Epidemiology of Respiratory Transmitted Infections

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Learning objectives-1

- Technological developments in molecular biology are showing that known respiratory viruses are more prevalent than previously thought across the childhood age period.
- *New viruses continue to be discovered in association with acute lower respiratory tract infections (ARI).*
- The study of morbidity and mortality that is due to ARI is hampered by lack of precise definitions and specific, practical diagnostic methods.

Lower respiratory infectious disease is the 5th leading cause of death and the combined leading **infectious** cause of death, being responsible for 2.74 million deaths worldwide. This is generally similar to estimates in the 2010 ***Global Burden of Disease Study***.

Learning objectives-2

- Children in developing countries account for at least 70% of the global burden and mortality from acute lower respiratory tract infection (ARI).
- *Malnutrition, **poverty**, indoor smoke, and co-morbid conditions, including malaria, tuberculosis, and human immunodeficiency virus infection (HIV-AIDS), greatly increase the risks of children acquiring and dying from acute lower respiratory tract infection.*
- Emerging respiratory diseases present an ongoing risk for children in an era of **globalization**.

Infections in the lower respiratory tract are primarily the result of: **viruses**, as with the **flu** or respiratory syncytial virus (RSV) **bacteria**, such as Streptococcus or Staphylococcus aureus. And *fungal infections.*

Upper respiratory tract infection (URTI) definition and facts

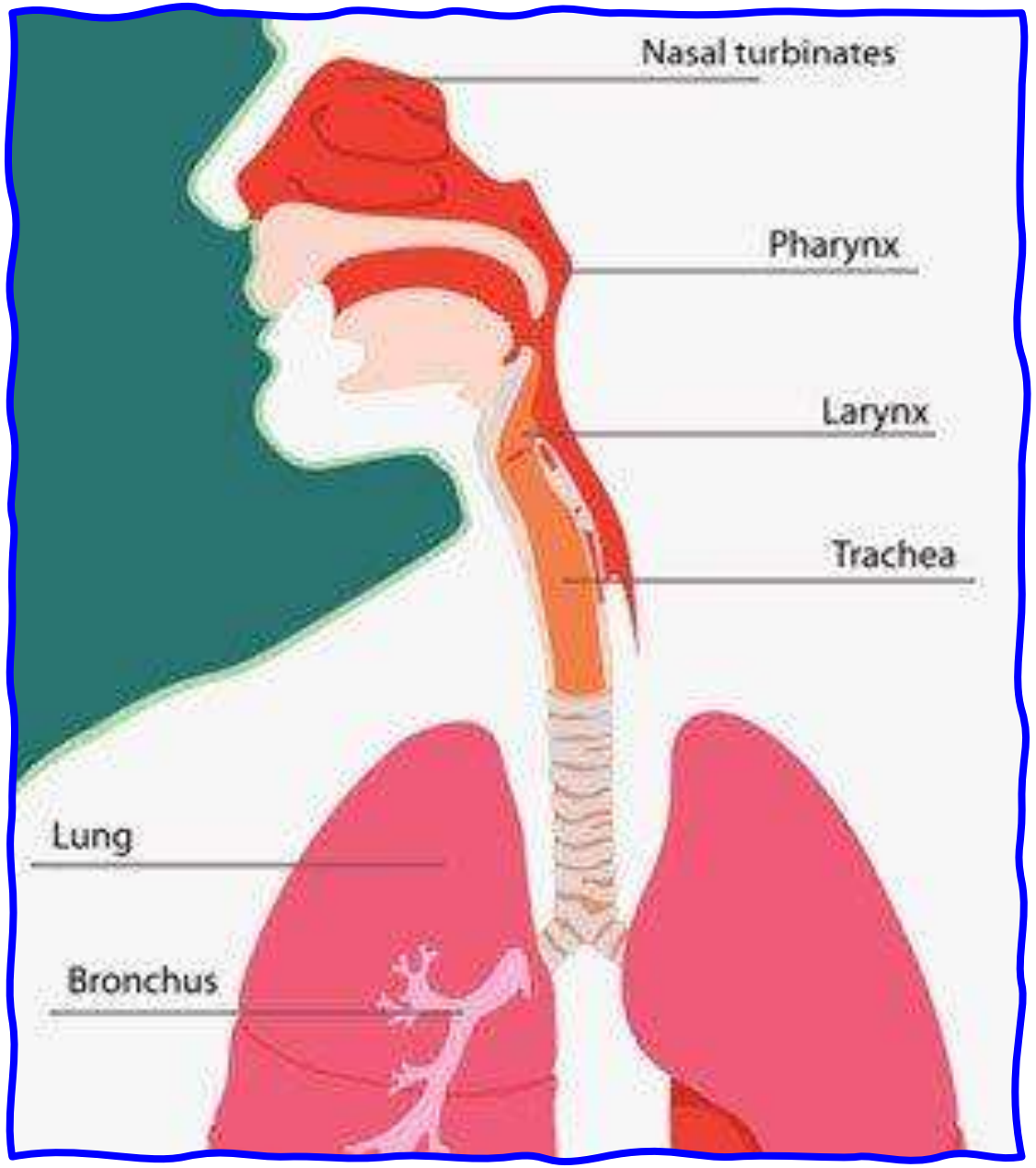
INTRODUCTION

- Upper respiratory tract infection (URI) represents the most common acute illness evaluated in the outpatient setting. URIs range from the common cold--typically a mild, self-limited, catarrhal syndrome of the nasopharynx--to life-threatening illnesses such as epiglottitis. Viruses account for most URIs. Bacterial primary infection or superinfection may require targeted therapy.

- Upper respiratory infections (URIs) are one of the most common reasons for doctor visits.
- Upper respiratory infections are the most common illness resulting in missed work or school.
- **Upper respiratory tract infections** can happen at any time but are most common in the fall and winter.
- The vast majority of upper respiratory infections are caused by **viruses** and are self-limited.

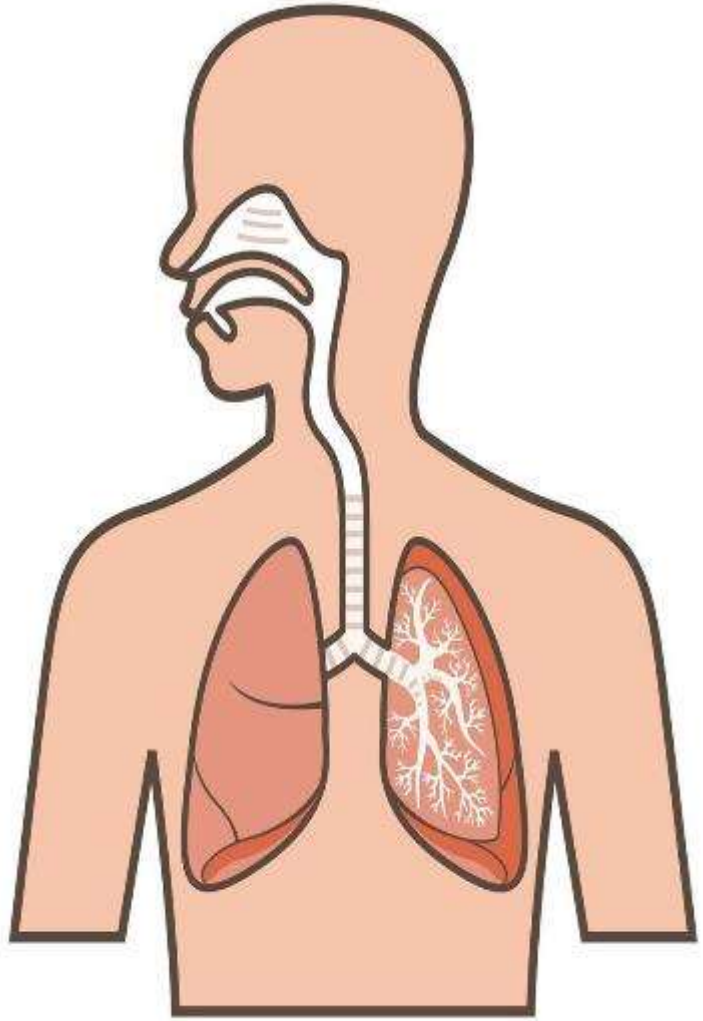
What is a upper respiratory infection?

- The upper respiratory tract includes the sinuses, nasal passages, pharynx, and larynx.
- These anatomial structures direct the air we breathe from the outside to the trachea and eventually to the **lungs** for **respiration** to take place.
- An **upper respiratory tract infection**, or upper **respiratory infection**, is an infectious process of any of the components of the upper **airway**.



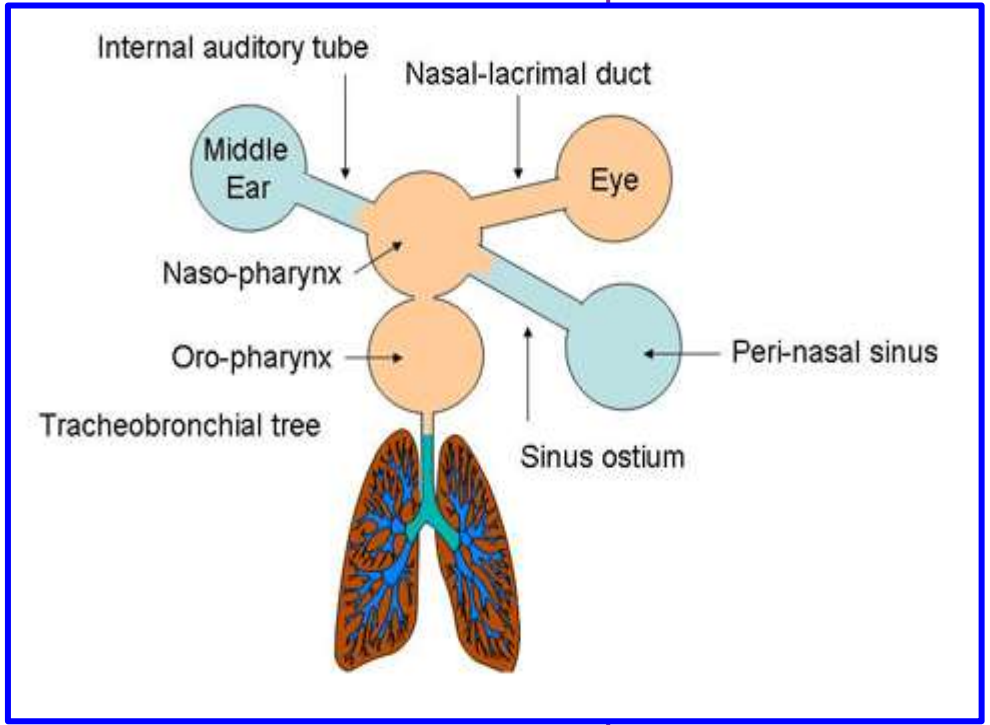
What is a upper respiratory infection?

- Infection of the specific areas of the upper respiratory tract can be named specifically. Examples of these may include **rhinitis** *(inflammation of the nasal **cavity**)*, **sinus infection** *(**sinusitis** or rhinosinusitis)* -inflammation of the sinuses located around the nose, **common cold** *(nasopharyngitis)*- inflammation of the nares, pharynx, hypopharynx, uvula, and **tonsils**, **pharyngitis** *(inflammation of the pharynx, uvula, and **tonsils**)*, epiglottitis *(inflammation of the upper portion of the larynx or the **epiglottis**)*, **laryngitis** *(inflammation of the larynx)*, laryngotracheitis *(inflammation of the larynx and the trachea)*, and tracheitis *(inflammation of the trachea)*.



Upper respiratory tract infection (URTI) definition and facts

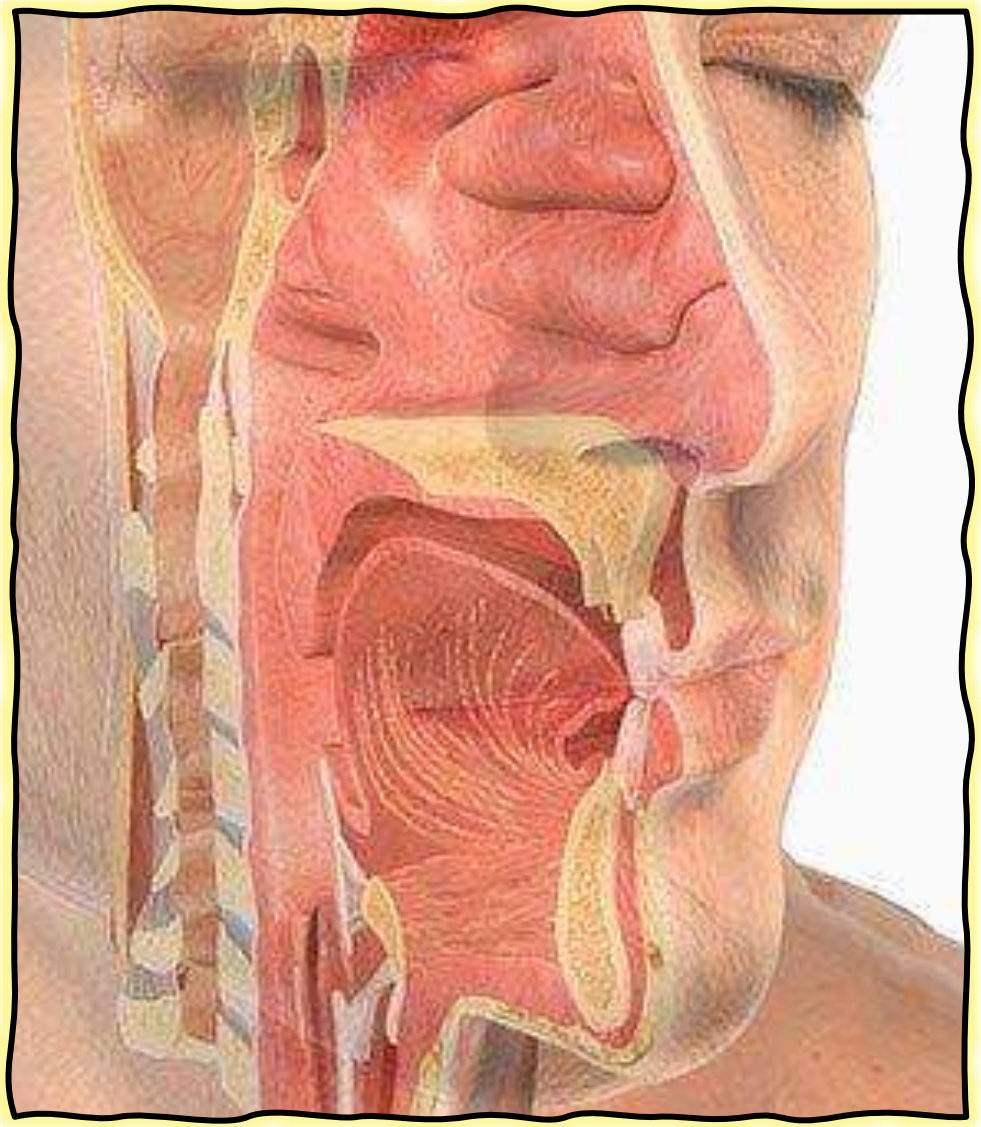
- **Symptoms of upper respiratory infection include**
- cough,
- sneezing,
- nasal discharge,
- nasal congestion,
- runny nose,
- fever,
- scratchy or sore throat
- nasal breathing.
- **Antibiotics are rarely needed to treat URIs and generally should be avoided unless the doctor suspects a bacterial infection.**



