Infectious Respiratory Conditions After SCI

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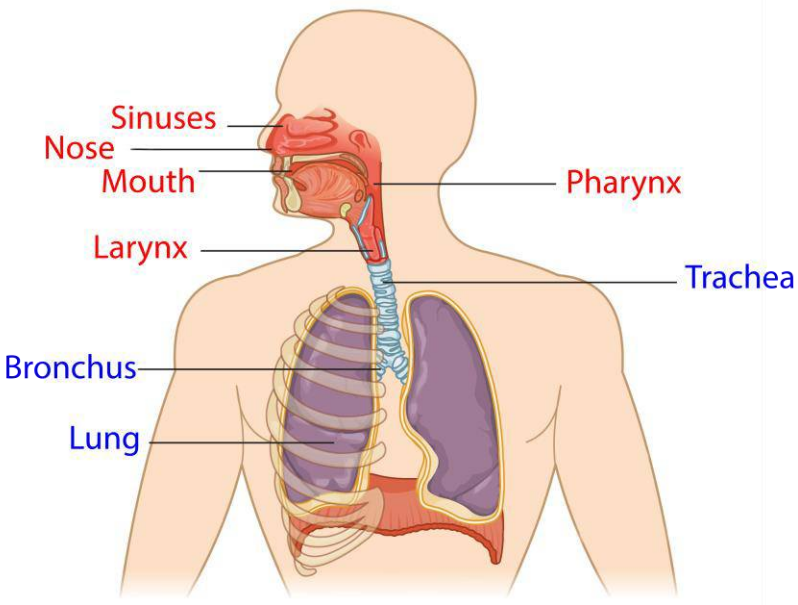
The adverse effects of a spinal cord injury (SCI) on the respiratory and immune systems can increase the risk of getting an infectious respiratory condition. This page reviews the relationship between SCI and infectious respiratory conditions.

Key points

- Many respiratory changes occur after SCI, including a weakened ability or a loss of breathing and/or coughing function.
- Individuals with acute SCI are more susceptible to infectious respiratory conditions due to a weakened immune system and a potentially lessened ability to cough or clear secretions.
- As individuals with SCI transition from acute to chronic injury, they are less likely to catch infectious respiratory conditions. If they do, the conditions may present more severely.
- The best thing to do is to try to prevent these conditions! Strategies such as vaccinations and good hand washing practice can help.

What happens to the respiratory system after SCI?

The respiratory system involves the lungs, and is responsible for breathing, coughing, and speaking. It consists of the upper respiratory tract (nose, mouth, and the throat (*pharynx*)), and the lower respiratory tract (voice box (*larynx*), airways (windpipe or *trachea*), and lungs). Breathing and coughing both depend on various muscles in the chest and neck. Changes to respiratory function after SCI depend on the level of injury and completeness of the injury. After SCI, especially high cervical level injury, some muscles required for breathing may be affected.



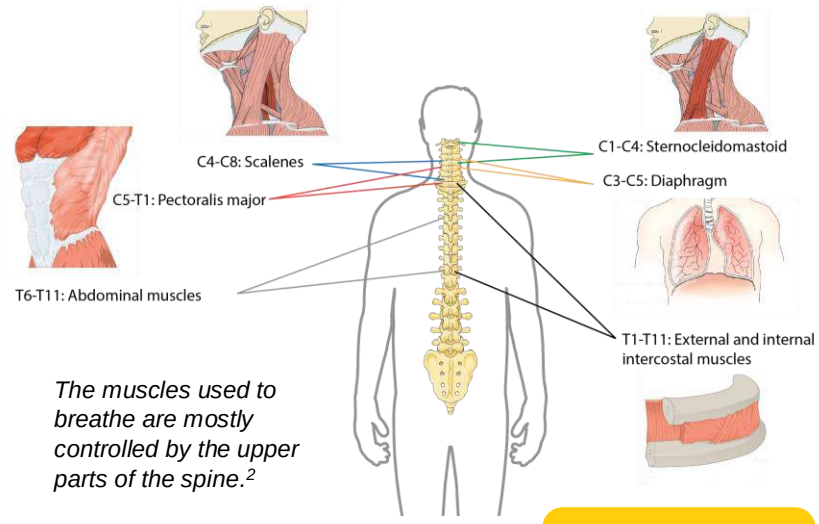
The upper respiratory system (red) and lower respiratory system (blue).[1]

