

## Vaccines and Chronic Disease

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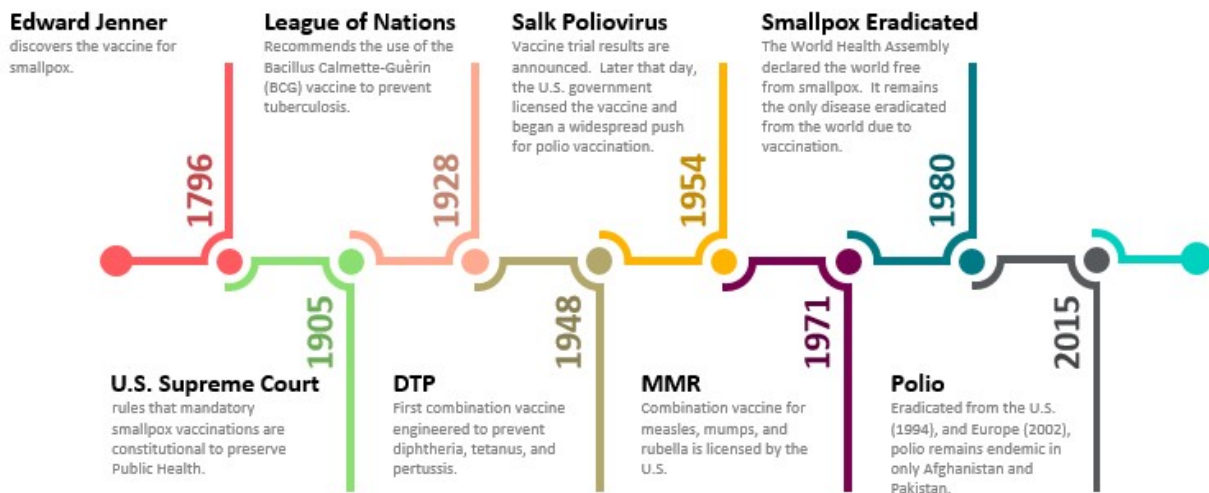
### IMMUNIZATION

The Centers for Disease Control and Prevention (CDC) recommend that all adults continue to receive certain vaccinations throughout their lives. These vaccinations limit the spread of, reduce the severity of, and strengthen an adult's immune response to an infectious disease. There are certain vaccines recommended for all adults, but those with chronic diseases must be even more vigilant.

### History

At the beginning of the 20<sup>th</sup> Century, diseases like smallpox, measles, diphtheria, and pertussis ran rampant throughout the United States, and killed many of the population. Although Edward Jenner had discovered the vaccine for smallpox in 1796 (see Figure 1), the use of the vaccine was not widespread enough to control the disease.<sup>2</sup>

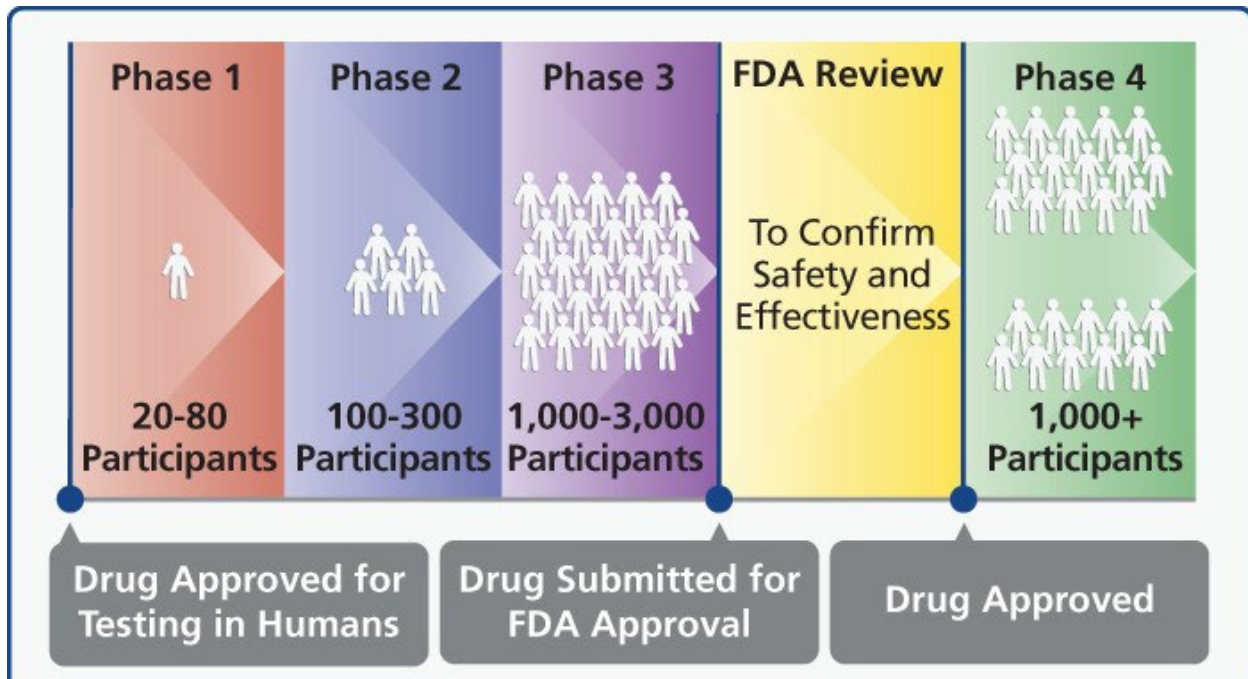
Figure 1. Timeline of Vaccines<sup>1</sup>



