

Vaccines: What you really need to know

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Misconceptions

- Vaccinations Cause Autism
- Natural Immunity is better than Vaccine Acquired Immunity
- Vaccines Contain Unsafe Toxins
- Vaccines are 100% Effective
- Vaccine-Preventable Diseases are not that Dangerous
- Infant Immune System Cannot Handle Multiple Vaccines
- Better Hygiene Is Responsible For Decreased Infections
- Vaccines Are Not Worth The Risk
- Vaccines Can Cause The Disease They Are Supposed To Prevent
- Vaccines Are Unnecessary Due To Low Infection Rates In The US

Vaccinations Cause Autism

- In 1998, Andrew Wakefield, et al. published a study in The Lancet that documented an association between MMR vaccine and symptoms of autism
- Study by Funderberg in 1996 suggested that autism may be an autoimmune disorder, and that individuals with certain genetic predispositions should avoid live vaccines until 3 years of age
 - Follows current recommendations that patients with compromised immune systems should first discuss receiving any live vaccinations with doctor
- Study by Gupta in 1996 suggested patients with autism presented shortly after receiving MMR vaccine

Vaccinations Cause Autism cont.

- Flaws of Wakefield study
 - 12 children studied
 - The parents linked the MMR vaccine to onset of behavioral problems, not diagnosed by a physician
 - No control group in the study
 - Wakefield had filed a patent for a measles vaccine
- Flaws in all of these studies
 - Observation only

Vaccinations Cause Autism cont.

- Numerous studies were conducted in response to Wakefield's publication
 - Cohort study in Denmark with 537,303 children found no increase in the risk of autism between unvaccinated and vaccinated children
 - Several retrospective, observational studies
 - Several prospective, observational studies
 - All found no association between the MMR vaccine and autism

Vaccines Cause Autism cont.

- In 2004, 10 of the original 12 authors of the Wakefield study retracted the original interpretation of the causal link between the MMR vaccine and autism
- The Lancet retracted the article in 2010

Vaccines Cause Autism cont.

- A new theory arose that thimerosal in vaccines was causing autism
- In 1999, the Public Health Service, CDC, Health Resources and Services Administration, and the American Academy of Pediatrics issued joint statements urging manufactures to reduce or eliminate thimerosal in vaccines
- FDA conducted a review on the use of thimerosal and found no evidence to support that it caused any harm other than local hypersensitivity reactions
- Thimerosal is no longer in any vaccines recommended in childhood routine vaccination schedules

Vaccine-Preventable Diseases are not that Dangerous

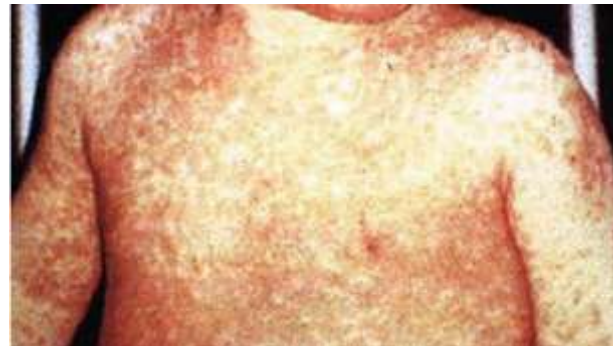
Impact of Vaccines in the 20th & 21st Centuries

Comparison of 20th Century Annual Morbidity & Current Morbidity

Disease	20 th Century Annual Morbidity*	2013 Reported Cases [†]	% Decrease
Smallpox	29,005	0	100%
Diphtheria	21,053	0	100%
Pertussis	200,752	28,639	86%
Tetanus	580	26	96%
Polio (paralytic)	16,316	1	>99%
Measles	530,217	187	>99%
Mumps	162,344	584	>99%
Rubella	47,745	9	>99%
CRS	152	1	99%
<i>Haemophilus influenzae</i>	20,000 (est.)	31 [§]	>99%

Vaccine-Preventable Diseases are not that Dangerous

- Measles used to be so common that nearly everyone got measles before it was vaccinated against
 - 3 to 4 million people were killed every year
 - 500,000 cases were reported each year to the CDC
 - 400-500 died each year
 - 48,000 were hospitalized
 - 1,000 developed encephalitis
- Measles cases are less than 99% of what they were before vaccination began



Vaccine-Preventable Diseases are not that Dangerous cont.