These include:

- The *diaphragm*, which is the main muscle that assists with pulling air into the lungs,
- The *abdominal muscles*, which helps to expel air from the lungs and produce a forceful cough, and
- The muscles in between your ribs (*intercostal muscles*), which help squeeze air out of the lungs.

As a result, sustaining a higher-level injury may result in impaired respiratory function. Some of these changes include:

- A reduction in the amount of air you are able to breathe,
- A stiffer lung, making it difficult to take a full, deep breath,
- A weak or ineffective cough,
- An increased amount of mucus, and
- Difficulties with swallowing.



The muscles used to breathe are mostly controlled by the upper parts of the spine.[2]

Despite these changes, many technologies and techniques are available that can assist with breathing and coughing. Moreover, the greatest amount of air you can blow out after taking your biggest breath in increases over time from injury.

Refer to our article on Respiratory Changes after SCI for more information.

What is the immune system?

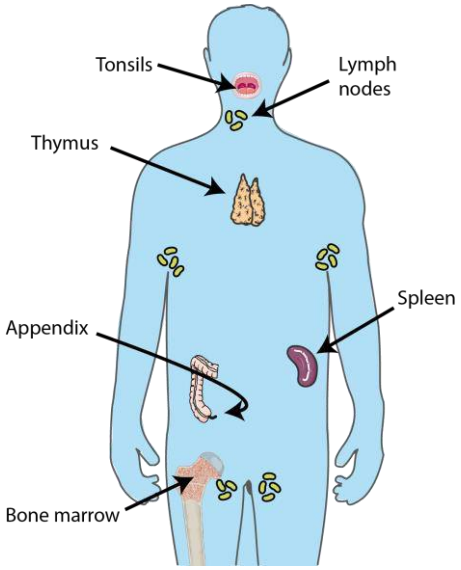
The immune system is responsible for fighting infections and preventing illness. To keep our bodies healthy, the immune system does three main things:

1. Recognizes harmful germs, such as bacteria and viruses, when they enter the body,
2. Kills germs and removes them from the body, and
3. Fights changes in the body that may cause illness (e.g., cancer cells)

Who are the key players in the immune system?

The immune system is comprised of two main parts: the *innate immune system* and the *adaptive* (or *acquired*) *immune system*. The innate immune system refers to a *non-specific line of defence* (i.e., it acts against all germs in the same manner) that you are born with. It is often the first line of defense, which is made up of parts of your body that prevent germs from entering. This includes:

- The outer layer of the skin, which acts as a physical barrier to germs,
- Mucus and hair, which traps germs,
- Saliva, which rinses out germs from the mouth,
- Bodily fluids, such as stomach acid, which kills bacteria, and
- Urination and defecation, which excretes germs from the body.



Many organs throughout the body contribute to producing cells required to keep you healthy.[3]

If germs manage to invade the body, the innate immune system is the first system to recognize them. The innate immune system will then trigger a general attack, such as inflammation and fever (Tortora and Derrickson, 2013). This attack affects the entire body, and does not directly target the germ. Innate immune cells then enlist the help of the adaptive immune system.

The second line of defense involves the *adaptive immune system*, which initiates specific defences for each germ that enters your body. For example, the body will react differently to a virus that causes influenza versus one that causes measles. The main players in the second line of defense are various types of white blood cells. This includes: *natural killer cells*, which kill any cell that is not recognized as part of the body, *lymphocytes*, which help the body remember the invaders for the future and destroy them, and *phagocytes*, which help "eat" and break up invading organisms.

The cells that contribute to the first and second line of defence are produced in organs all over the body, including the bone marrow, spleen, lymph nodes, adrenal glands, tonsils, and thymus.