The United States Advisory Committee on Immunization Practices (ACIP) consists of 15 people responsible for making and approving vaccine recommendations.<sup>3</sup> Fourteen of them have degrees in vaccines, immunology, pediatrics, internal medicine, nursing, family medicine, virology, public health, infectious disease, and preventive medicine. One member is a representative of the general public. This committee works with highly regarded professional health and medical organizations – like the American Academy of Pediatrics (AAP) and the American Academy of Family Physicians (AAFP) – to discuss research and scientific data related to vaccine safety, effectiveness, clinical trial results, and labeling and package information.<sup>3,4</sup>

The ACIP approves the childhood and adult immunization schedules recommended by the CDC based on the safety and effectiveness of the vaccine at given ages, the severity of the disease, the number of people who would get the disease if there was no vaccine, and how well a vaccine works for people of different ages.<sup>3,4</sup> They also monitor how rigorously a vaccine manufacturer conducts studies to prove that a vaccine is safe for the public.<sup>3,4</sup> These clinical trials, or medical research studies, are conducted in phases, to determine the safety, efficacy, and side effects of a drug or vaccine (see Figure 2).<sup>5</sup> These trials are considered by the Federal Drug Administration (FDA) as part of the approval process for new medications, and all treatments, medications, and vaccines in the United States must go through this process before being approved for use.<sup>4,5</sup>

Figure 2. Timeline of Clinical Trials<sup>4</sup>



## Recommended Vaccines for Adults

Every year, thousands of adults in the U.S. are hospitalized and die from diseases for which vaccines are available.<sup>6,7</sup> Although vaccines have greatly reduced or eliminated many diseases that plagued humanity in the past, the viruses and bacteria that produce many of these diseases are still present in the world and can infect those who have not been vaccinated.<sup>6-8</sup> Some vaccinations require an additional dose to remind the immune system of the disease and keep it in the forefront of the immune system's memory.<sup>9</sup> Other infections are extremely detrimental to those adults with heart, lung, and immune system disorders. For these reasons and others, the ACIP and the CDC recommend all adults receive the following vaccines.<sup>6,7</sup>

### Influenza.

Influenza is a respiratory disease that attacks the nose, mouth, and throat and is caused by a family of viruses. It is contagious, and millions of people in the U.S. will contract the disease each year. Since 2010, flu-related hospitalizations in the U.S. have ranged from 140,000 – 710,000 people, and deaths due to flu range from 12,000 – 56,000 patients. Since anyone can get the flu, the CDC recommends that everyone over the age of 6 months get a flu shot every year.<sup>6,7</sup>

### **Pneumococcal Disease.**

Pneumococcal disease is caused by *Streptococcus pneumoniae* bacteria that can spread from person to person through close contact, and can lead to serious infections of the lungs, blood, and spinal cord. About 900,000 people will contract pneumococcal disease every year, and approximately 18,000 older adults will die from the disease. There are two kinds of pneumococcal vaccines, and recommendations on receiving one over the other are based on age, medical conditions, and lifestyle choices.<sup>6,7</sup>