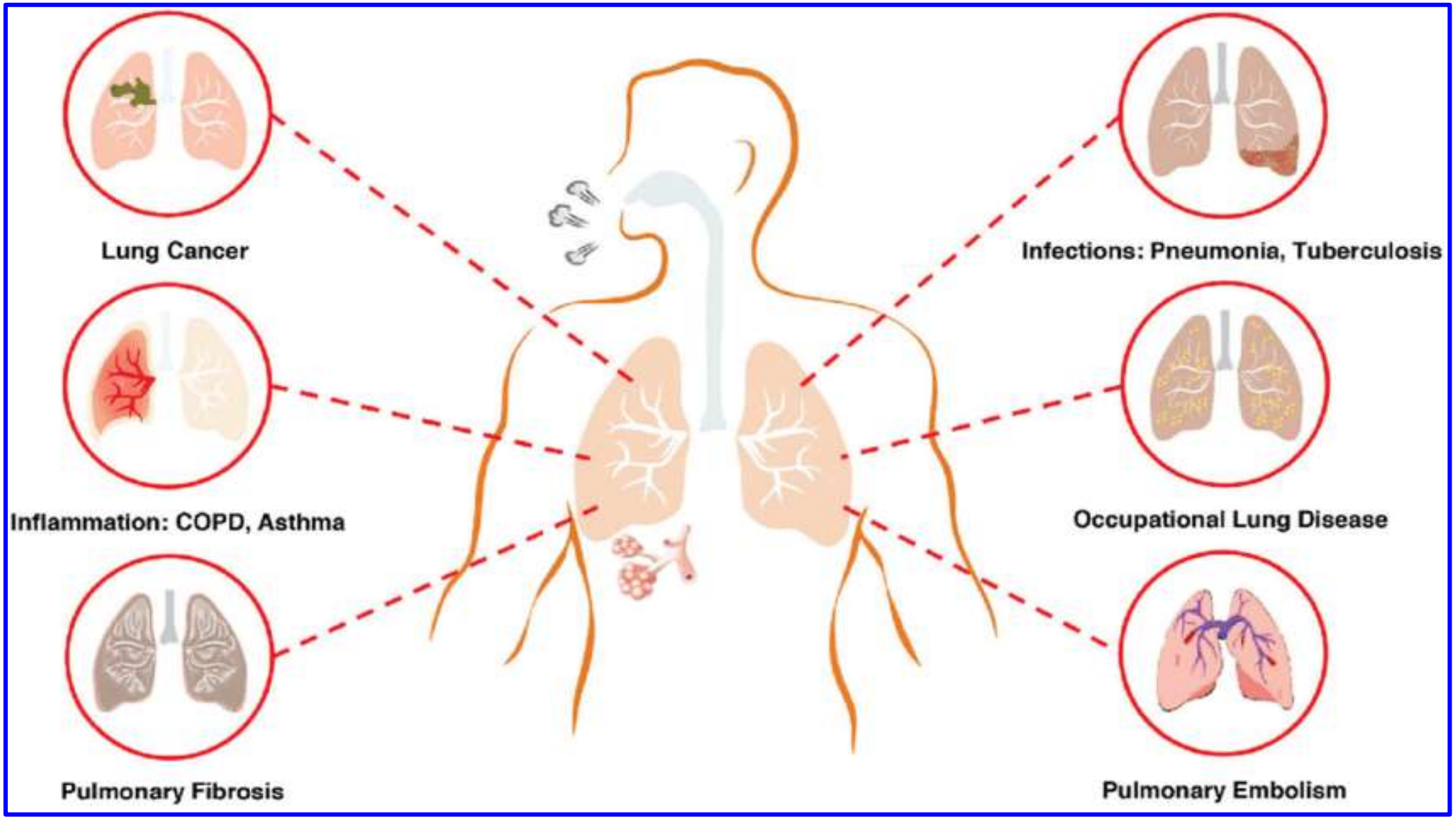
- Simple techniques, such as proper handwashing and covering the face while coughing or sneezing may reduce the spread of respiratory tract infections.
- The general outlook for upper respiratory infections is favorable, although, sometimes complications can occur.

Is a upper respiratory infection contagious?

- A majority of upper respiratory infections are due to self-limited viral infections.
- Occasionally, **bacterial infections** may cause upper respiratory infections.
- *Most often, upper respiratory infection is **contagious** and can spread from person to person by inhaling respiratory droplets from **coughing** or **sneezing**.*
- The transmission of respiratory infections can also occur by touching the nose or mouth by hand or other objects exposed to the virus.

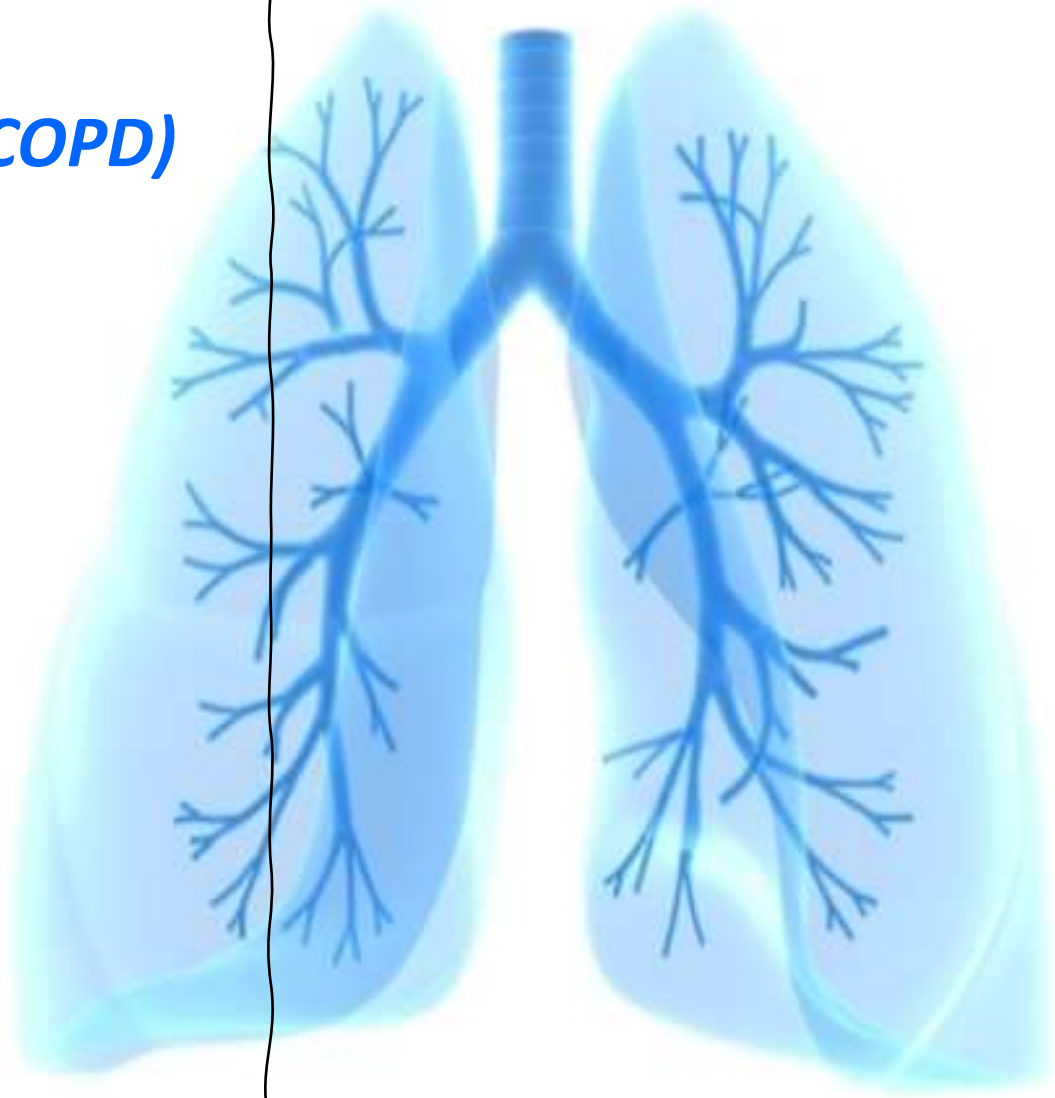


The Top Respiratory Illnesses and Diseases

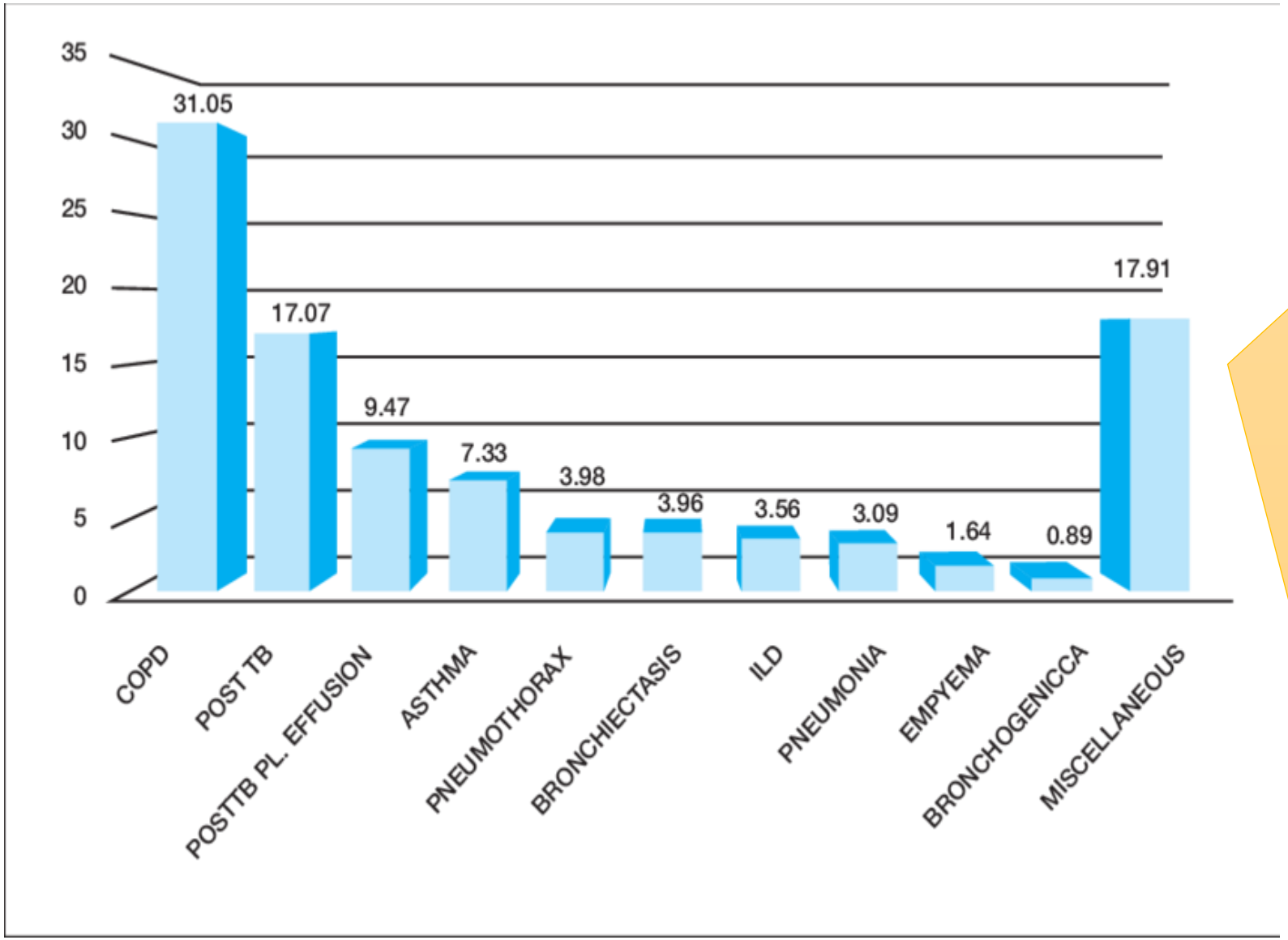


The Top 8 Respiratory Illnesses and Diseases

- Asthma. ...
- *Chronic Obstructive Pulmonary Disease (COPD)*
- Chronic Bronchitis. ...
- *Emphysema. ...*
- Lung Cancer. ...
- *Cystic Fibrosis / Bronchiectasis. ...*
- Pneumonia. ...
- *Pleural Effusion.*