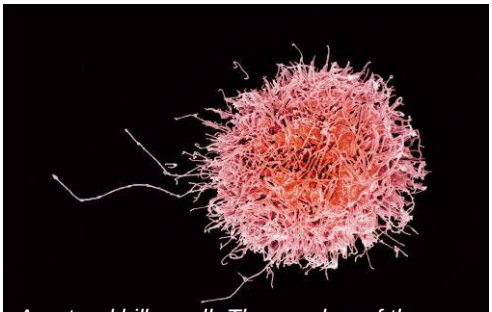
What happens to the immune system after SCI?

Spinal Cord Injury Immune Depression Syndrome (SCI-IDS) is a condition that weakens the immune system after SCI. Weak evidence suggests that SCI-IDS commonly occurs among acute SCI. That said, there is also early evidence that SCI-IDS can persist and be present in those with chronic (>1 year) SCI. Although researchers are unsure why the immune system is weakened after SCI, hypotheses have been made:

For a review of what we mean by "strong", "moderate", and "weak" evidence, refer to the SCIRE Community Evidence Ratings.

- SCI-IDS may be a self-defence mechanism that lowers the body's immunity to prevent the body from attacking itself after the damage that occurred in the spinal cord.
- Many of the organs associated with the immune system, such as the spleen, thymus, and lymph nodes, are controlled by the *sympathetic nervous system*. These nerves are impaired when an individual sustains an injury at T6 or above. As a result, the immune system may not be as active.

Weak evidence suggests that immune system changes may occur regardless of level of injury. For example, the amount of natural killer cells are reduced in adults with SCI, regardless of level of injury, in comparison to an able-bodied population. This reduces the body's ability to fight off germs, which may cause infections, disease, and illnesses. Moreover, early animal research suggests that individuals with SCI may be more susceptible to viruses, such as the flu due to impairments in the body's immunity. However, it is important to note that these findings have not yet been replicated in humans.



A natural killer cell. The number of these cells is decreased after SCI.[4]

Although the immune system recovers after acute SCI, some (weak) evidence suggests that lowered immunity may extend into the chronic stage of SCI. One study investigated the genes responsible for programming and developing immune cells. The authors found that the genes that normally create natural killer cells are reduced, resulting in lower amounts of these germ-fighting cells throughout the body. A second study supported these findings, as individuals with SCI were found to have lower amounts of natural killer cells in their blood compared to an able-bodied population.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Having an SCI in combination with a weakened immune system has many implications for secondary complications. For example, after SCI many individuals may have difficulties with or may be unable to effectively void urine, which encourages the growth of bacteria. This, in combination with a weakened immune system, may explain why urinary tract infections (UTIs) are common secondary complication of SCI. Although SCI complications and a weakened immune system may contribute to many other secondary complications (e.g., UTI, pressure sores), this article will focus on infectious respiratory conditions that are common with SCI.

For more information, refer to our articles on UTIs and Pressure Injuries!

Why are people with SCI at higher risk for respiratory infections?

Respiratory infections can occur in anyone, but people with SCI are at a higher risk for the following reasons:

- Weakened immune system: After SCI, individuals may have a weakened immune system, some researchers believe that this may make them more prone to infections.
- Reduced/absent respiratory functioning: As people with SCI may have an inability/weakened ability to cough, mucus begins to build up in the airways and the lung. This accumulation of mucus creates a breeding ground for bacteria and viruses.
- Inhaling your food, drinks, or saliva (aspiration) is common after SCI. This results in these substances collecting in your lung, which may result in pneumonia.
- Use of mechanical respiratory devices: The use of mechanical ventilation can cause ventilator-assisted pneumonia, especially in hospital environments. If parts of the ventilation system (e.g., tubing) are not cleaned properly, bacteria can grow.