### **Shingles.**

Adults are at an increased risk of shingles as they age, and the CDC recommends all adults over the age of 60 receive the vaccination. Shingles infection is due to the herpes zoster virus. This virus causes a painful rash to develop on one side of the body, generally over the torso, but sometimes affecting the face as well. This rash usually clears up in a few weeks, but some adults are at risk of developing Post-Herpetic Neuralgia (PHN), pain at the site of the rash that can last for years.<sup>6,7</sup>

### **Tetanus, Diphtheria, and Pertussis (Tdap).**

Tdap is one of two conjugate vaccines approved by the CDC and ACIP to prevent against multiple diseases.<sup>3,6</sup> The tetanus, diphtheria, and pertussis booster is recommended for all adults at least once every ten years. A booster shot is given, in this case, because the immune response memory weakens over time.<sup>9</sup> Additionally, adults in close contact with newborns should receive a pertussis (whooping cough) booster to keep from infecting the infants too young to be vaccinated.<sup>6,7</sup>

### **Booster Shots**

“Some vaccines, like the ones for diphtheria, meningitis, and cervical cancer (HPV), may require booster shots to remain effective during a person’s lifetime because the disease progression is too fast for the memory response to occur in time. For slow moving infections like hepatitis, polio, measles, mumps, and German measles [Rubella] immune memory is activated within plenty of time to prevent the disease after a person has been vaccinated and booster vaccines are not needed.”<sup>9</sup>

## **CHRONIC DISEASE**

The World Health Organization (WHO) defines a chronic disease as a disease of long duration, slow progression, and one that is not passed from person to person.<sup>10</sup> Chronic diseases are responsible for 38 million deaths each year. Although diseases like addiction, arthritis, autism, osteoporosis, and various psychotic disorders are considered chronic and affect thousands of people in the United States each year, the CDC does not recommend any vaccines specifically for the people suffering with those diseases beyond those recommended for all adults.<sup>3,7</sup> People suffering from these diseases should check with their doctor regarding vaccines appropriate for their lifestyles.<sup>7</sup>

The WHO recognizes four main categories of non-communicable diseases: cardiovascular disease (17.5 million deaths per year), cancer (8.2 million), chronic respiratory disease (4 million), and diabetes (1.5 million).<sup>11</sup> The CDC does recommend additional immunizations for people with these diseases because of the complications that may develop when both the chronic disease and the vaccine preventable disease are present inside the body.<sup>7</sup>

## **Cardiovascular Disease**

Cardiovascular diseases are the number one global cause of death.<sup>10</sup> The term heart disease describes an array of disorders affecting the heart. These diseases can include disorders of the blood vessels, heart rhythms, and defects of the heart.<sup>12</sup> According to the CDC, the most common type of cardiovascular disease in the United States is coronary artery disease (CAD), which can lead to a heart attack.<sup>11,13</sup>

**Atherosclerotic Disease.** Diseases of the blood vessels fall under the category of atherosclerotic disease. These disorders - coronary heart disease, cerebrovascular disease, and peripheral arterial disease – narrow, block, or stiffen blood vessels, preventing the brain, heart, or other parts of the body to receive less blood.<sup>12</sup>

**Arrhythmia.** An abnormal heartbeat, or arrhythmia, can lead to shortness of breath, racing or slowing heartrate, fainting, and dizziness. This speeding up or slowing down of the heart rhythm can cause problems with the distribution of blood throughout the body.<sup>12</sup>

**Defects.** Heart defects can be congenital or acquired, and can change the flow of blood through the heart. Rheumatic heart disease occurs after a bacterial infection causes structural damage to the heart muscle and valves.<sup>10</sup> The American Heart Association (AHA) has stated that congenital defects (present from birth) affect 8 out of every 1,000 newborns.<sup>14</sup> Many of these defects are not life-threatening, and can be monitored by a health professional.

