about this research, there is an additional resource list at the back of this booklet.

Is there mercury in vaccines and will this be toxic for my child?

Extensive research shows that there is no link between the levels of mercury, also referred to as thiomersal, used in vaccines and conditions such as brain damage and autism in children. Nevertheless, in an effort to reduce global environmental exposure to mercury, US and EU regulators have phased out thiomersal use in vaccines and none of the routine vaccines in the UK contain thiomersal.[10, 22, 23]

Is it safer to receive vaccines separately rather than in combination?

Multiple vaccines are given in a single healthcare appointment to make sure that your child is protected from a disease as soon as possible and to avoid you having to make multiple appointments. There is no medical benefit to spreading vaccinations out over multiple appointments.

Some vaccines are combined into a single shot to limit the number of injections your child has to receive; for example the 6-in-1 vaccine reduces the number of injections from six to one. The combined vaccines have been shown to be as effective as the single injection and they do not pose any safety concerns or greater risk to your child.

Do vaccines cause allergies and autoimmune diseases?

The occurrence of autoimmune diseases, such as rheumatoid arthritis, and allergies has increased over the last few decades and it is still unclear why this is happening. Vaccination rates have also increased during this time, which has led some people to believe that vaccines could be the cause. However, many large-scale studies have not found any evidence that vaccination triggers allergies or causes autoimmune disease.[24, 25] The rise in allergies and autoimmune diseases has been more closely linked to lifestyle and environmental changes.

Are animal products used in vaccines?

Some live vaccines contain gelatine, which is derived from pigs. This is used to stabilise the vaccines so that they can be stored safely at different temperatures. The gelatine used is highly purified and broken down into very small molecules. Members of some faiths may however be concerned about using vaccines containing pig-derived gelatine. According to Jewish laws, there is no problem with porcine products in non-oral products – including vaccines.[26] Similarly, many Muslim leaders have ruled that the presence of gelatine in vaccines does not break religious dietary laws due to its high purification and non-oral administration.[26]

Additional resources

To access the references in this guide
www.immunology.org/celebratevaccines/references

British Society for Immunology
www.immunology.org

Childhood routine immunisation schedule
http://bit.ly/ImmsSch

NHS website – vaccinations and when to have them
http://bit.ly/NHSvacc

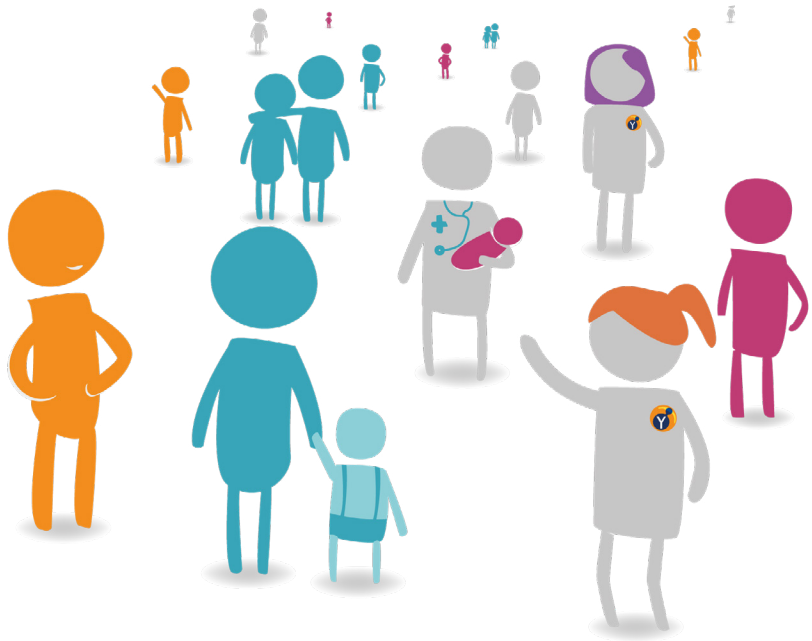
NHS website – why vaccination is safe and important
http://bit.ly/NHSsafe

Vaccine Knowledge Project (University of Oxford)
http://vk.ovg.ox.ac.uk/

Public Health England 'Immunisations up to one year of age' information booklet
http://bit.ly/PHEyear1

MHRA yellow card scheme
https://yellowcard.mhra.gov.uk/

If you have any questions about vaccines, ask your GP, nurse or other healthcare professional.



The British Society for Immunology's mission is to promote excellence in immunological research, scholarship and clinical practice in order to improve human and animal health.

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