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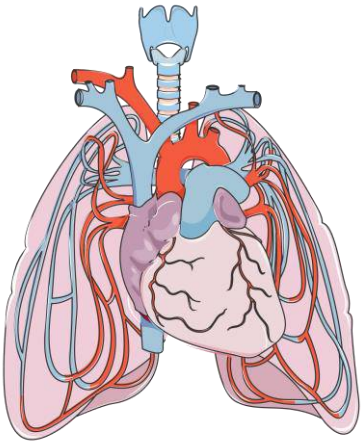
What infectious respiratory conditions should I be aware of?

Infectious respiratory diseases can target either the upper respiratory tract (i.e., the nose, mouth, and throat), or the lower respiratory tract (i.e., the voice box, windpipe, airways into the lungs, and the lungs). Oxygen is required for each organ to function properly. When a part of your respiratory system becomes infected, the amount of air you breathe in may be reduced. This reduces the amount of oxygen

available for the body and may quickly affect the function of the brain and other organs. Moreover, an infection can spread all over the body (*sepsis*). Once it spreads, it becomes more difficult to treat.

As a SCI can negatively affect respiratory and immune function, the rates of respiratory diseases, such as bacterial pneumonia and influenza, among individuals with SCI is high. In fact, respiratory diseases account for just over 80% of all deaths after SCI. In addition, respiratory conditions often present more severely in SCI. This was shown in a (weak evidence) study, where people with SCI who contracted influenza or pneumonia were 37 times more likely to die from the infection compared to an able-bodied population. Two of the most common respiratory infections in people with SCI are pneumonia and the flu. These conditions are particularly infectious and can be caught through inhaling tiny droplets of fluid in the air that may be released as a cough or a sneeze. Also, these droplets may fall on surfaces, and can spread if someone touches the surface, then touches their mouth or eyes.

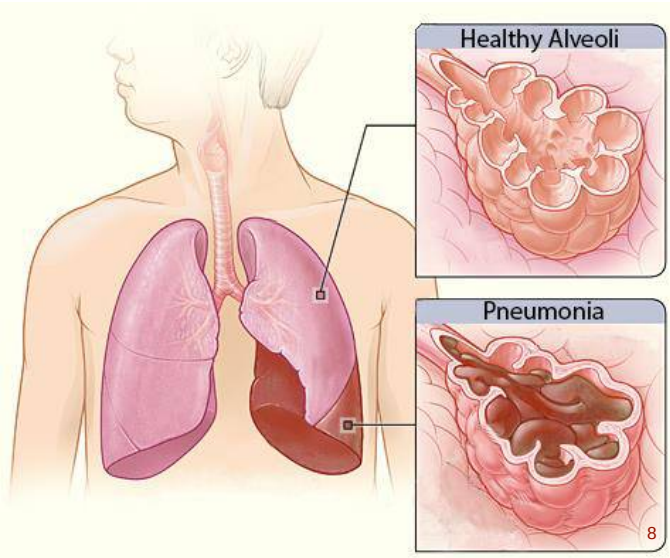


The heart (in the center) and lungs are complexly interconnected. The lungs help oxygenate the blood, which is pumped by the heart.[7]

Some (weak evidence) research done to predict who is more likely to experience respiratory illness after SCI indicated that those with a complete injury and those with tetraplegia are at an increased risk of dying from a respiratory related infection. Another study found that during acute care, those with a complete injury were at a greater risk of getting pneumonia. This is related to the lack of/weakened ability to cough and clear mucus from the airways. Secondary complications that may predispose people with SCI to respiratory illnesses include: obesity, heart disease, asthma, chronic obstructive pulmonary disease (COPD), chronic coughing, chronic existence of phlegm, wheezing, and the use of pulmonary medications.

Pneumonia and SCI

Pneumonia is an infection caused by a bacteria or virus, which leads to an infection of the small air sacs in the lungs. It is one of the most common infections in acute SCI with about 30% of individuals with acute SCI experiencing pneumonia (weak evidence), dropping to about 3.5% in the chronic stages of SCI (i.e., 1-20 years post injury). Although the chance of getting pneumonia decreases after acute SCI, it is important to remember that pneumonia manifests more severely in people with SCI. That is to say, while your chances of getting pneumonia may be reduced at longer times after SCI, if you do get it, it is more severe.