**Stroke.** A stroke occurs when blood flow to an area of the brain is cut off, causing the cells in that area to die. Once an area of the brain has died, the abilities of that area of the brain (like memory, or muscle control) are lost. This can lead to memory loss, loss of motor function, loss of language. This group of symptoms is known as dementia.<sup>15</sup>

There are two types of stroke. A hemorrhagic stroke is due to a weakened or burst blood vessel, and will most likely cause death. An ischemic stroke occurs when a blood vessel carrying blood to the brain is blocked, either by a blood clot or due to plaque build up in the vessels. Ischemic stroke is the leading cause of adult disability in the United States, and up to 80% can be prevented.<sup>15</sup>

## **Dementia**

Dementia is a general term that describes a group of symptoms (like memory loss, loss of motor control, loss of language) due to the permanent damage or death of brain cells. One of the most common causes of dementia is due to ischemic stroke. Other causes of dementia include alcohol and trauma. Alzheimer's Disease is the most common cause of dementia in people over the age of 65.<sup>16</sup>

## **Recommended Immunizations**

Heart disease can make it more difficult to achieve a full immune response to certain diseases, and make it more likely that an infectious disease will lead to serious complications. For this reason, the CDC recommends that individuals with heart disease get vaccinated against influenza, pneumococcal disease, and whooping cough.<sup>6,7</sup> Additionally, inflammation is thought to play a large role in CAD development and complications. Many vaccine-preventable diseases can lead to inflammation, and the CDC suggests immunization against these diseases if someone has neither previously been immunized nor contracted the disease.<sup>7</sup>

Influenza. Among adults hospitalized with the flu in the 2015-2016 flu season, 41% had heart disease. The CDC notes that “influenza is associated with an increase of heart attacks and stroke.”<sup>6</sup> Influenza vaccination has been proven to decrease the frequency of future ischemic events.<sup>17</sup> It was also determined that administering the influenza vaccine to patients with acute coronary syndrome (ACS) had a protective effect, and reduced the incidence of major cardiovascular events in these patients.<sup>18</sup> A systematic review and meta-analysis found that “the use of influenza vaccine was associated with a lower risk of major adverse cardiovascular events.” The prevention of influenza with the yearly vaccine was seen with greatest effect in high-risk patients with active coronary disease.<sup>19</sup>

Pneumococcal disease. The United States Department of Health and Human Services (DHHS) recommends that one dose of the pneumococcal polysaccharide vaccine PPSV23 be given to anyone age 2 to 64 years with a long term health problem, such as heart disease.<sup>20</sup> Pneumococcal disease, if left untreated, can enter the bloodstream and cause bacteremia – an infection in the blood.<sup>7</sup> For patients who already have some degree of cardiovascular disease, this can be deadly.

Other vaccine preventable diseases. Any infection causes inflammation, and this inflammation can be dangerous for patients with a weak cardiovascular system.<sup>6,7</sup> Inflammation is common in heart disease and stroke patients, and is thought to be a response to a build-up of plaque in the arteries.<sup>21</sup> It is therefore critical that patients with heart disease receive vaccinations for infectious diseases like shingles (if they are 60 years or older), as well as the Tdap (tetanus, diphtheria, and pertussis) booster.<sup>7</sup>

## **Diseases Suppressing the Immune System**

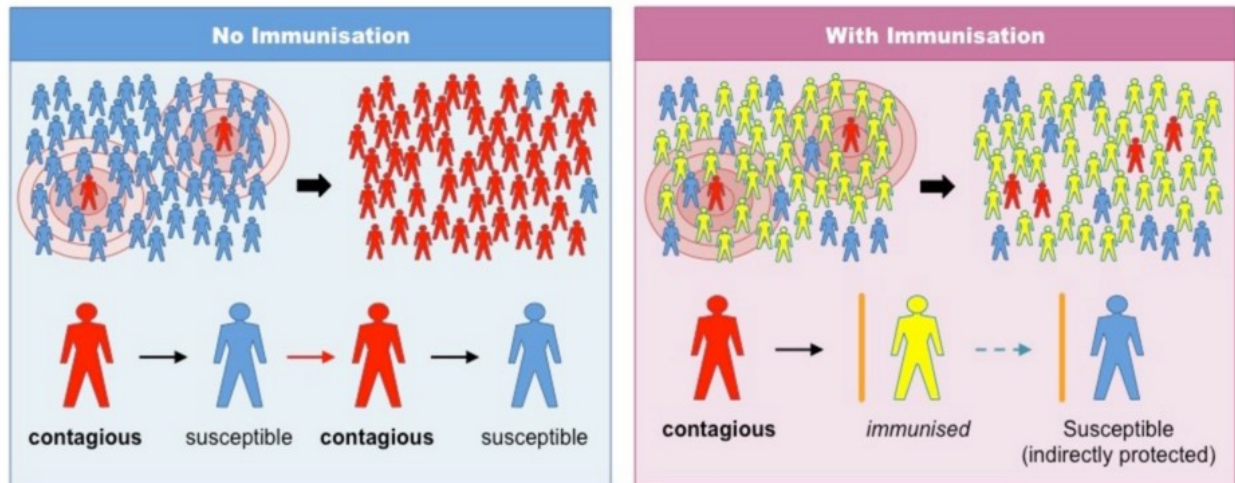
The immune system is a network of cells, tissues, and organs in the body that work together to protect the body from bacteria, viruses, fungi, and other forms of infection. Bone marrow creates stem cells, which are primitive cells that have the ability to turn into different kinds of cell. One type of stem cell in bone marrow turns into immune system cells (white blood cells): monocytes, macrophages, neutrophils, basophils, eosinophils. Another kind of stem cell will become lymphocytes (T cells, B cells, and natural killer cells). Both lymphocytes and white blood cells are important components in a healthy immune system.<sup>22</sup>