- Rubella killed 2,000 babies and caused 11,000 miscarriages in the United States in 1964-1965
 - Rubella affects pregnant women and developing babies most seriously by causing miscarriages or death soon after birth
 - Babies that survive to birth with mothers infected with rubella will likely be born with serious birth defects known as congenital rubella syndrome
- Rubella can result in brain infections, bleeding problems, and arthritis in adults
- Only 15 cases of rubella have been reported in the last 5 years due to high vaccination rates

Vaccine-Preventable Diseases are not that Dangerous cont.

- Diphtheria caused the death of more than 15,000 Americans in 1921
- Diphtheria has a fatality rate of around 5-10%
- Serious complications include myocarditis and neuritis that can lead to heart failure and paralysis
- Less severe complications of diphtheria include otitis media and respiratory insufficiency
- Only two reported cases of diphtheria were reported between 2004-2014

Vaccine-Preventable Diseases are not that Dangerous cont.

- Tetanus complications include laryngospasm, bone fractures, pulmonary embolism, pneumonia, and breathing difficulty
- Results in death for 1-2 out of ten cases
- Tetanus cases are at historically low rates in the United States due to vaccinations



Vaccine-Preventable Diseases are not that Dangerous cont.

- Hepatitis complications are rare but extremely deadly
 - Hepatitis A can cause fulminant hepatitis with mortality rates up to 80%
 - Hepatitis B causes fulminant hepatitis in about 1-2% of infected patients resulting in the death of around 200-300 Americans every year



Natural Immunity is better than Vaccine Acquired Immunity

- Natural immunity and vaccine acquired immunity produce the same response from the immune system
 - T cells and B cells are activated to fight off infections
 - Memory T cells and B cells are formed after the infection is cleared so that whenever a person is re-exposed, the body mounts an immune response and fights off the infection before it progresses to a major infection like the first exposure
 - The major difference between natural immunity and vaccine acquired immunity is that vaccine acquired immunity does not cause an actual infection
- Natural immunity can be acquired through breast milk
 - Passive immunity
 - Only lasts for a few weeks
- Infection with vaccine preventable diseases can result in serious complications

Natural Immunity is better than Vaccine Acquired Immunity cont.

- Natural immunity does last longer than most vaccine acquired immunity
- Some vaccinations provide better immunity than natural infection does
 - Human papillomavirus (HPV)
 - *Haemophilus influenzae* type b (Hib)
 - Tetanus
 - Pneumococcal

Natural Immunity is better than Vaccine Acquired Immunity cont.

- HPV vaccines are highly immunogenic, generating antibody concentrations after the 3rd immunization that are 1-4 logs higher than those in natural infections
- The higher antibody concentrations last for about 7-9 years
- The antibody response from the HPV vaccine is thought to be more potent due to:
 - Natural infection in epithelial cells does not allow direct access to lymphatic tissue that an injection does
 - The cells that respond to natural infection are macrophages and Langerhans cells vs dendritic cells that respond first to the HPV vaccine exposure
 - Dendritic cells act quickly to recruit T and B cells to fight off the infection

Natural Immunity is better than Vaccine Acquired Immunity cont.

- Hib and pneumococcal vaccines provide a better immune response in children under 2 than natural infection does
 - Children under 2 do not yet have the full B-cell response from their immune systems that older children and adults do
 - Without the fully activated B-cell response, children do not respond as well to the polysaccharide on the surface of Hib and pneumococcal pathogens
 - Vaccines contain a helper protein that creates a better response from the immune system to help it recognize the polysaccharide complex

Natural Immunity is better than Vaccine Acquired Immunity cont.

- Tetanus toxin is so potent that the amount that actually results in disease is smaller than the amount required for long-term immunity
- The tetanus vaccination contains a much higher amount of inactivated toxin that produces a longer lasting immunity than natural infection does
- Booster shots every 10 years are still required for tetanus vaccinations because the vaccine does not produce lifelong immunity

Natural Immunity is better than Vaccine Acquired Immunity cont.