Influenza and SCI

Influenza, or the flu, is a respiratory condition caused by a virus. There are multiple types and sub-types of influenza, although type A and B are the strains that most often cause the flu season. The flu virus affects the nose, throat, and sometimes the lungs, and can lead to secondary conditions such as pneumonia. Flu vaccines are recommended, especially for people with SCI as they are a vulnerable population. There is weak evidence that supports the use of flu vaccines for people with SCI, as their immune system responds similarly to the drug compared to able-bodied individuals. That said, those with tetraplegia may have a reduced response to the vaccine. Animal studies suggest that vaccines may be less effective with higher levels of SCI. More research is required to determine the response to influenza vaccines after SCI.

Other infectious respiratory conditions and SCI

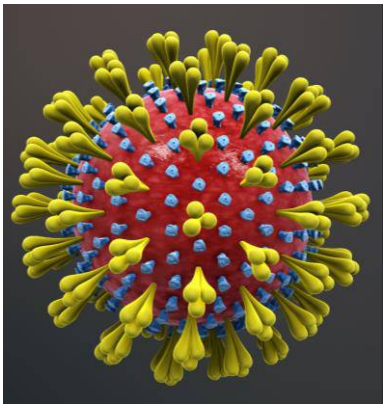
There are many other infectious respiratory conditions that exist, such as the common cold, tuberculosis, and coronaviruses. However, little to no research has been done on the impact of these conditions in the SCI population. Although the available research is limited, it is important to note that individuals with SCI are still at an increased risk of contracting these conditions. The following section describes various respiratory infections in the able-bodied population unless otherwise noted.

Common Cold

The common cold (or simply, *the cold)* is a general term for a mild upper respiratory tract condition affecting the nose and throat. Common symptoms include stuffy nose, sneezing, sore throat, and cough. Unlike other conditions, there are multiple types of viruses that can cause a cold. *Rhinoviruses*, *coronaviruses*, and *influenza viruses* account for the majority of cases. The cold occurs most frequently in the fall, and decreases upon the arrival of spring. On average, a person will catch the cold once a year, but it is likely that this rate is underestimated.

Coronaviruses

Coronaviruses are responsible for many health conditions including the common cold, Middle East Respiratory Syndrome (MERS), Severe Acute Respiratory Syndrome (SARS), and novel coronavirus disease 2019 (COVID-19). While there are over a hundred different strains of coronaviruses, seven are known to affect humans, and the aforementioned are the four strains that are responsible for 10-30% of upper respiratory tract infections. Although these viruses are genetically related, they cause very different conditions. The severity of the conditions they may cause varies from mild (such as the common cold, described above), to severe (such as MERS, SARS, and COVID-19). Though MERS, SARS, and COVID-19 can all lead to pneumonia, each condition affects the body differently: MERS has a greater impact on the digestive system and kidneys, while SARS and COVID-19 most heavily impact the respiratory system, clotting function, and heart activity.



A coronavirus (above), which gets its name from the spikes on the outside that resemble a crown, which is "corona" in Latin.[10]

The 2019 Novel Coronavirus (COVID-19)

The COVID-19 outbreak began in 2019 in Wuhan, China, and has since spread around the world. The virus appears to attack the respiratory system, resulting in symptoms such as cough, shortness of breath, and pneumonia, in addition to fever and kidney failure. The extent of the symptoms ranges from mild to severe, and it is possible for someone to be infected without symptoms. This virus has caused a sense of unease among the SCI community. In a survey conducted by a group of researchers, some of the most common concern included increased vulnerability to infection, decreased availability of caretakers, inability to obtain medical supplies, the inability to be appropriately tested, an inability to travel to medical appointments, and an inability to self-quarantine.