## **Herd Immunity**

The primary function of the immune system is to protect the body from foreign organisms. Deficiency or suppression of the immune system leaves the body open to attack from bacteria, viruses, fungi, and other disease causing organisms.<sup>22</sup> For this reason, public health depends on a form of immunity called ‘herd immunity’ to keep these immunosuppressed people protected from disease (see Figure 3). Herd immunity occurs when a high percentage of a population is

vaccinated against a certain disease: this provides a measure of protection for those people who are not or cannot be vaccinated like newborns, pregnant mothers, and those people with suppressed immune systems.<sup>24</sup> In order to have as little contact as possible between the disease and those susceptible, most experts agree that vaccination rates should be as high as 80-95% to have a protective effect.<sup>25</sup>

Figure 3. Herd Immunity<sup>23</sup>



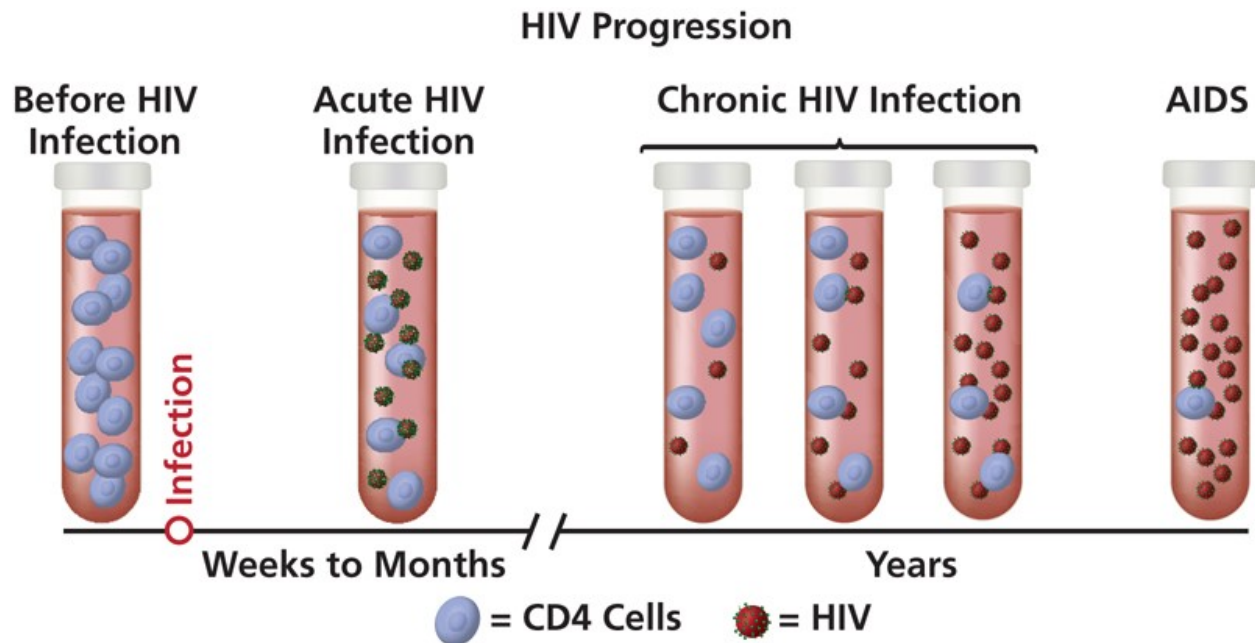
**Cancer.** Cancer is the second-leading cause of death in the United States.<sup>26</sup> The National Cancer Institute (NCI) defines cancer as a disease in which cells in the body do not stop dividing, and become immortal.<sup>27</sup> These cells eventually spread into the surrounding tissues.<sup>27</sup> This spread of cells can lead to tumors in the body, as well as the blood and lymph nodes. Signs and symptoms of cancer will vary depending where the dividing cells are located in the body, but can range from fatigue and unexplained fevers and joint pain to lumps, skin changes, cough and hoarseness, or changes in bowel and bladder habits.<sup>26</sup> Older age, lifestyle choices like drinking alcohol, excessive sun exposure, and unsafe sex, as well as family history and environment can be risk factors for various cancers.<sup>26</sup>