- Vaccinations offer an additional advantage over natural immunity because they provide protection against several strains of an infection whereas natural infection only provides immunity against that one strain of disease
- Example: Seasonal influenza vaccination
 - Includes protection against certain A and B subtypes depending on the season
 - Usually three of four strains
 - Natural immunity only provides protection against the one subtype that caused the infection

Vaccines Contain Unsafe Toxins

- Ingredients included in vaccines serve useful purposes and are not harmful in the amounts given
- For most of the ingredients found in vaccines, more is consumed from everyday lifestyle than the vaccine contains
- Components of vaccinations help to ensure vaccines remain sterile, potent, and stable

Vaccines Contain Unsafe Toxins cont.

- Common ingredients in vaccinations include:
 - Suspending fluids
 - Sterile water, saline, fluids with protein
 - Preservatives
 - Thimerosal, phenol, benzethonium chloride, 2-phenoxyethanol
 - Stabilizers
 - Sugars, amino acids, salts, proteins
 - Adjuvants
 - Aluminum hydroxide, aluminum phosphate, mixed aluminum salts
 - Antibiotics
 - Formaldehyde
 - Egg protein

Vaccines Contain Unsafe Toxins cont.

- Thimerosal, a mercury-containing preservative, is the most controversial preservative
- Thimerosal contains ethylmercury not methylmercury
 - Methylmercury is attained through eating fish and other seafood and is the dangerous form of mercury
 - Ethylmercury is less toxic due to faster degradation
- Thimerosal has also been removed as a component of all childhood vaccines

Vaccines Contain Unsafe Toxins cont.

- Formaldehyde is used to inactivate the viral or bacterial component so that they do not actually cause disease
- The concentration of formaldehyde left in the final vaccine product is extremely small and higher amounts are found in the body naturally
 - FDA study conducted showed that the formaldehyde levels in vaccines is less than or equal to 0.02%
 - Formaldehyde is removed from the injection site within 30 minutes
 - The peak concentration of formaldehyde in the blood from vaccines was found to be less than 1% of the amount of formaldehyde found in the body naturally

Vaccines are 100% Effective

- Everyone has a unique immune system that can respond to immunizations differently
 - Some do not generate an adequate response to a vaccine
- Vaccine effectiveness is extremely high
 - 97% of people are immune to measles and 88% of people are immune to mumps after two doses of MMR
 - Polio vaccine is 99% effective after receiving three doses
 - 85% of individuals are immune to varicella and 100% are immune from moderate and severe chicken pox after one dose
 - Influenza vaccine effectiveness depends on the year but is estimated to be around 50-60% when the vaccine viruses chosen match most of the circulating influenza viruses

Vaccines are 100% Effective cont.

- Influenza vaccine effectiveness depends on who is being vaccinated
 - Most effective in healthy adults and older children
 - People with suppressed immune systems do not always mount a sufficient immune response
- Influenza vaccine effectiveness is continually studied by the CDC as part of the U.S. Flu Vaccine Effectiveness Network
 - Has been studied since the 2003-2004 flu season
 - Effectiveness varies from 10-60% with the lowest effectiveness in 2004-2005 and the highest effectiveness in 2010-2011
 - 2014-2015, influenza vaccine effectiveness was at 19%, the lowest effectiveness since 2004-2005

Vaccines are 100% Effective cont.

- Multiple vaccinations are required to build up the full immune response for some diseases
- Tetanus and diphtheria shot is required every 10 years to ensure an adequate response is still produced if exposed to these diseases
- Varicella, HPV, MMR, pneumococcal, hepatitis A, and hepatitis B vaccines all require booster doses to maintain an active immune response

Infant Immune System Cannot Handle Multiple Vaccines

- Children are normally given multiple vaccines in the same doctors visit in order to:
 - Get the child protected as soon as possible
 - Reduce the number of doctors visits, saving time and money
 - Reduce the number of traumatic experiences to the child

Infant Immune System Cannot Handle Multiple Vaccines Cont.