To date, few weak evidence studies on COVID-19 and SCI have been completed. This biggest take away is that the typical symptoms of COVID-19 as reported by the World Health Organization (i.e., cough, fever, and shortness of breath) are not necessarily applicable to people with spinal cord injuries. As coughing is often impaired with SCI, it can be absent in reported cases of COVID-19 in people with SCI.

Instead, common symptoms of COVID-19 in people with SCI include a fever and feeling weaker than normal. Other symptoms that have been reported include shortness of breath, body aches/worsening pain, sweating, chest pain, and increased spasticity, a worsened ability to clear secretions, and abnormally fast breathing. Although people with SCI may have fewer of the typical COVID-19 symptoms, one study has found that they are more likely to experience COVID-19 more severely compared to able-bodied individuals.

Tuberculosis

Tuberculosis is an infection of the lungs that can be caused by a bacteria. The presence of tuberculosis is higher in developing countries in comparison to developed countries. This is related to factors such as lower rates of vaccination and higher rates of HIV (an immune compromising condition) in developing countries. Treating tuberculosis is particularly difficult, as many strains of the virus/bacteria are resistant to drugs.

Upper respiratory tract infections

Upper respiratory tract infections are a group of conditions that affect the nose and throat. Some conditions include *pharyngitis* (sore throat) and *laryngitis* (inflammation of the voice box; when you lose your voice). These infections are of particular note to those using ventilators, as over 90% of pneumonia and hospitalizations start with an upper respiratory tract infection.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What can you do to prevent infectious respiratory conditions?

In order to avoid getting infectious respiratory conditions, prevention is key, especially in the community. Here is what you can do to stay healthy:

- Wash your hands with warm water and soap for 20-30 seconds
- Get vaccinated for pneumonia, the flu, and COVID-19. Vaccinations are especially important, as weak evidence suggest that rates of vaccination for pneumonia and flu are still low.
- Stay hydrated! Drinking water can help loosen up the mucus in your lungs.
- Clean surfaces that may have been in contact with a sick person. This includes parts of your wheelchair, including the joystick, pushrims, etc.


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- Avoid smoking. Smoking can damage the lung's ability to fight infections, which can compound issues with an already weak immune system.
- Practice good health habits, such as exercising and having a healthy diet.
- Stay home if you are sick.
- Let the people around you know you are feeling unwell. This way they can check up on you and know to avoid close contact.

The bottom line

After an SCI, respiratory functions (i.e., breathing and coughing) and the immune system are compromised. Researchers are still unsure about why the immune system is suppressed. While there is some weak evidence for why the immune system changes after SCI, more clinical trials are required to determine the specific effects of SCI on the immune system.

Given the changes to respiratory and immune functioning after SCI, there is a higher risk of getting an infectious respiratory disease. The best thing to do is to work at prevention, which can be done through a variety of ways such as getting vaccinated and staying hydrated. Discuss all treatment options with your health providers to find out which treatments are suitable for you.

For a list of included studies, please see the Reference List. For a review of what we mean by "strong", "moderate", and "weak" evidence, refer to the SCIRE Community Evidence Ratings.

Related resources

SCIRE Community. "Respiratory Changes After SCI". Available from: community.scireproject.com/topic/respiratory-changes/

SCIRE Community. "COVID-19 & SCI Infographic". Available from: community.scireproject.com/covid-19/infographics/

Abbreviated reference list

Parts of this page have been adapted from the SCIRE Project "Respiratory Management Following Spinal Cord Injury" Chapter:

Sheel AW, Welch JF, Townson AF (2018). Respiratory Management Following Spinal Cord Injury. In: Eng JJ, Teasell RW, Miller WC, Wolfe DL, Townson AF, Hsieh JTC, Connolly SJ, Noonan VK, Loh E, Sproule S, McIntyre A, Querée M, editors. Spinal Cord Injury Rehabilitation Evidence. Version 6.0. Vancouver: p. 1-72.

Available from: scireproject.com/evidence/rehabilitation-evidence/respiratory-management/

Full reference list available from: community.scireproject.com/topic/infectious-respiratory-conditions/#reference-list/
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