Surgery, chemotherapy, and radiation therapy are the most common treatments for cancer.<sup>28</sup> Radiation, chemotherapy, or both may be used before the surgery to shrink a tumor by targeting the immortal tumor cells for destruction.<sup>28</sup> Chemotherapy drugs cannot tell the difference between cancer cells and healthy cells, and so may damage normal cells as well as the ones causing the tumor. The most common cells to be targeted by chemotherapy drugs are those that grow and reproduce quickly: blood-forming cells in the bone marrow, hair follicles, and cells in the mouth, digestive tract, and reproductive system.<sup>22</sup> Because the bone marrow is one of the targets of chemotherapy, immune system suppression is a common side effect of these drugs.<sup>28</sup>

**HIV & AIDS.** Human Immunodeficiency Virus (HIV) attacks the CD<sub>4</sub> cells (T cells) that make up part of the body's immune system. HIV reduces the number of T cells in the body, making that person more likely to contract an infection (see Figure 4).<sup>22,29</sup> If enough of these cells are destroyed, the body is unable to fight off even the simplest of infections.<sup>22</sup> These simple, opportunistic infections signal that a person has so little of their immune system functioning (less than 200 T cells per cubic millimeter of blood) that they have reached the last stage of HIV infection, Acquired Immune Deficiency Syndrome (AIDS).<sup>22,29</sup> Not every person with HIV will progress to this stage of the disease, and many of the current drug therapies – such as

antiretroviral therapy (ART) – can keep people healthy, prolong their lives, and decrease their chance of transmitting the virus.<sup>29</sup>