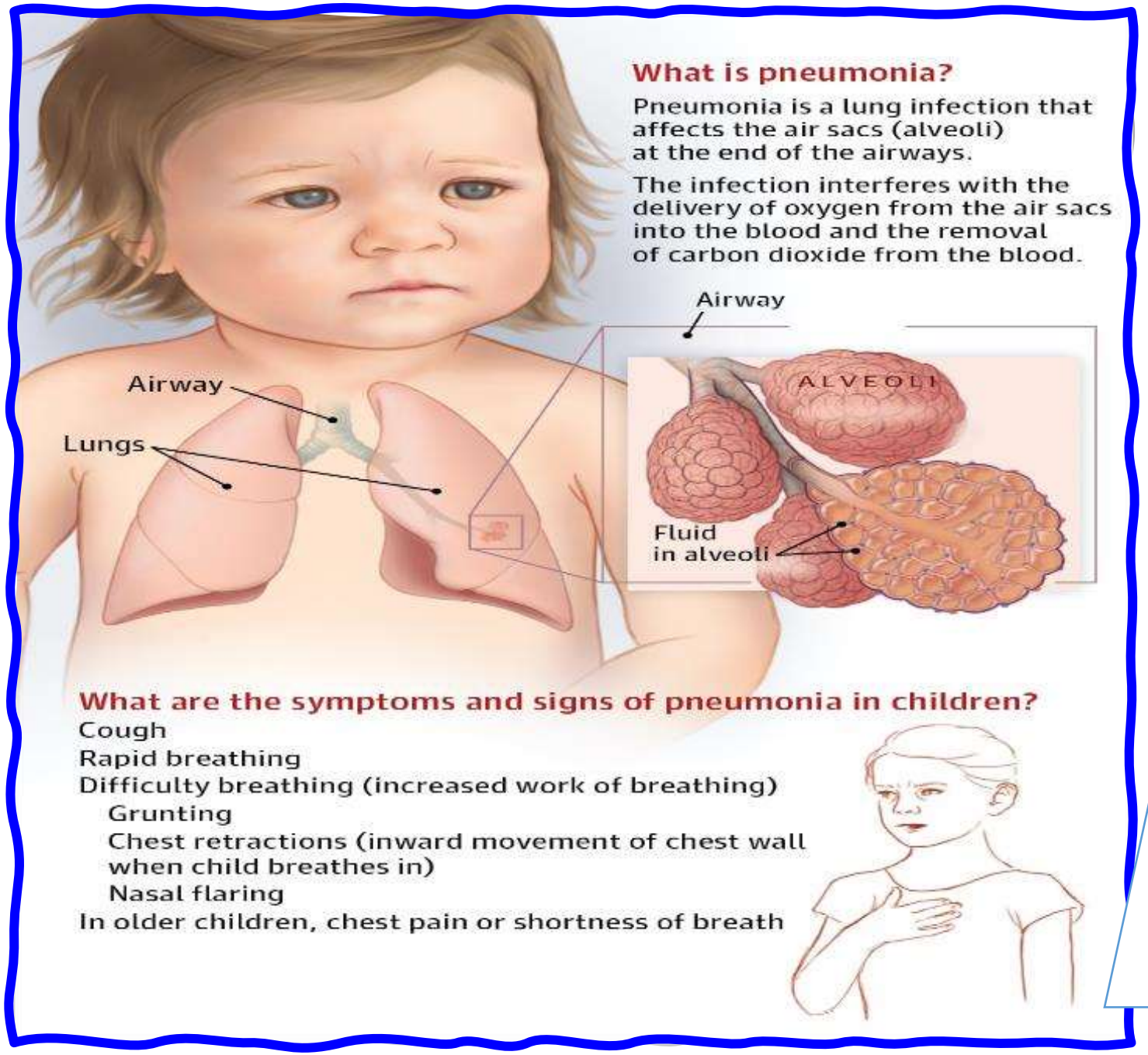


The Top Respiratory Illnesses and Diseases



Community-acquired pneumonia (CAP) :

This term is most commonly used in studies in developed countries and usually includes a radiological finding of pneumonia. Used in distinction to ***hospital-acquired pneumonia***, which follows injury, surgery, immobility, or immunosuppression or is due to unusual hospital pathogens.



•Pneumonia :

Inflammation of the lung with consolidation. The term is usually used to indicate infection (most commonly bacterial or viral) *of the lung parenchyma resulting in obliteration of alveolar air space by purulent exudate.*

ACUTE LOWER RESPIRATORY TRACT INFECTION

- ✓ To prove a diagnosis of "**pneumonia**" according to the first, pathologic definition requires proof that there is infection of the lung parenchyma and proof that there is airspace consolidation.
- ✓ *The definition of ARI or clinical pneumonia, on the other hand, relies on clinical signs only and requires no such proof.*
- ✓ The chief difficulty in studying cases of pneumonia, especially for Epidemiologists, is that of reconciling these two definitions.
- ✓ *When we describe the Epidemiology of **clinical pneumonia** we need to know:*

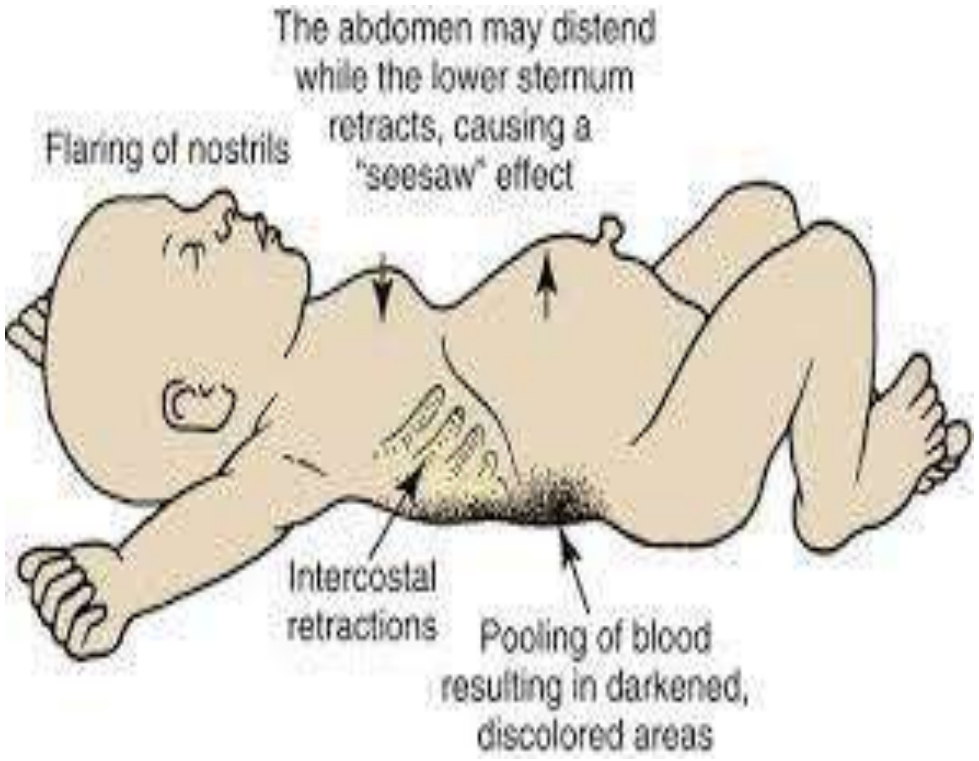
•***Pneumonia :***

• *What is the relationship between the condition we are describing and the more objective pathologic entity of pneumonia? (Validity)*

•• *How confident are we that the studies we collect in our description are identifying the same condition? (Reliability)*

What is the difference between the upper and lower respiratory tract?

- **The upper** airways or upper respiratory tract includes the nose and nasal passages, para-nasal sinuses, the pharynx, and the portion of the larynx above the vocal folds *(cords)*.
- **The lower** airways or lower respiratory tract includes the portion of the larynx below the vocal folds, trachea, bronchi and ***Bronchiectasis***.



https://www.youtube.com/watch?v=owTxXpmc2C0

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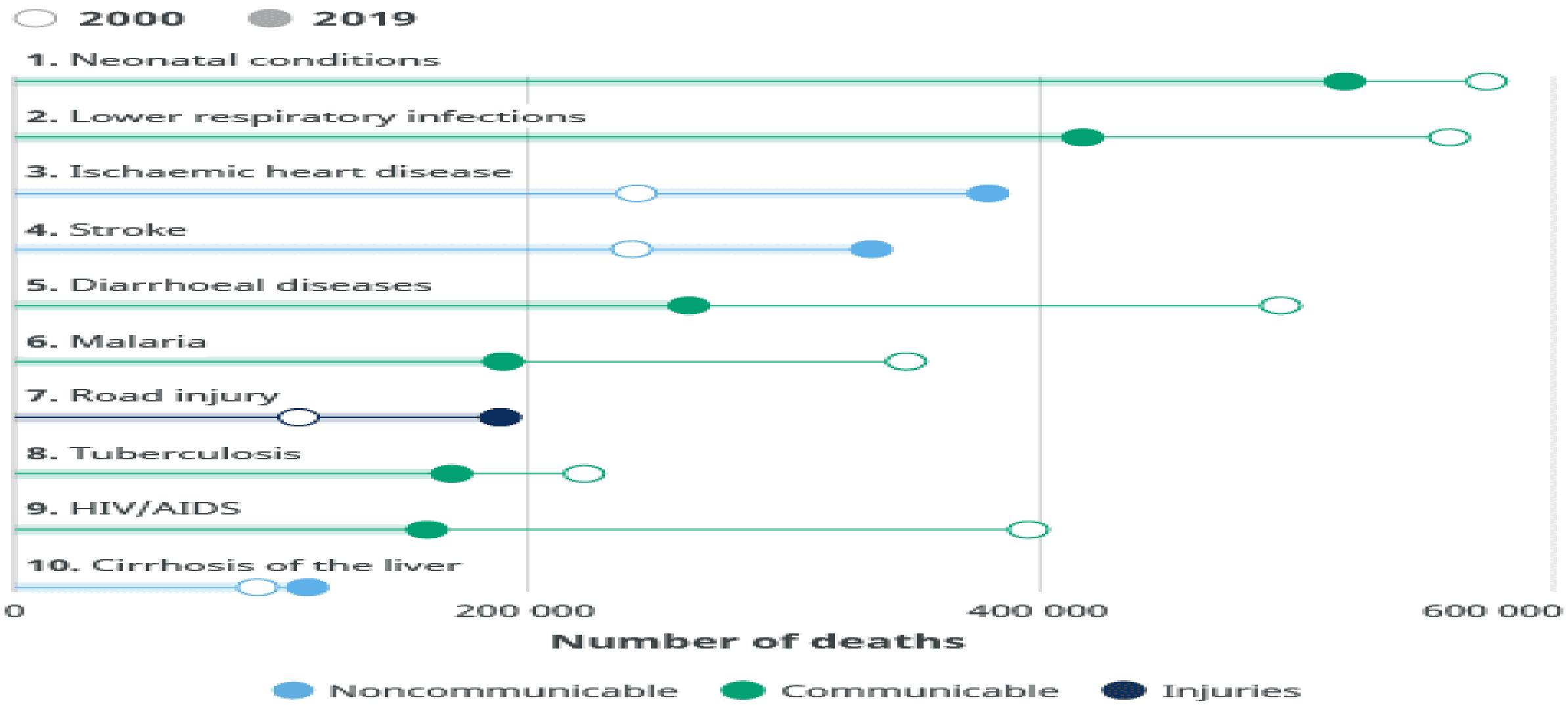
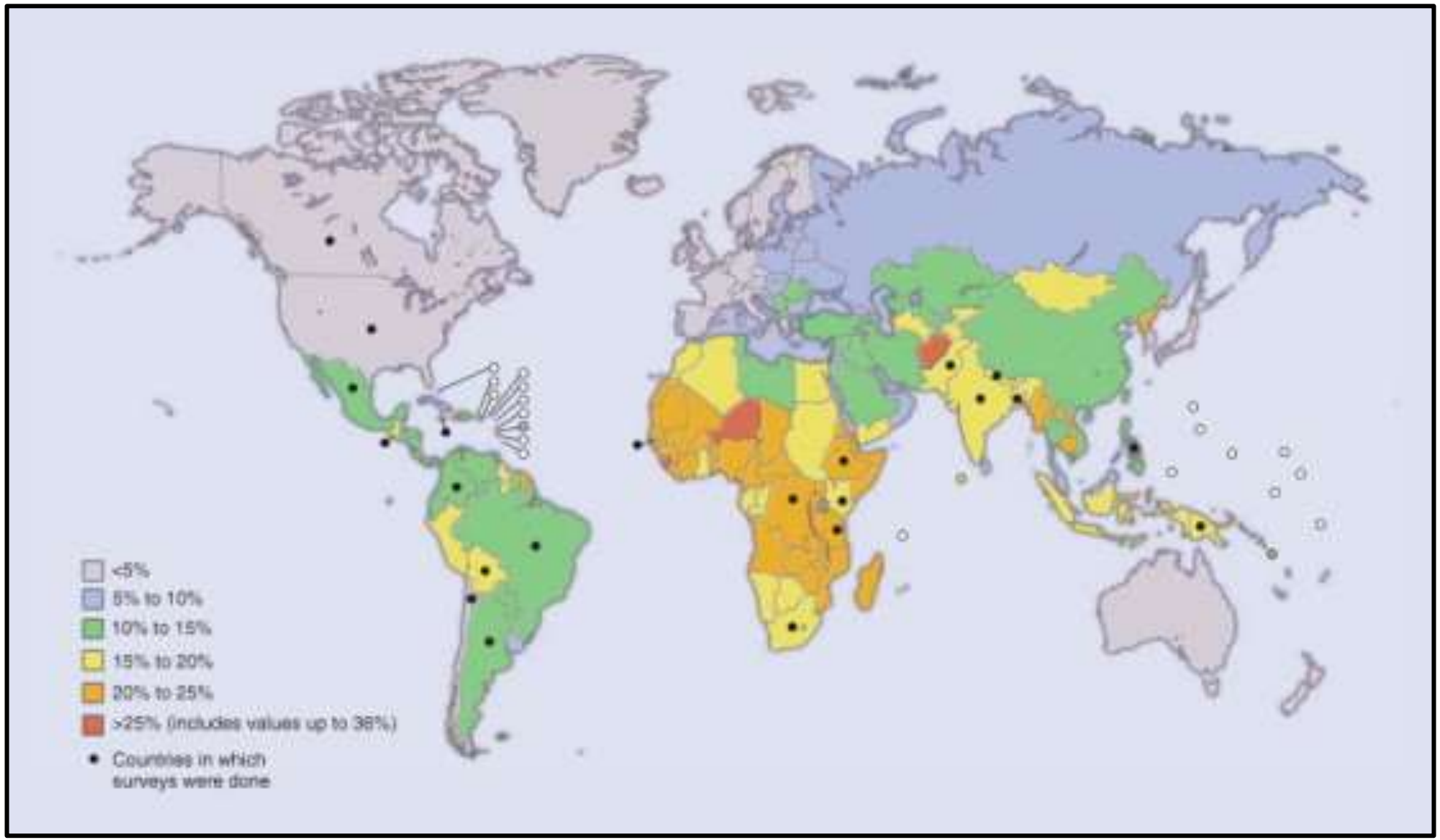
Leading causes of death in low-income countries