- Some believe that giving multiple vaccines at the same time can overwhelm an infant's or child's immune system, and therefore increase the risk for harmful side effects
- This concern has increased as more vaccines have been developed and become apart of the immunization schedule
- Fear is increased when multiple vaccines are given in a combined injection

Infant Immune System Cannot Handle Multiple Vaccines Cont.

- Children are exposed to many antigens on a daily basis from the environment
- Antigens exposed to from vaccines do not notably increase antigen exposure burden
- Parents believe that more vaccines means more antigens
 - This is not always the case since some vaccines are switching from live to inactivated cells
- CDC recommends vaccinating children on the normal schedule, and not extending the vaccine schedule to spread out vaccines

Infant Immune System Cannot Handle Multiple Vaccines Cont.

- If vaccines are given together they must be studied as a combination to ensure that they are equally effective
 - Before being licensed must be shown that a new combination vaccine does not increase the risk of adverse effects above that of the component vaccines
- Scientific data shows that getting several vaccines at the same time does not cause any chronic health problems
- Multiple vaccines given together can cause fevers
 - If get high enough can lead to febrile seizures
 - Temporary and normally don't cause lasting damage

Better Hygiene Is Responsible For Decreased Infections

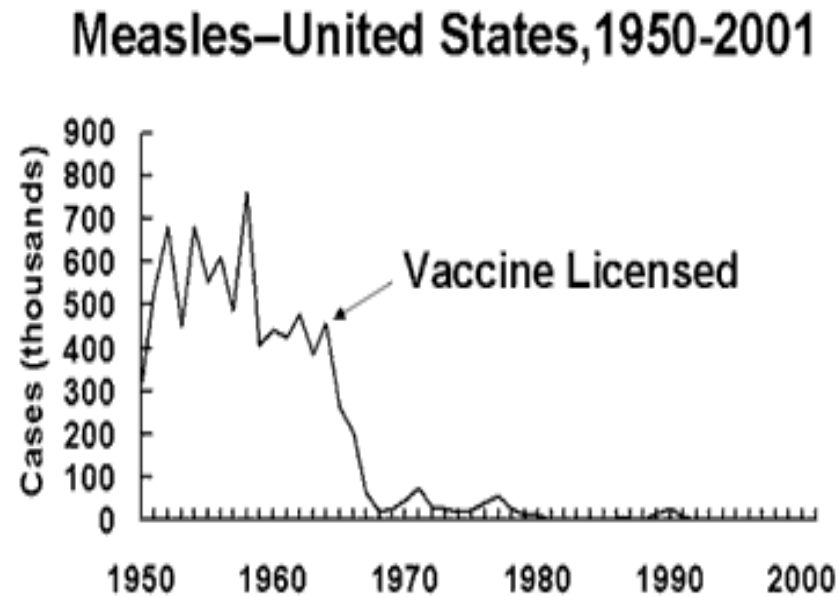
- Many of the diseases we vaccinate against are associated with the past, since this is when they were more common and more deadly
- We also associate the past with poor hygiene and sanitation practices
- People believe infection rates have dropped due to increased hygiene and sanitation, rather than vaccines

Better Hygiene Is Responsible For Decreased Infections Cont.

- Evidence supports that vaccines are the true cause for decreased infection rates
- When the use of the measles vaccine became widespread it led to a greater than 99% reduction in measles cases compared to the pre-vaccine era

Better Hygiene Is Responsible For Decreased Infections Cont.

- Infection rates were slowly decreasing due to increased hygiene and the development of antibiotics, the true drop came from vaccines



Better Hygiene Is Responsible For Decreased Infections Cont.

- As the antivaccination movement spread, infection rates of preventable diseases increased despite modern hygiene and sanitation practices
 - In 2014 there were a record number of measles cases, with 667 cases from 27 states reported to the CDC
 - Led to the measles outbreak linked to Disney theme parks

Better Hygiene Is Responsible For Decreased Infections Cont.