Figure 4. HIV Progression<sup>5</sup>



### **Recommended Vaccinations**

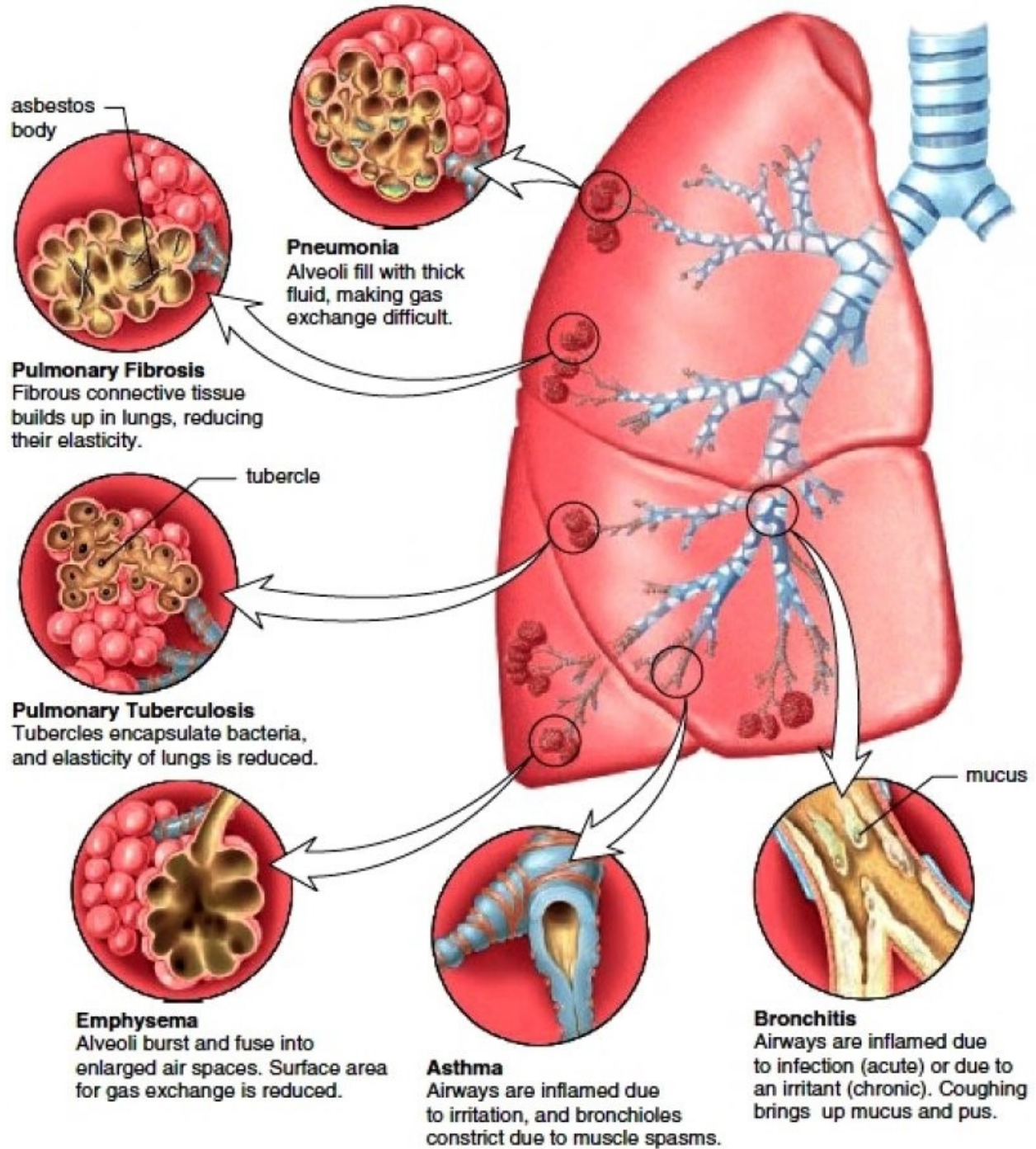
Because cancer treatment often leads to immune system suppression, any infection can be a dangerous one.<sup>28</sup> For this reason, the CDC recommends that anyone with a suppressed immune system get a yearly flu shot, a Tdap booster, both types of pneumococcal vaccine, and the HPV vaccine (up to 26 years of age).<sup>6,7</sup> Additionally, the CDC recommends that patients with HIV and CD4 counts greater than 200 get the Hepatitis B vaccine, the MMR vaccine (if they were born after 1957 and have not had the disease or vaccination), and the varicella (chicken pox) vaccine in an effort to prevent a future infection with these diseases.<sup>7</sup>

### **Lung Disorders**

Lung disorders like Asthma or Chronic Obstructive Pulmonary Disease (COPD) are at a higher risk of hospitalization and complications from certain vaccine-preventable diseases, especially influenza and pneumococcal disease.<sup>6,7</sup>

**Asthma.** Asthma is a lung disease due to chronic inflammation of the airways. Inflammation leads to the swelling and tightening of the airways – an “asthma attack.” These attacks can be triggered by infections, allergies, air pollution, and other irritants, but they can be prevented by limiting exposure to these triggers.<sup>30</sup>

**Chronic Obstructive Pulmonary Disease.** COPD is a term used to describe progressive lung diseases like emphysema, chronic bronchitis, refractory or non-reversible asthma, and some forms of bronchiectasis (see Figure 5).<sup>32</sup> Mild chronic inflammation throughout the airways that can lead to damaged lung tissue is characteristic of COPD.<sup>30</sup> COPD affects 30 million Americans, and one major risk factor for these diseases is the inhalation of pollutants, especially cigarette smoke.<sup>32</sup>

Figure 5. Lung Disorders – COPD<sup>31</sup>

### **Recommended Vaccines**

**Influenza.** An influenza infection can be more serious for people with asthma or COPD because the flu can produce further inflammation of the airways and lungs. Infection with the influenza virus can trigger an asthma attack, worsening of symptoms, and is more likely to lead to pneumonia than in those without a lung disease.<sup>6,7</sup>



Pneumococcal Disease. Pneumococcus bacteria is one of the most common causes of severe pneumonia. Since people suffering with asthma and COPD already have inflamed lungs, any additional inflammation can lead to serious side effects, like pneumonia, which may require hospitalization.<sup>7</sup>

Additional Recommendations. As with all adults, the CDC recommends a shingles vaccine (for people 60 and older) and a Tdap booster.<sup>6,7</sup>