Source: WHO Global Health Estimates. Note: World Bank 2020 income classification.

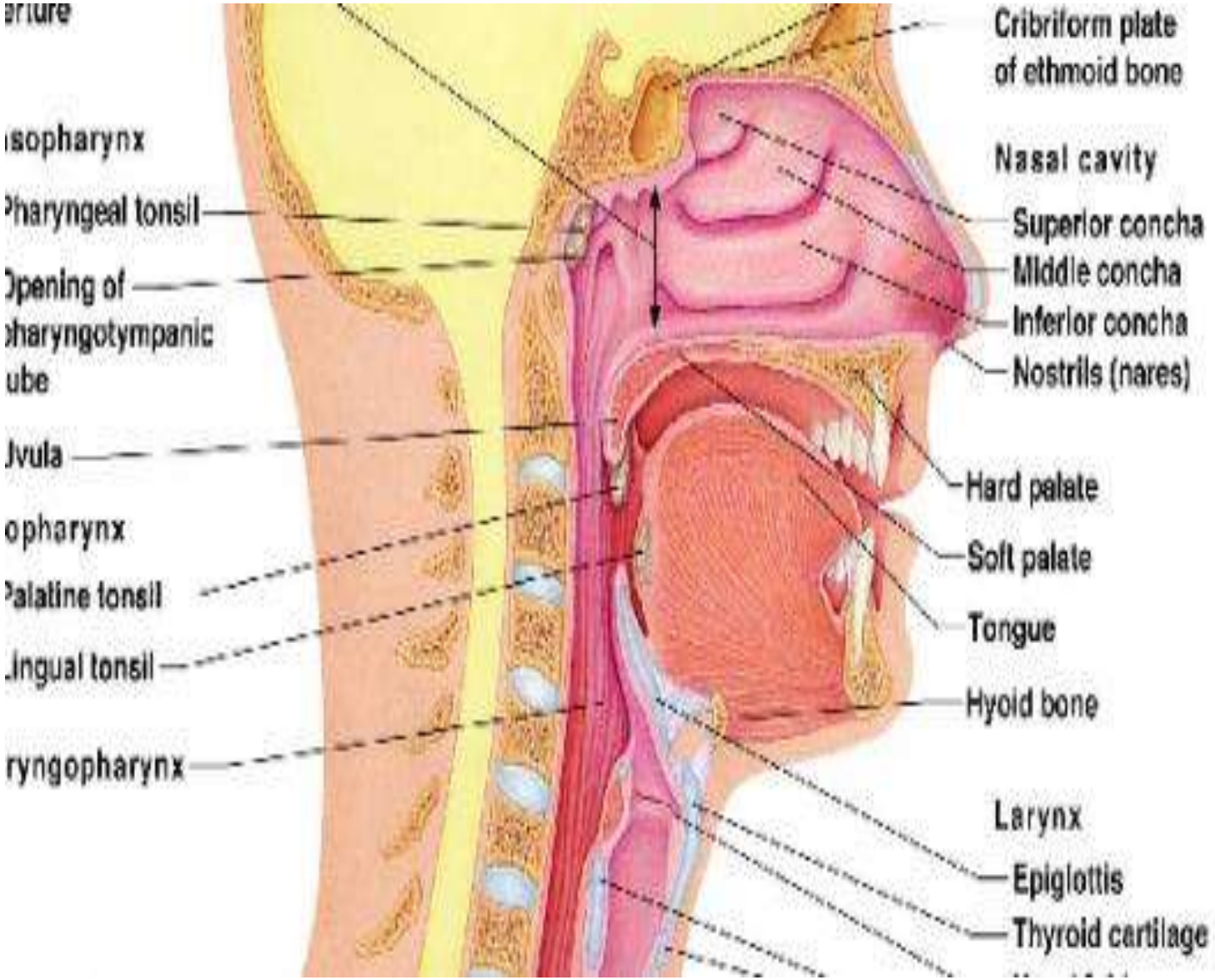
Estimates of the percentage of childhood deaths that are attributable to acute lower respiratory tract infection (ARI) by country in 2000. *The last category includes values up to 36%.*



https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7151775/ 4.5.21

What are the causes of upper respiratory infection?

- The URTI is generally caused by *the direct invasion* of the inner lining *(mucosa or* ***mucus*** *membrane)* of the upper **airway** by the culprit (agent) virus or bacteria. In order for the pathogens *(viruses and bacteria)* to invade the mucus membrane of the upper airways, they have to fight through several physical and immunologic barriers.



What are the causes of upper respiratory infection?

- The hair in the lining of the nose acts as a physical barrier and can potentially trap the invading organisms.
- *Additionally, the wet mucus inside the nasal **cavity** can engulf the viruses and bacteria that enter the upper airways.*
- There are also small hair-like structures *(cilia)* that line the trachea which constantly moves any foreign invaders up towards the pharynx to be eventually swallowed into the digestive tract and into the stomach.

•***ARI or clinical pneumonia:***

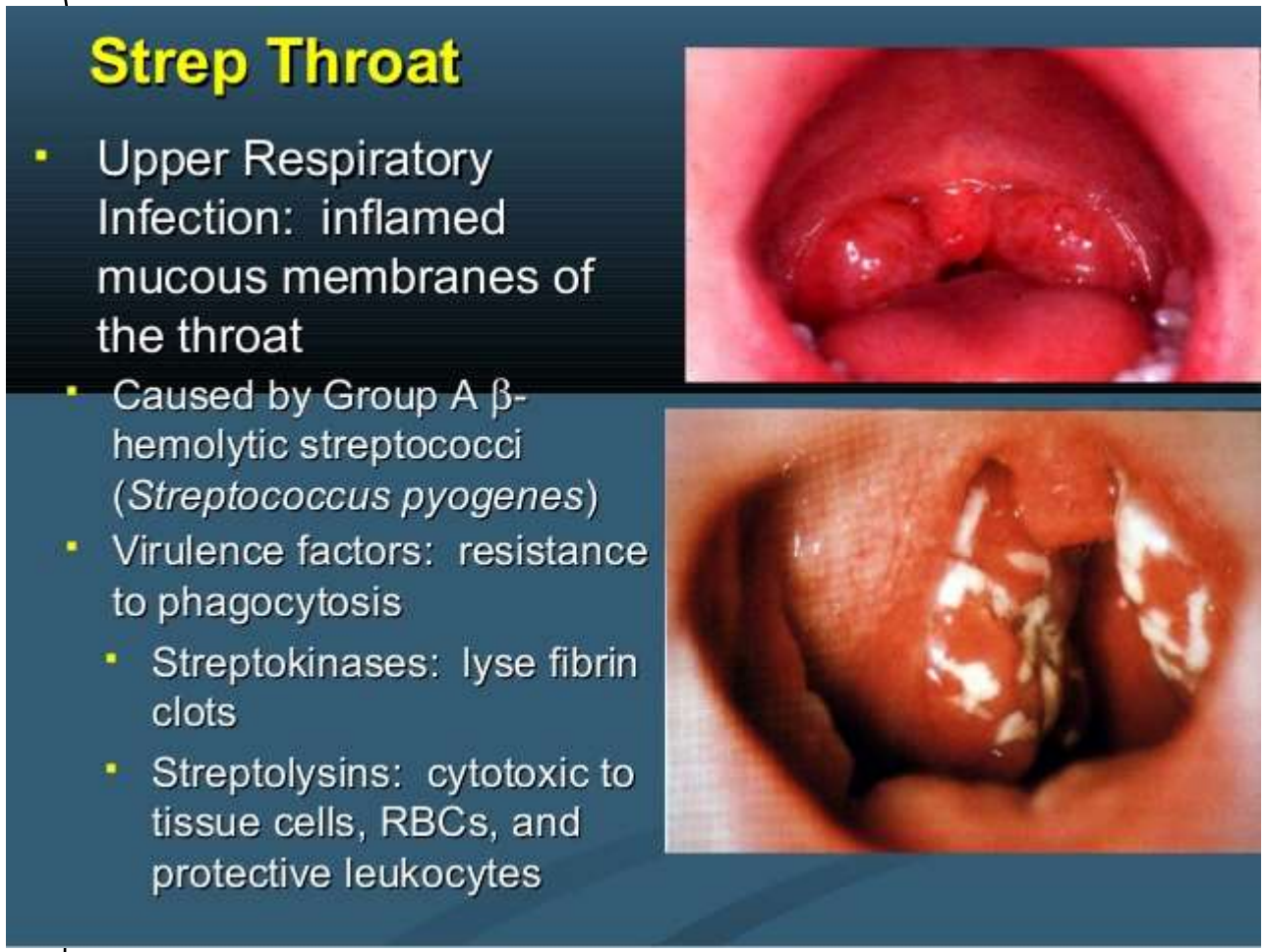
These terms are commonly used in studies in developing countries for a clinical diagnosis of infection of the lower respiratory tract *(below the larynx)* based on the 3 signs of ***fever, cough, and rapid breathing***. Other signs, such as grunting, indrawing, bronchial breathing, auscultatory crackles, etc., may or may not be present.

What are the causes of upper respiratory infection?

- In addition to these intense physical barriers in the upper respiratory tract, the **immune system** also does its part to fight the invasion of the pathogens or microbes entering the upper airway.

- *Adenoids and tonsils located in the upper respiratory tract are a part of the immune system that helps fight infections.*

- Through the actions of the specialized T cells, antibodies, and chemicals within these lymph nodes, invading microbes are engulfed *(swallowed)* within them and are eventually destroyed.



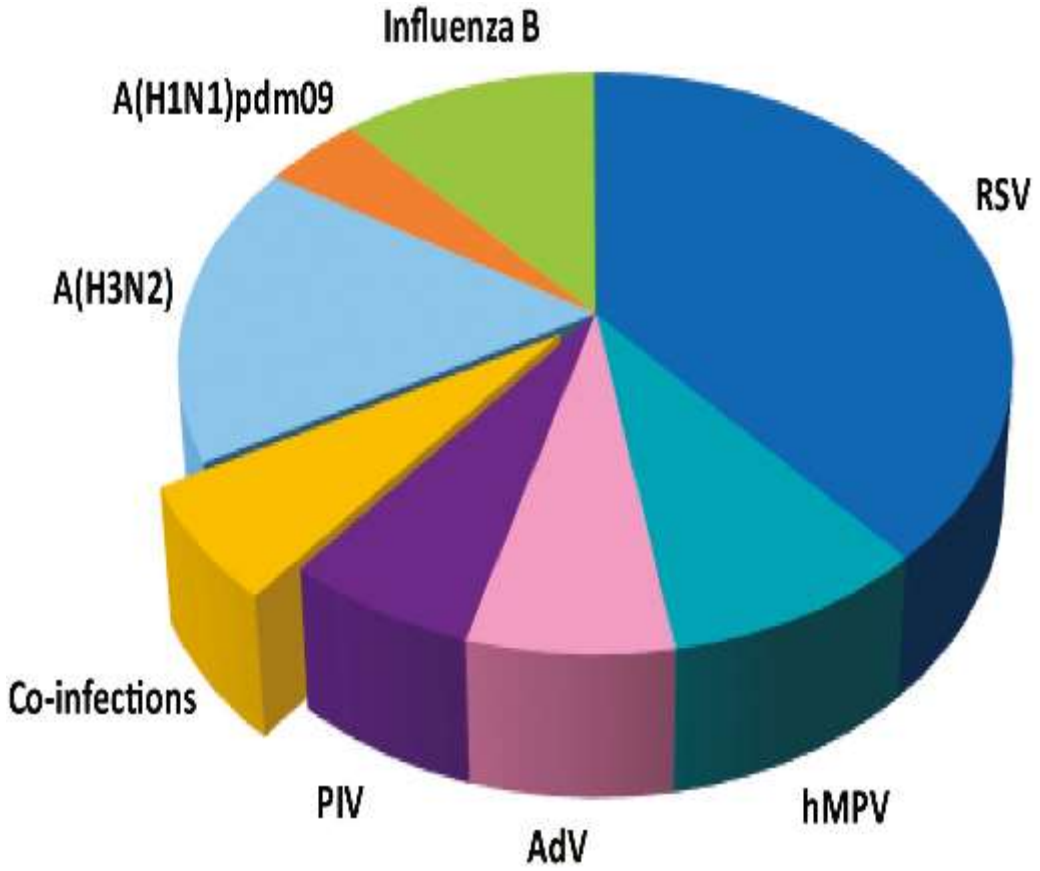
COMMON RESPIRATORY VIRUSES

- Respiratory tract infections are among the most frequent diseases in early life.
- *Many viruses are known to be associated with symptomatic respiratory tract infections, the most common being respiratory syncytial virus (RSV), influenza viruses types A and B, parainfluenza viruses, adenoviruses, and rhinoviruses.*
- Viral infections are consistently more commonly found in younger children, among whom viruses are the cause of as many as 90% of all lower respiratory tract infections (LRIs).