- Hib is another example that shows the effects of vaccines, rather than just hygiene

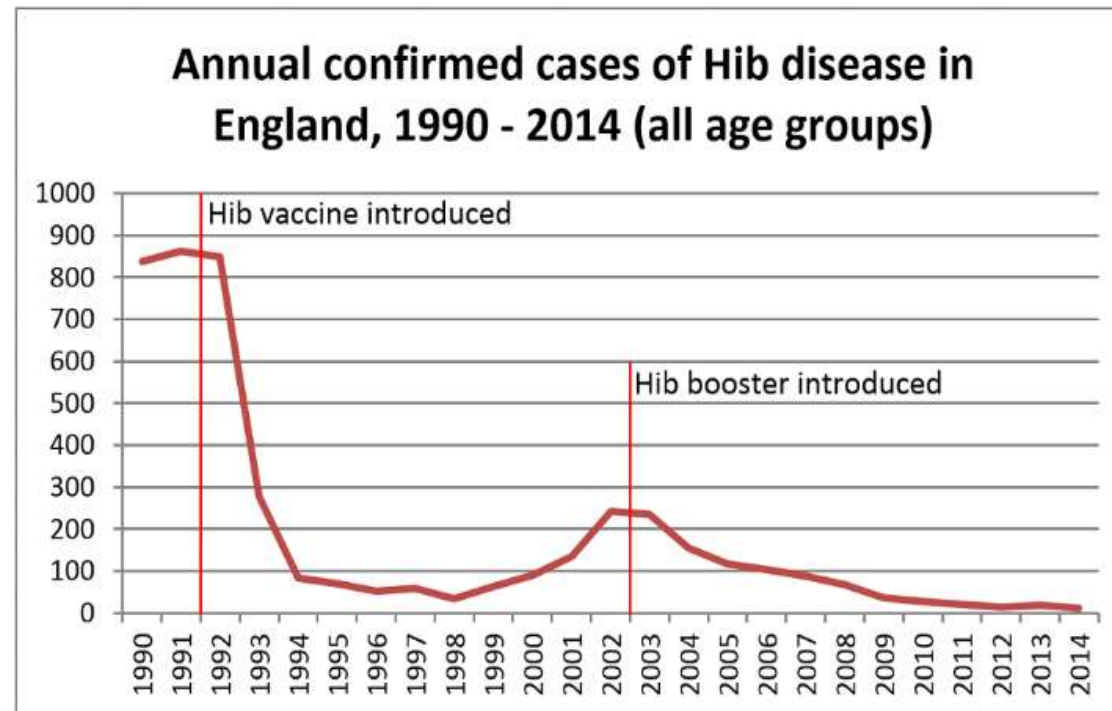


Image From: <http://vk.ovg.ox.ac.uk/sites/default/files/u77/Hib%20disease%201990-2014.png>

Vaccines Are Not Worth The Risk

- Many concerns stem from the media, and stories spread on social media
 - These can be exaggerated, and commonly stem from a single, or just a handful, case events
- Side effects are the major basis for concerns about vaccines
 - Specific side effects vary between vaccines

Vaccines Are Not Worth The Risk Cont.

- One vaccine we can look at for an example is DTaP, which vaccinates against diphtheria, tetanus, and pertussis.
 - Mild reactions (common)
 - Fever, redness or swelling at injection site, soreness and tenderness at injection site, swelling of the arm or leg that shot was given in, fussiness, tiredness, poor appetite, vomiting
 - Moderate reactions (uncommon)
 - High fevers around 105°F, seizures, non-stop crying for 3 hours or more in children
 - Severe reactions (rare)
 - Serious allergic reactions, long-term seizures, coma, lowered consciousness, permanent brain damage
 - So rare none of these have been confirmed to actually be caused by vaccine

Vaccines Are Not Worth The Risk Cont.

- Risk of not getting children vaccinated is that they will contract serious diseases, and expose others that cannot be vaccinated
 - Two main susceptible demographics are infants too young to be fully vaccinated, and immunocompromised (transplant, HIV, etc.)
- Parents must be educated if they choose not to vaccinate
 - Need to inform doctors so they can include these in potential diagnoses
 - Need to know the signs and symptoms of diseases
 - Need to inform the child's school
 - If child gets one of these diseases not to take public transportation and avoid public places

Vaccines Can Cause The Disease They Are Supposed To Prevent

- This results from people mistaking common mild reaction symptoms from the vaccine as signs of infection
- There has only been one recorded instance in which a vaccine was shown to cause disease
 - Oral polio vaccine

Vaccines Can Cause The Disease They Are Supposed To Prevent Cont.