## Diabetes

Diabetes mellitus (DM) is a group of metabolic diseases sharing the characteristic of high blood sugar, or hyperglycemia. Chronically high blood sugar may lead to complications in the eyes, kidneys, nerves, and blood vessels.<sup>33</sup> These complications can lead to high cholesterol, high blood pressure, heart disease, stroke, blindness, kidney disease, and even amputations due to nerve disease.<sup>34</sup> In 2014, it was estimated that 29.1 million people in the U.S. had diabetes, but only 21 million of them had been diagnosed.<sup>34</sup> Each year, it is estimated that an additional 800,000 people will develop diabetes, and 54,000 will die from diabetes related complications.<sup>35</sup>

**Type I diabetes.** Previously called insulin dependent diabetes or juvenile onset diabetes, type I diabetes develops when the cells in the pancreas that produce insulin are destroyed by the body's own immune system, and is considered an autoimmune disease.<sup>35</sup> Insulin is a hormone that is required to lower blood sugar, or glucose. Glucose is the primary energy source for all the cells of the body, and insulin is the hormone that transports the glucose into the muscle, liver, and fat cells.<sup>35</sup> Without this insulin, people with type I diabetes will suffer from hyperglycemia and its complications. The only treatment for type I diabetes is insulin injection.<sup>34</sup>

**Type II diabetes.** Also known as non-insulin dependent diabetes or adult onset diabetes, type II diabetes accounts for 90-95% of all diagnosed diabetes cases.<sup>34</sup> In this type of diabetes, a person's body becomes resistant to the insulin their body is producing. The cells within the person's muscles, liver, and fat do not use the insulin properly and the glucose cannot leave the blood to enter the cells. The body's feedback mechanisms recognize this hyperglycemia and signal the pancreas to produce more and more insulin. Gradually, the insulin-producing cells lose the ability to produce sufficient insulin, and the body's ability must be supplemented by oral medications. Older age, obesity, a family history of diabetes, a history of gestational diabetes, and physical inactivity are all risk factors for type II diabetes.<sup>34</sup>

**Gestational diabetes.** Gestational diabetes is diagnosed during the second or third trimester of pregnancy, and is a form of glucose intolerance. Increasing blood levels to both the fetus and the mother can increase the risk of complications during gestation and birth, and may necessitate treatment with diet, exercise, or insulin. After giving birth, 5-10% of women with gestational diabetes continue to have hyperglycemia and are diagnosed with type II diabetes.<sup>34</sup>

## Recommended Vaccines

Diabetes, and hyperglycemia, can make it harder for an immune system to fight infections, and can in fact exacerbate immune system disorders. Long-standing diabetes tends to lead to poor blood flow, which can increase the risk of infection. Diabetic neuropathy (the loss of nerves in the hands and feet due to hyperglycemia) can also lead to sores and cuts in the feet that go unnoticed, increasing the risk of infection.<sup>35</sup>

Influenza. Many illnesses can increase blood glucose, and in those people with hyperglycemia, this can lead to dangerous conditions. The flu shot is recommended for all diabetics.<sup>7</sup>

Hepatitis B. People with diabetes must constantly check their blood glucose levels by way of a finger prick. There have been hepatitis B outbreaks associated with blood glucose monitoring procedures, and for this reason, the CDC recommends all diabetics receive the hepatitis B vaccine.<sup>7</sup>

Pneumococcal. Due to the high amounts of blood sugar, poor blood flow, and other complications of diabetes, people with the disease are at an increased risk of pneumonia, bacteremia (blood infection), and meningitis (infection of the lining of the brain and spinal cord). For this reason, the CDC recommends a pneumococcal vaccination for diabetics.<sup>7</sup>

Other recommendations. The CDC also recommends a Tdap booster and a shingles (zoster) vaccine for diabetics. These vaccines are recommended for all adults, but diabetics are at an increased risk of infection owing to the high amounts of sugar in their blood.<sup>7</sup>

## CONCLUSION

Immunizations are not only for children. Adults are an important part of herd immunity, and should continue to make their health a priority by keeping up to date with their vaccines. Influenza; tetanus, diphtheria, and pertussis; pneumococcal disease; and shingles are vaccines recommended for many adults. Those adults with chronic diseases can manage their illnesses by talking to their doctor, and following suggested guidelines for vaccinating themselves.

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