Influenza *viruses* can cause any of the typical respiratory syndromes. Very young infants often present with fever only and no specific lower respiratory tract symptoms. School-age children and adolescents most often present with symptoms of classic influenza (i.e., febrile tracheobronchitis with myalgia and cough).

Epidemiology of respiratory infections

- **Respiratory** tract **infections** are among the most frequent diseases in early life. Many viruses are known to be associated with symptomatic **respiratory** tract **infections**, the most common being **respiratory** syncytial virus (RSV), influenza viruses types A and B, para-influenza viruses, adeno-viruses, and rhino-viruses.
- It has been estimated that 60% of children who are born are infected during the 1st year of life, and all children have had contact with it by their 2nd year; 25-40% of primary infections evolve as acute lower respiratory tract infections, and 2% of them require *hospitalization*.



Epidemiology of respiratory infections

PERIODICITY AND SEASONALITY

In tropical climates, seasonality also exists. In these regions, RSV occurs predominantly in the rainy season, whereas influenza activity occurs throughout the year with a marked peak in activity during the dry season and a lesser peak during the rainy season.

Seasons of both higher and lower temperature have been associated with these viruses in different countries. The reasons for the seasonality of respiratory virus infections and their variation by latitude are not clear.

More important than the environmental conditions themselves may be their effect on behavior.

Seasons when people spend more time indoors, in closer contact with other people (colloquially called "closed-in season" in some regions), will favor more rapid person-to-person transmission.

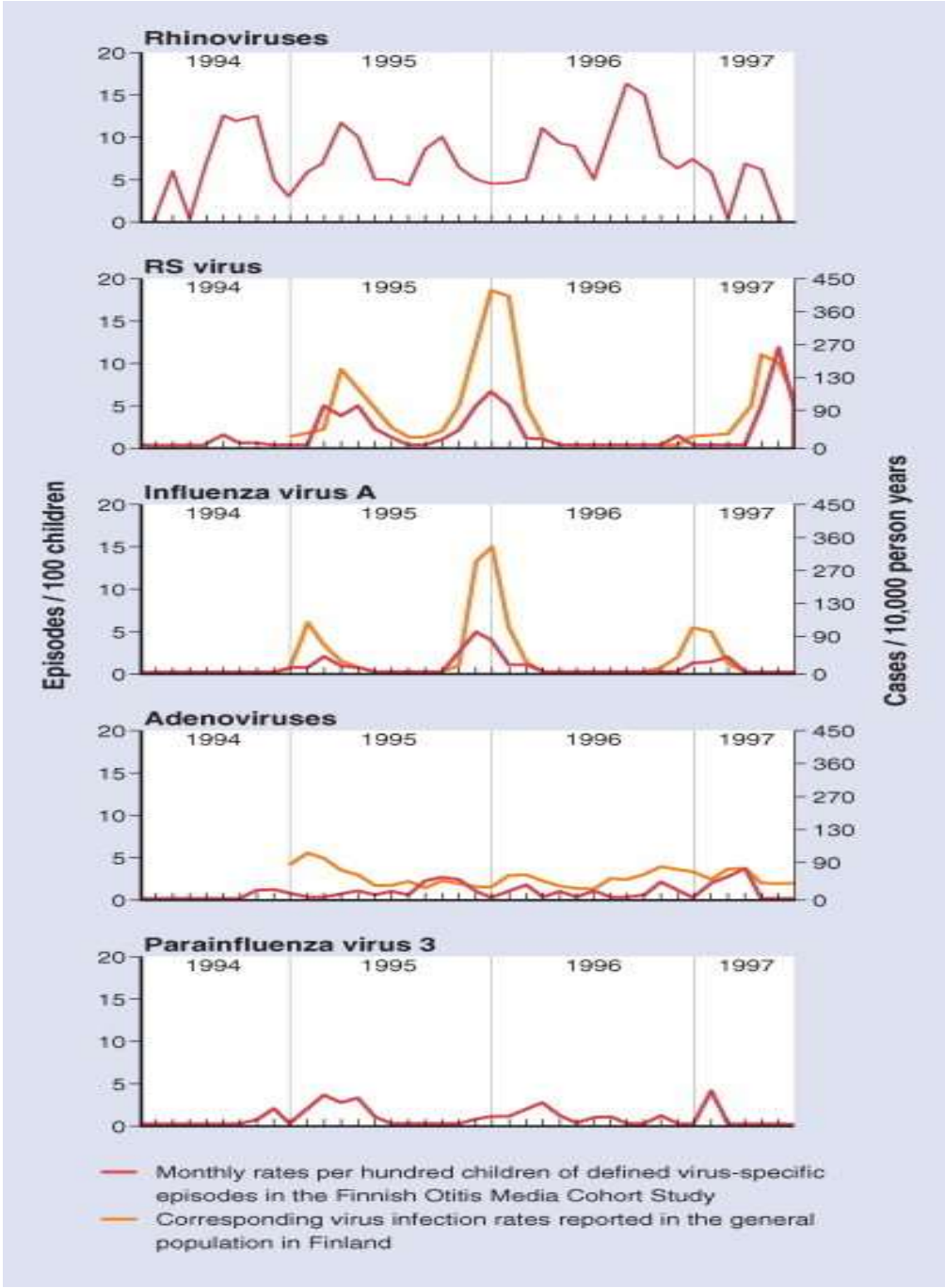
Epidemiology of respiratory infections

PERIODICITY AND SEASONALITY

Both the periodicity and the seasonality of viruses that cause respiratory tract infections are well established in temperate climates.

Most viruses circulate in a community every year; however, some, especially influenza type B and the parainfluenza viruses, may cause epidemics at biennial (every 2 years) or longer intervals.

3 Different viruses also predominate in a community during different seasons of the year; overlap invariably occurs and the actual timing and severity of each outbreak or epidemic can vary from one year to another.



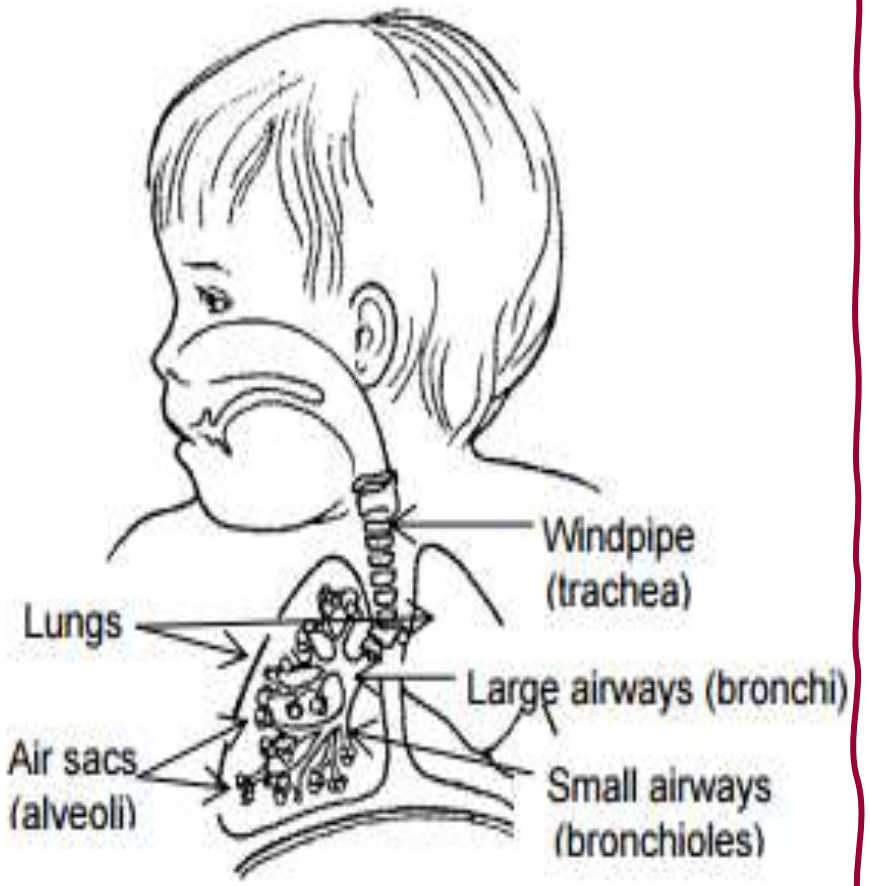
The Global Impact of Respiratory Disease

- ✓About 65 million people suffer from **chronic** obstructive **pulmonary disease** (**COPD**) and 3 million die from it each year, making it the 3rd leading cause of death worldwide.
- ✓*About 334 million people suffer from asthma, the most common **chronic disease** of childhood affecting 14% of all children globally.*

https://www.who.int/gard/publications/The_Global_Impact_of_Respiratory_Disease.pdf 4.5.21

Mortality from respiratory diseases

- Mortality from respiratory diseases is the 3rd main cause of death in EU countries, accounting for 8% of all deaths in 2015.
- *More than 440 000 people died from respiratory diseases in 2015, an increase of 15% over the previous year.*
- Most of these deaths (90%) were among people aged 65 and over. The main causes of death from respiratory diseases are ***chronic obstructive pulmonary disease (COPD)*, pneumonia, asthma and influenza**.



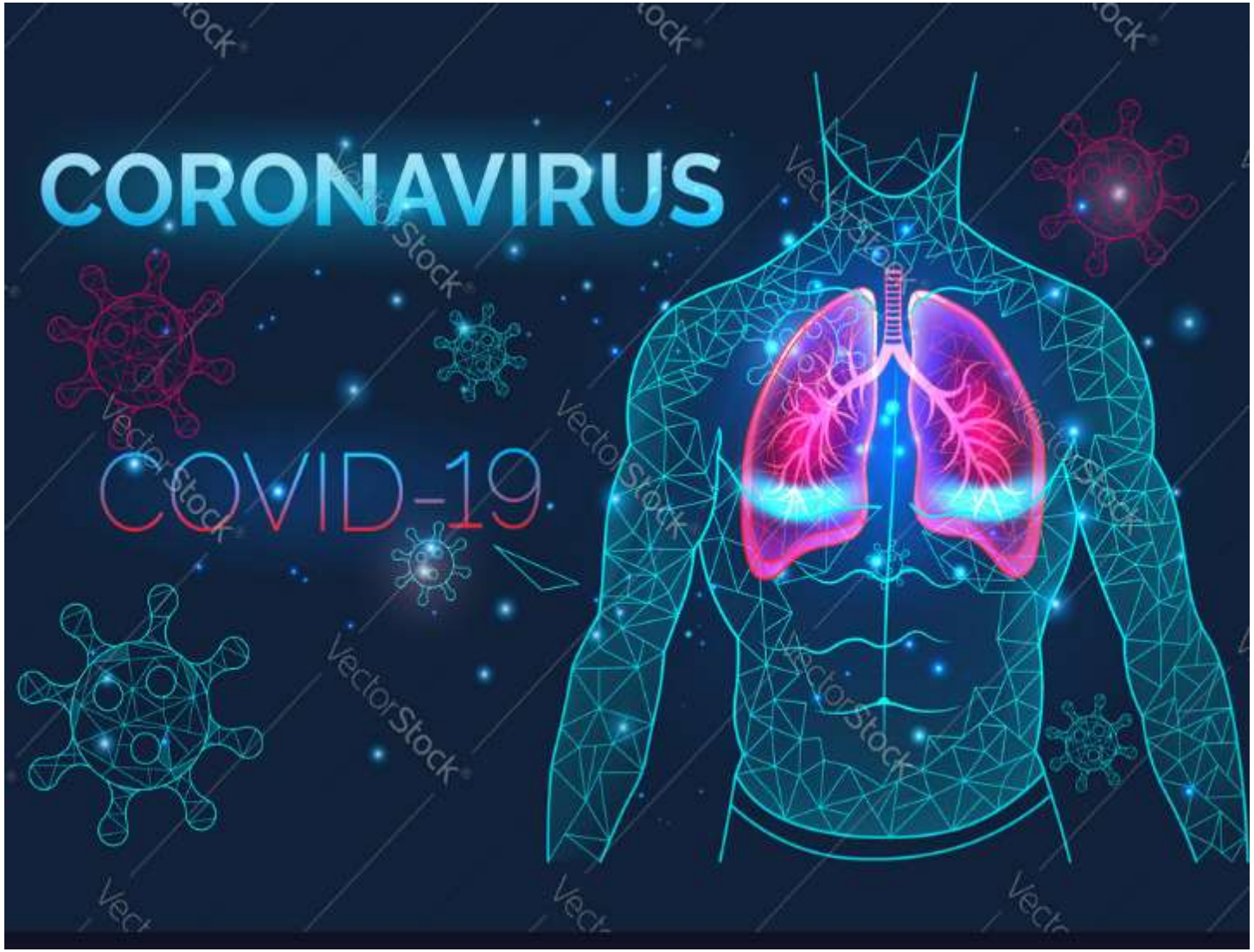
Picture 1. Inside the lung, surfactant keeps the tiny air sacs open.