- The oral polio vaccine is an attenuated (weakened) vaccine
 - This means it is a live vaccine that has just been weakened
 - Beneficial so that vaccinated individual develops immune response to virus, and excretes it
 - Excreted vaccine-virus can spread to others and offers them protection through passive immunization
 - Very beneficial in developing countries
 - If population is under-immunized the excreted virus is allowed to circulate for an extended period of time
 - The longer it survives, the more genetic changes it undergoes
 - Rare instances it can change into a form that can paralyze
 - Circulation vaccine-derived poliovirus

Vaccines Can Cause The Disease They Are Supposed To Prevent Cont.

- If the vaccination rates of a community are high the virus cannot live long enough to develop into the disease causing strain
 - Generally has to circulate for a period of at least 12 months
- Since 2000 more than 10 billion doses of oral polio vaccine have been administered to nearly 3 billion children worldwide
 - More than 13 million cases of polio prevented
 - Disease reduced by more than 99%
 - 24 circulation vaccine-derived poliovirus outbreaks occurred in 21 countries, resulting in fewer than 760 vaccine-derived polio cases
 - Can be argued that the small risk is worth it for the benefits in developing countries

Vaccines Can Cause The Disease They Are Supposed To Prevent Cont.

- Due to the small risk of vaccine derived polio it is no longer used in the United States
- Now to be considered fully immunized for polio in the United States need to have received a primary series of at least three doses of inactivated polio vaccine
- Inactivated virus does not pose risk of developing vaccine-derived polio

Vaccines Can Cause The Disease They Are Supposed To Prevent Cont.

- People mistake vaccine reaction symptoms for disease itself
 - Flu shot vaccine reactions
 - Sore arm
 - Soreness at injection site
 - Fever
 - Muscle pain
 - Feelings of discomfort or weakness
 - If experienced at all, these effects usually last 1-2 days after vaccination
 - Much less severe than actual illness
- Vaccines cause the body to mount an immune response, this is what leads to symptoms
 - Important to educate patients about this

Vaccines Are Unnecessary Due To Low Infection Rates In The US

- Infection rates are so low in the United States due to herd immunity
- Herd immunity is when enough of a community is immunized against a contagious disease, that members of the community that cannot be immunized are protected from the disease due to little opportunity for outbreak
- Members of the community that cannot be immunized include
 - Infants
 - Pregnant women
 - Immunocompromised

Vaccines Are Unnecessary Due To Low Infection Rates In The US Cont.

- If herd immunity is lost, infection rates will spike as disease is allowed to spread
- While infection rates are low in the United States, this is not the case in other countries
 - If individuals are not immunized and travel internationally they can contract the disease, and then bring it back to the United States and pass the disease to other unimmunized individuals

Vaccines Are Unnecessary Due To Low Infection Rates In The US Cont.

- Outbreaks of preventable diseases have happened when the number of unimmunized people have reached a level where the diseases can take root in the community
- One example is the outbreak of pertussis (whooping cough) in 2010
 - Over 9,000 cases of pertussis were reported in California during 2010, the most in over 60 years
 - Including 10 infant deaths
 - Prompted a new law in California requiring all students entering grades 7 through 12 to provide proof that they received a vaccine for whooping cough
 - These laws are needed to maintain herd immunity and keep schools safe

Vaccines Are Unnecessary Due To Low Infection Rates In The US Cont.

- We cannot get rates of infection to zero, just need to strive to get them as low as possible to protect those that cannot be vaccinated
- When infection rates are low, people believe they can stop immunizing, then infection rates rise
- Patients need to be educated about herd immunity, and the importance of keeping vaccination rates high

Number of Measles Cases by Year Since 2010

Year	Cases
2010	63
2011	220
2012	55
2013	187
2014	667
2015	188
2016*	70
2017**	28

*Cases as of December 31, 2016. Case count is preliminary and subject to change.

**Cases as of March 25, 2017. Case count is preliminary and subject to change.

Table from: <https://www.cdc.gov/measles/cases-outbreaks.html>

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