COMMON RESPIRATORY VIRUSES

- *Increasingly, these viruses are also being associated with a substantial burden of respiratory disease in adults, including elderly persons, and in immunocompromised persons.*
- The advent of molecular technologies has improved laboratory detection of virus in clinical samples and extended the ability to characterize the epidemiology of respiratory virus infections, but it has also led to the identification of subtypes and genotypes of known respiratory viruses and to the discovery of novel respiratory viruses.

The most common lower respiratory syndrome caused by ***adenoviruses*** is pneumonia, but all syndromes can occur. Damage to bronchial architecture can occur with certain adenovirus strains, leading to life-threatening infections, and to bronchiolitis obliterans and bronchiectasis.

SARS-COV2
Viral Pneumonia



The ***coronaviruses*** *(hCoV-229E and hCoV-OC43) are a frequent cause of URIs in children and adults. Human bocavirus and the newer coronaviruses (hCoV-NL63 and hCo-HKU1) have been associated with respiratory tract infection in children, but their epidemiology remains to be fully elucidated.*

How are most respiratory infections transmitted?

- **Many** of the germs that cause **respiratory** (breathing) **diseases** are spread by droplets that come from coughing and sneezing.
- *These germs usually spread from person to person when uninfected persons are in **close contact** with a sick person.*
- Some respiratory illnesses, such as influenza, can be prevented with a **vaccine**.
- Check with local health officials to see if influenza vaccination is available at your region.

Respiratory viruses can be **transmitted** via 4 major modes of **transmission**:

1. Direct (physical) contact,
2. Indirect contact (fomite),
3. (large) droplets and
4. (fine) aerosols.

Facts about Spread of Respiratory Diseases

- Many of the germs that cause respiratory (breathing) diseases are spread by droplets that come from coughing and sneezing.
- *These germs usually spread from person to person when uninfected persons are in close contact with a sick person. Some people may become infected by touching something with these germs on it and then touching their mouth or nose.*
- In general, the best way to help prevent spread of respiratory germs is to avoid contact with droplets or secretions of saliva, mucus and tears. Things that can help include the following:

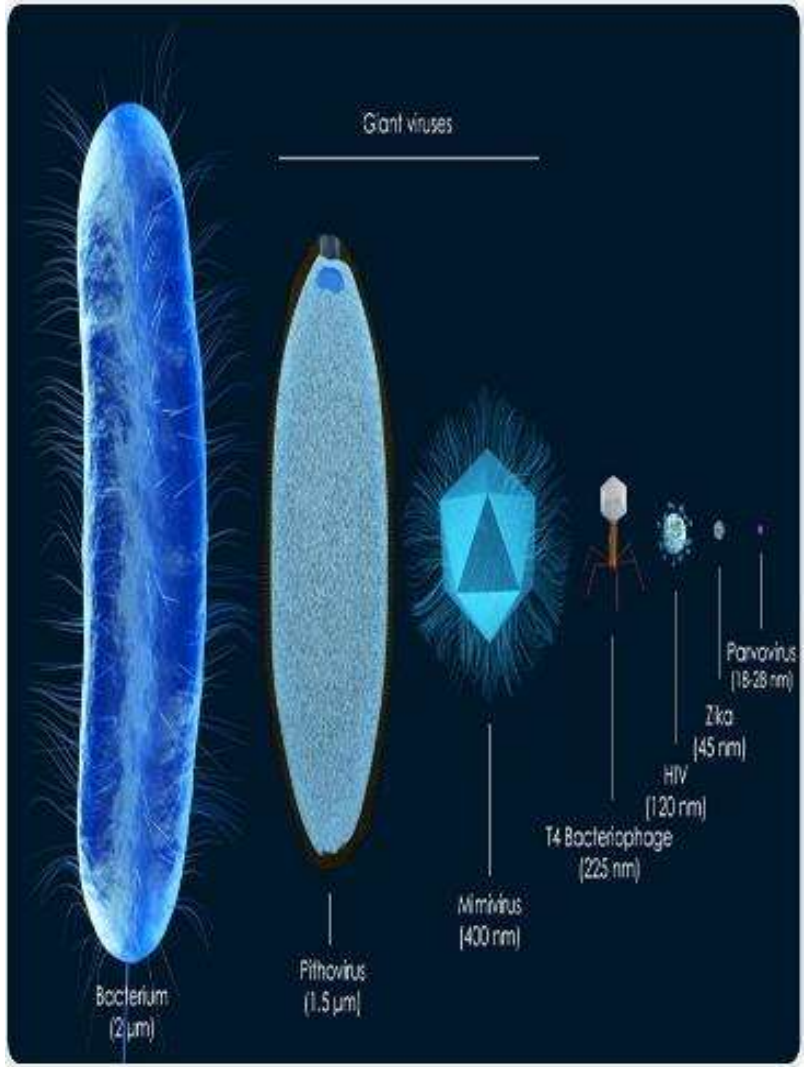
Symptoms of upper respiratory infection (URTI) include **cough**, **sneezing**, **nasal discharge**, **nasal congestion**, **runny nose**, **fever**, **scratchy or sore throat**, and ***nasal breathing***.

Facts about Spread of Respiratory Diseases

- Minimize ***close contact*** with persons who have symptoms of respiratory illness, such as coughing or sneezing.
- Help ill persons contain droplets that result from their coughing and sneezing *(see Respiratory Hygiene/Cough Etiquette)*.
- ***Wash your hands regularly.***
- **Avoid** *sharing personal items such as eating or drinking utensils, toothbrushes, and towels. You should especially avoid sharing these items with sick persons.*
- Maintain a clean environment.

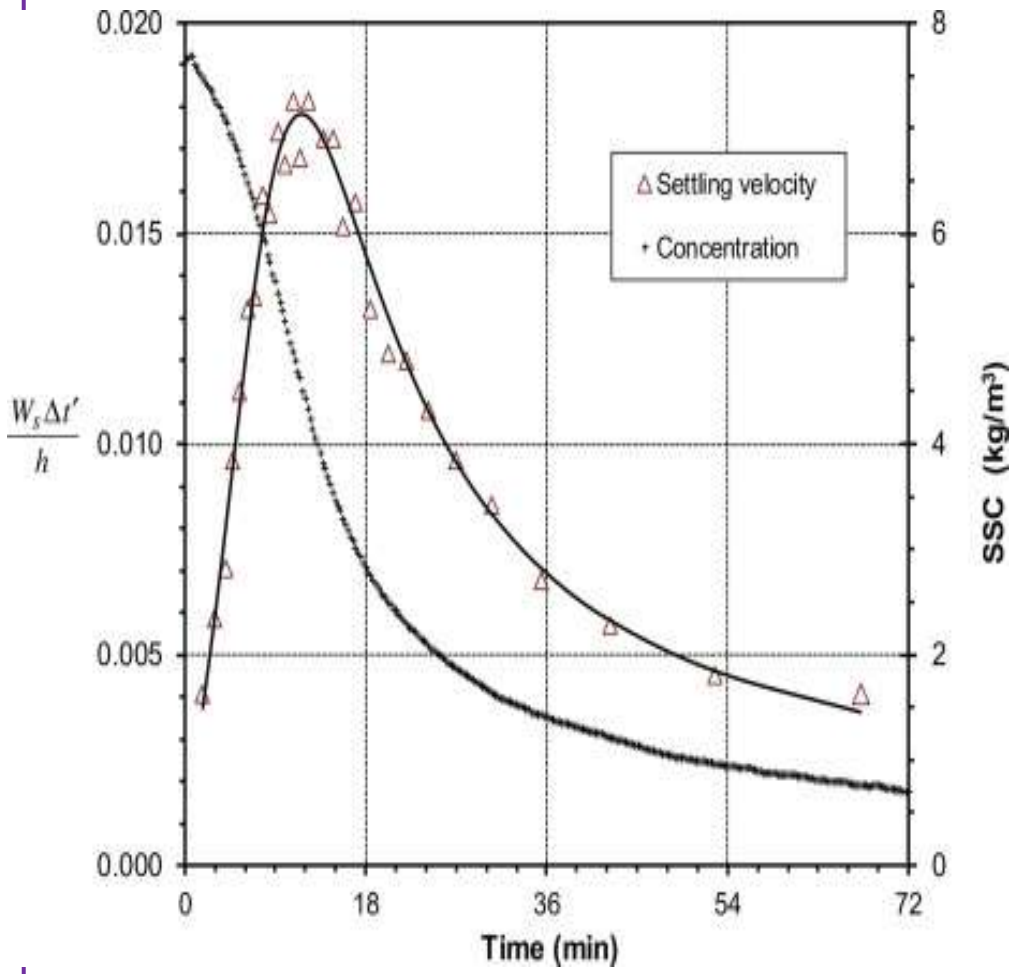
How are respiratory viruses transmitted?

- **Particle size, settling velocity..**
- Factors determining the efficiency of viral transmission include the size of the respiratory aerosol and the settling velocity of the particle.
- *Large particles settle more rapidly than small particles and present a risk mostly to those close to the infected person. Large particle droplets are generated during a sneeze or a procedure such as bronchoscopy or suctioning. Large particles travel less than 3-5 feet from an infected person and transmit infection when the particle lands on the conjunctiva or nasal mucosa of a susceptible person.*
- Infection caused by viruses spread by large particle aerosol may be intermittent and occur without clustering of cases. Pathogens spread by large particle droplet aerosol include adenovirus, influenza, rhinovirus and Bordetella pertussis.



How are respiratory viruses transmitted?

- **Particle size, settling velocity..**
- Small particles *(less than 10 microns in diameter)* remain airborne for longer periods of time than large particle aerosols.
- These small particles can be inhaled by susceptible persons in the same room or are capable of more distant spread as they are carried in air currents.
- Because viruses spread by small particle aerosol do not require close contact, the source of infection may not be evident and a more *rapid outbreak* may occur.
- Agents transmitted by small particle transmission include measles virus, varicella-zoster virus and *Mycobacterium tuberculosis*.

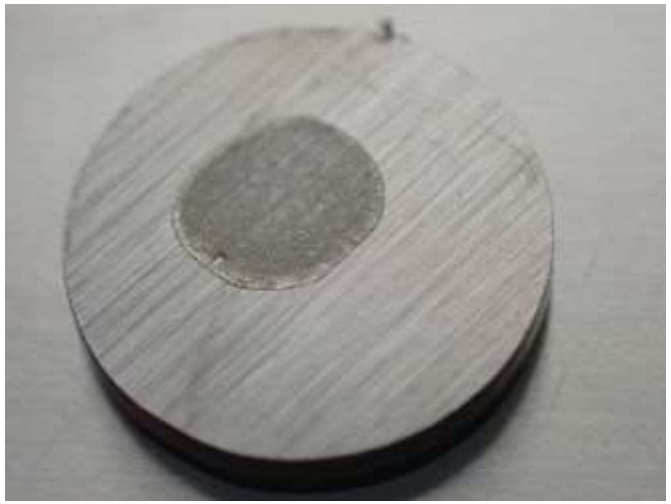


How are respiratory viruses transmitted?

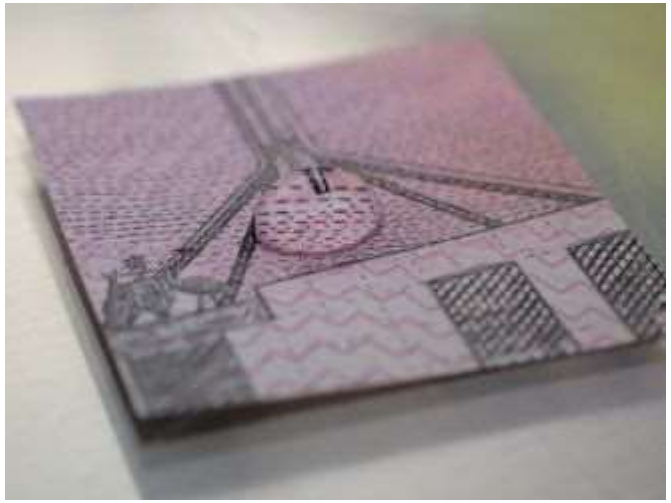
- **Particle size, settling velocity..**
- *Special ventilation is required to prevent airborne transmission (negative air pressure ventilation and an N95 respirator). Ultraviolet irradiation is highly effective at inactivating viruses in a small particle aerosol but is not effective for eliminating virus in surface contamination or large droplets.*
- Small respiratory particles contain fewer infectious viral particles *(virions)* but are more likely than large particles to be inhaled and reach the lower respiratory tract. Large particles are more likely to settle in the upper respiratory tract and tend to produce milder disease.

How are respiratory viruses transmitted?

- **Survivability of viruses**
- *Viruses generally survive longer on a hard surface than on a porous surface.*
- *Secretions containing influenza virus or respiratory syncytial virus (RSV) are infectious on a countertop for less than six hours.*
- *Infectivity is lost after 30 minutes or less from RSV or influenza-containing secretions on a gown. Rhinoviruses or adenoviruses are capable of surviving on contaminated surfaces for more than 24 hours.*



Virus on stainless steel



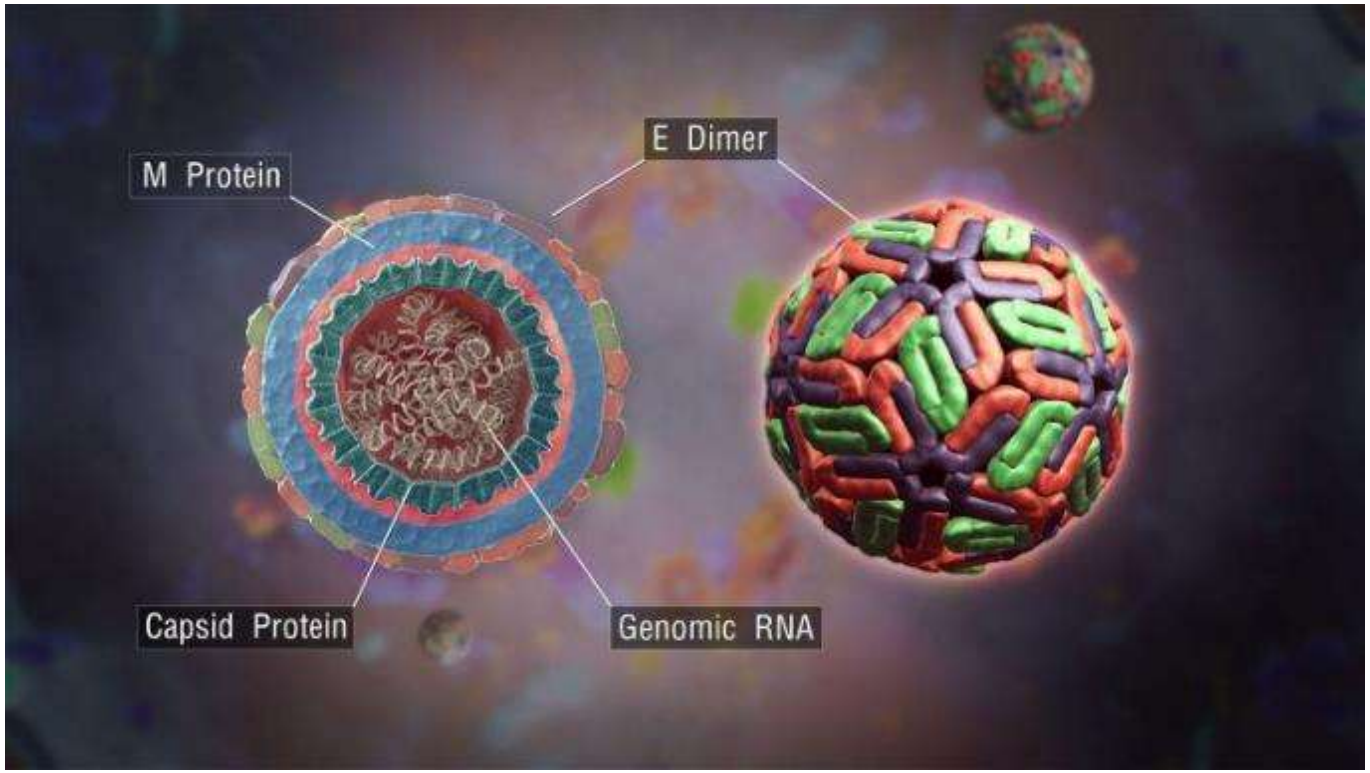
Virus droplet on five dollar note

How are respiratory viruses transmitted?

- **Survivability of viruses**
- *The difference in survivability partly is related to the presence or absence of a viral lipid envelope. Paramyxoviruses such as RSV, parainfluenza and human meta pneumovirus as well as influenza viruses (orthomyxoviruses) have a lipid envelope that is vulnerable to dehydration and rapid loss of infectivity.*

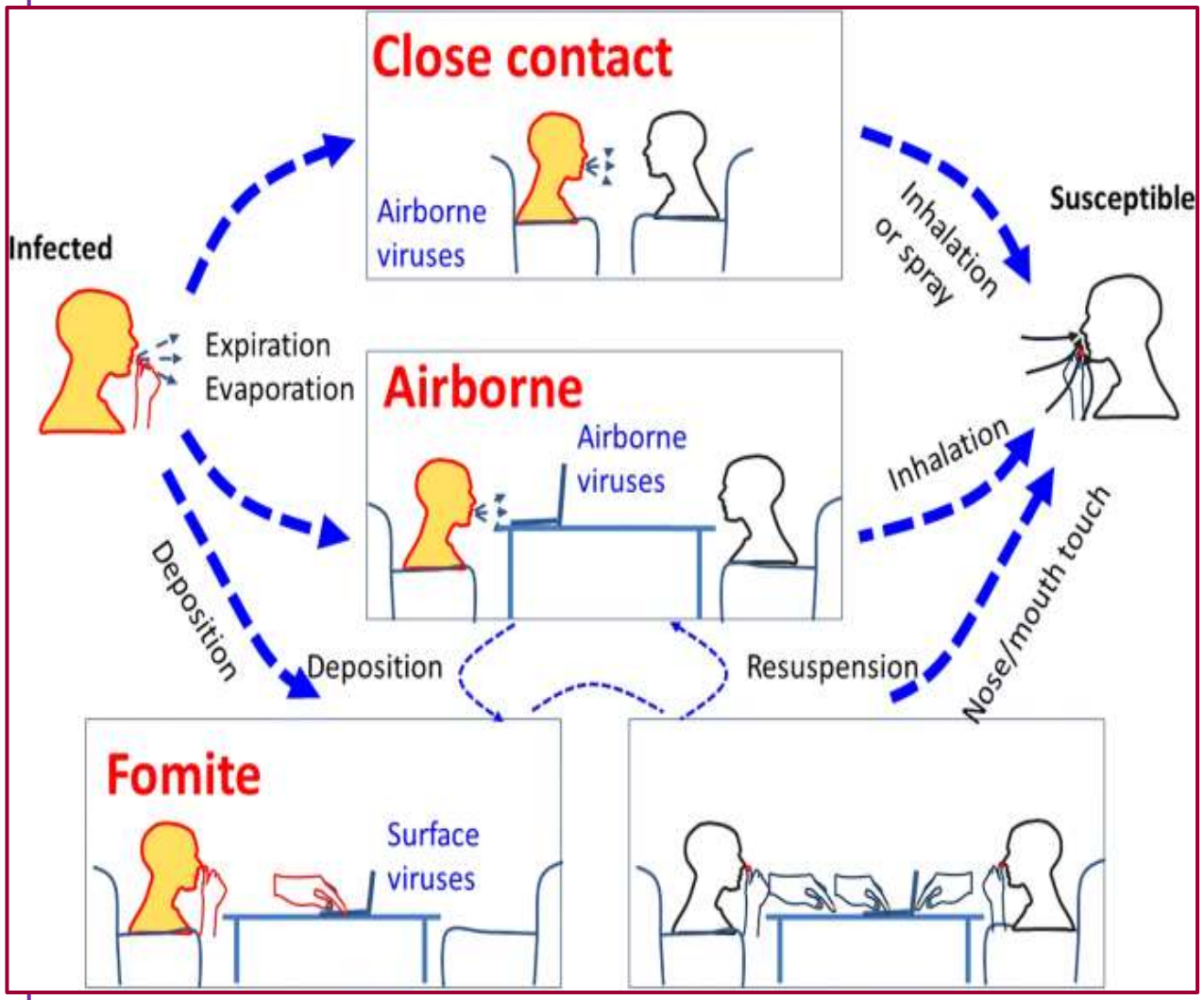
How are respiratory viruses transmitted?

- **Survivability of viruses**
- *Viruses that do not contain a lipid envelope (such as adenovirus, enterovirus and parechovirus) survive for longer periods in an extracellular environment than viruses containing a lipid envelope.*
- One role of the viral envelope is to anchor surface glycoproteins, enabling the virus to attach to specific epithelial cells in the respiratory tract which will support *viral replication* (*tropism*).



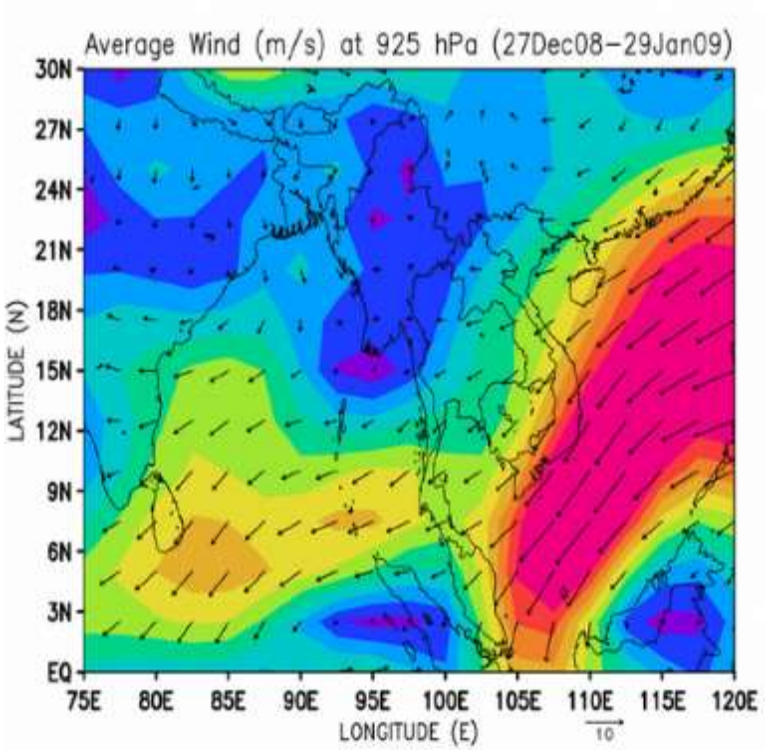
How are respiratory viruses transmitted?

- **Routes of transmission**
- Self-inoculation with contaminated secretions is the most common route of respiratory virus transmission in a health care setting.
- *This can involve direct contact between an infected person and a susceptible host or indirect contact with contaminated objects such as dressings, toys or instruments.*
- **Direct contact** with infectious secretions is most likely to occur with prolonged contact or in settings with poor hygiene such as homes or child care centers.



How are respiratory viruses transmitted?

- **Role of meteorological conditions-1**
- A clear seasonal pattern of outbreaks is well-recognized with many respiratory viruses.
- *Meteorological conditions such as relative humidity, minimum temperature, cloud cover, exposure to sunlight (ultraviolet A and B), barometric pressure and rainfall affect viral survival and infectivity.*
- For example, at locations with persistently warm temperatures and high humidity, RSV activity is present throughout the year. In temperate climates, RSV circulation correlates with lower temperature, and transmission is inversely related to temperature.

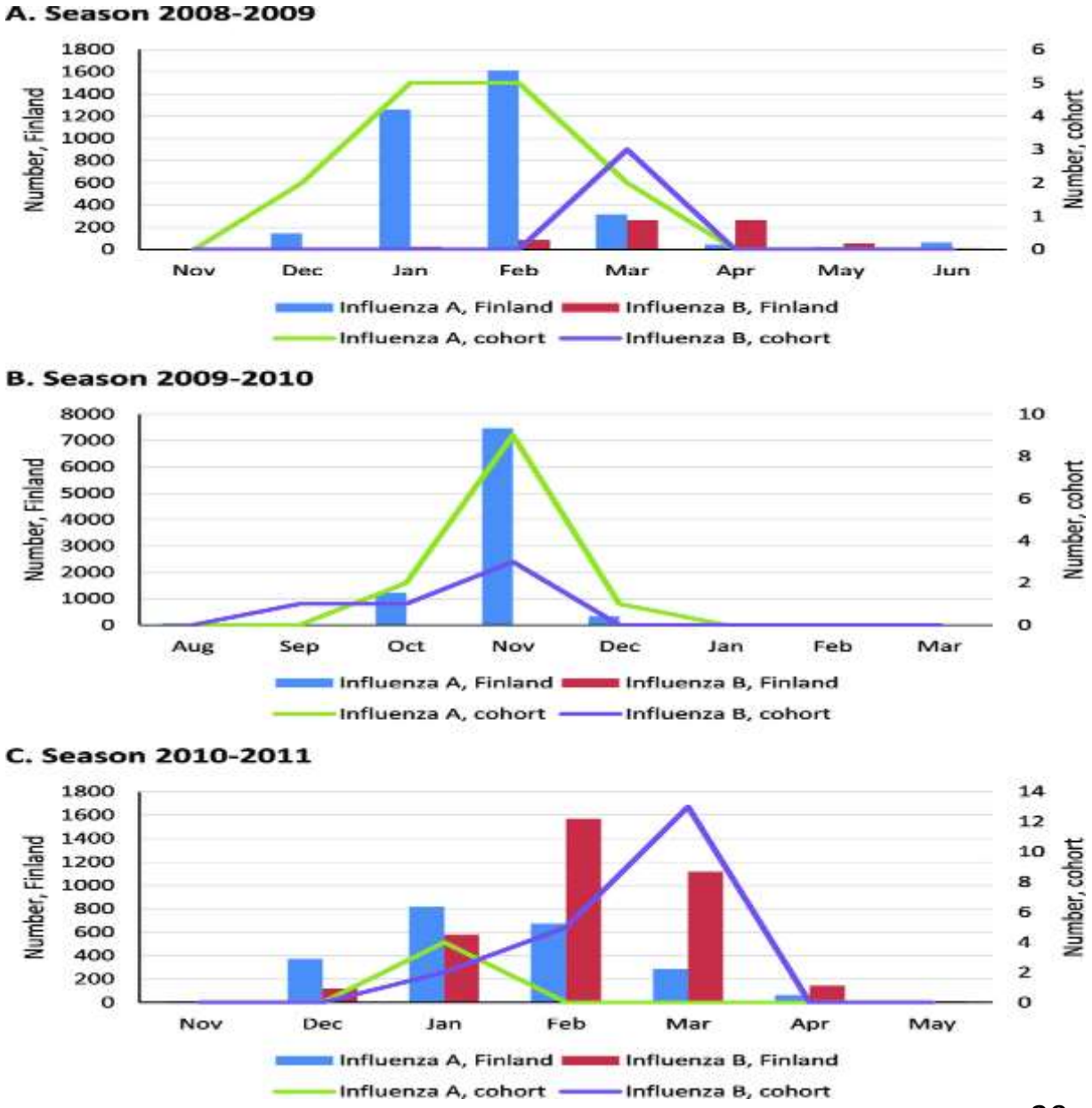


How are respiratory viruses transmitted?

- **Role of meteorological conditions-2**

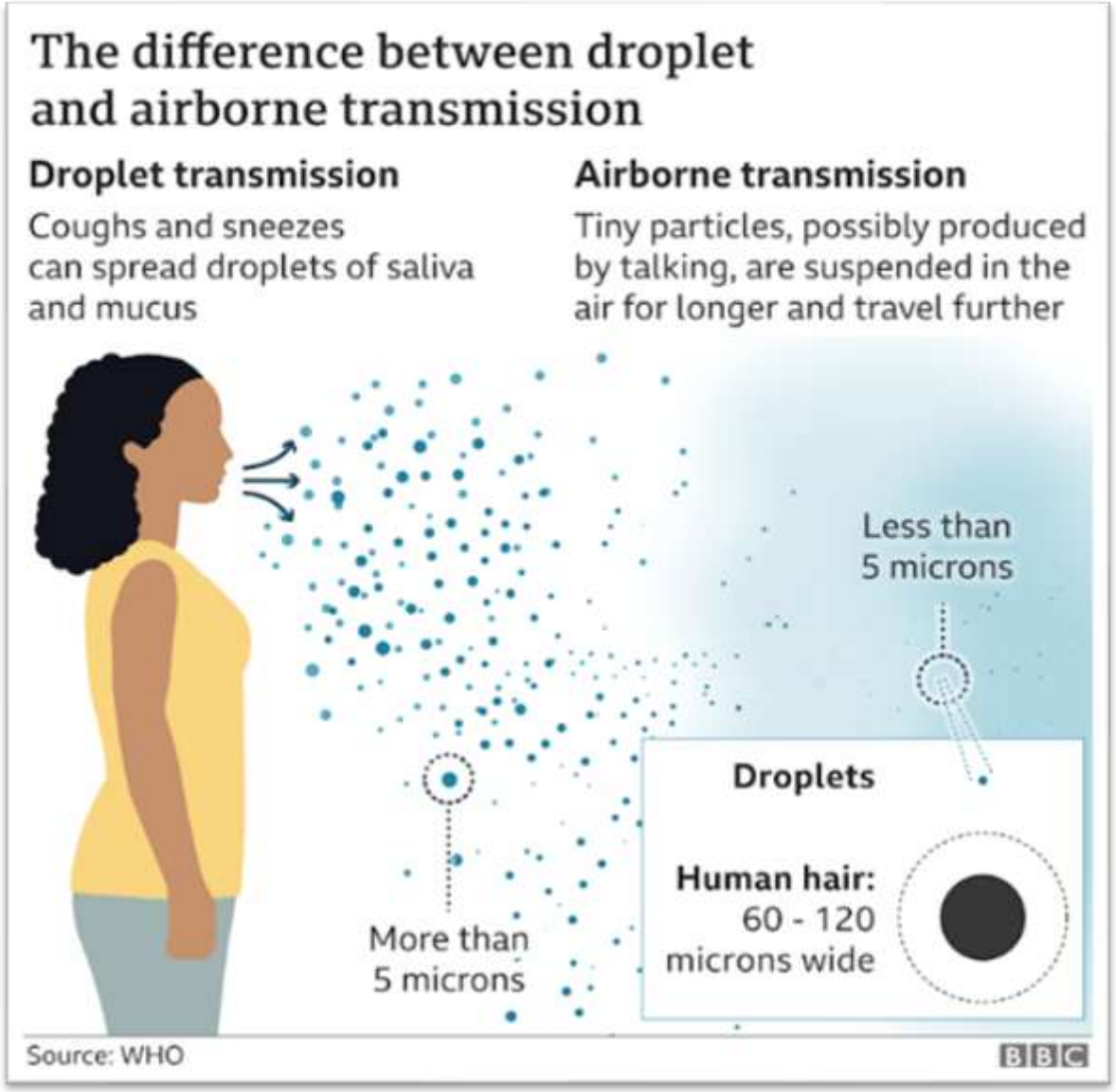
- In colder climates, RSV activity persists throughout the year.

- Conflicting results from studies regarding the role of these factors and different viral agents indicate a complex and poorly understood relationship between *viral survival* and meteorological conditions.



How are respiratory viruses transmitted?

- **Individual differences**
  - Infected individuals differ in their ability to spread respiratory viruses.
  - Sneezing and coughing are more effective means of generating infectious secretions than shouting.
  - "**Super-shedders**" are people who expel extraordinarily large amounts of infectious aerosols, which may account for a disproportionate amount of disease transmission.
  - Why this happens is not well-understood.



Laboratory Detection

- **Conventional virologic methods**, including antigen detection, serology, and culture, have clearly identified the viruses most frequently causing respiratory illnesses in children and associated with both upper respiratory tract (URI) and lower - LRI infections.

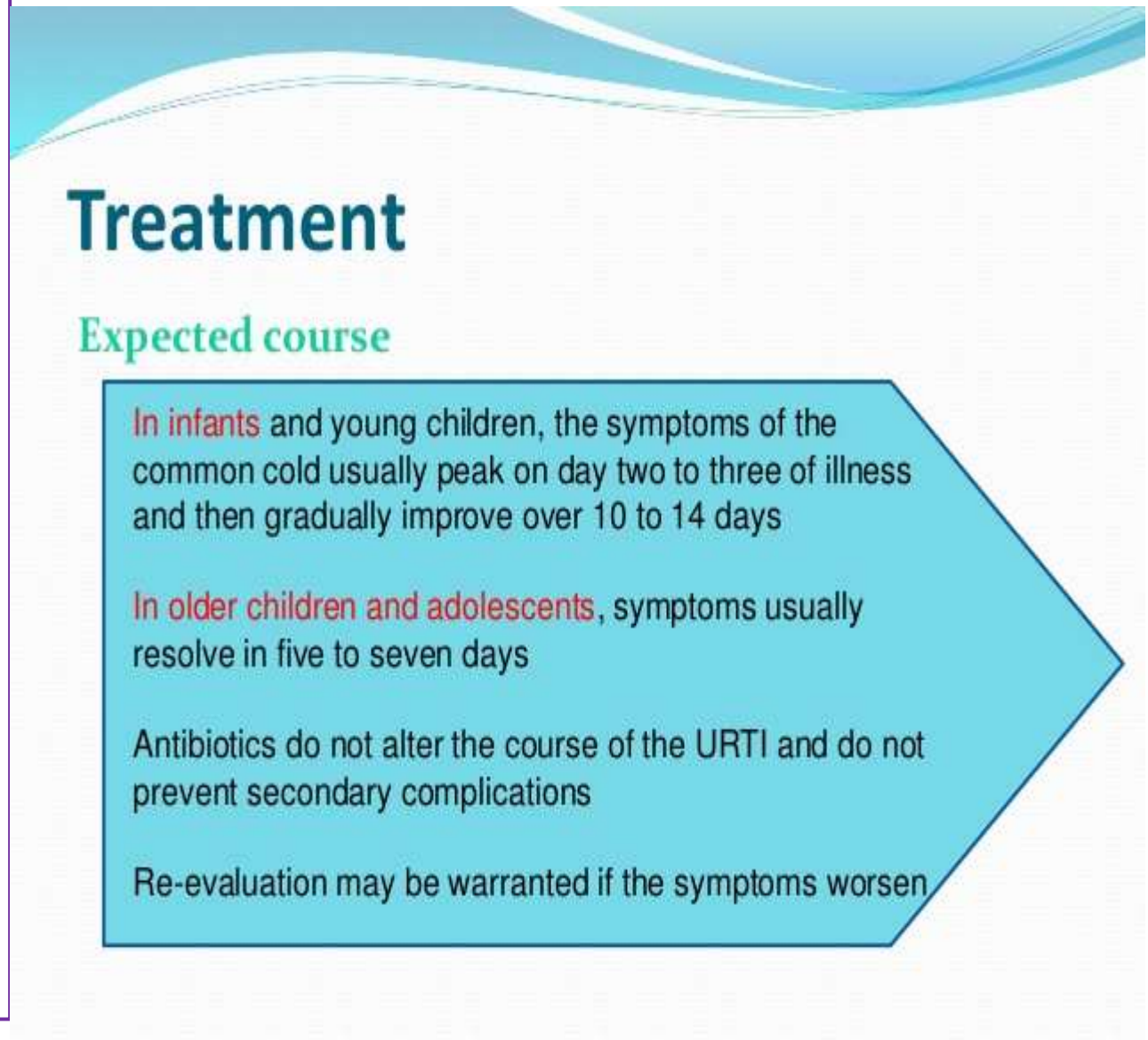
How is lower respiratory tract infection treated?

Medications

Non-steroidal anti-inflammatory drugs (NSAIDs), such as ibuprofen, naproxen, or aspirin can relieve pain and fever.

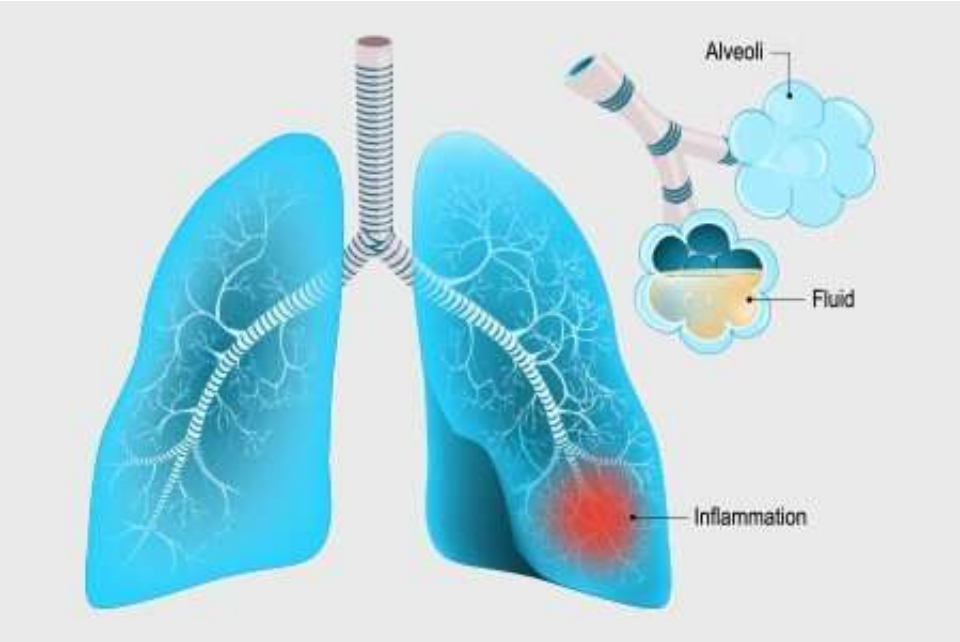
Acetaminophen can also provide relief from pain and fever.

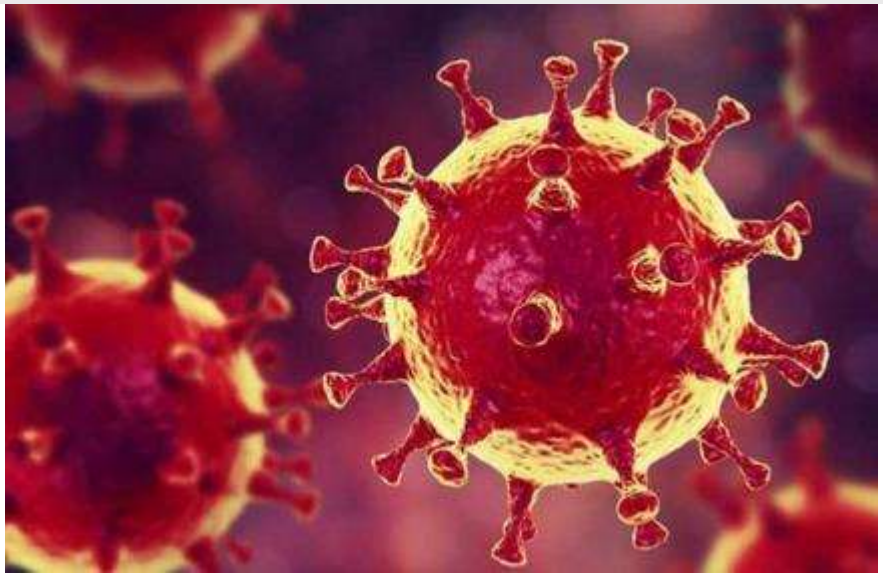
Using a bronchodilator inhaler can help wheezing and *shortness of breath*.



Do you need antibiotics for lower respiratory infection?

- **Antibiotics do** not help the many **lower respiratory infections** which **are** caused by viruses.
- While acute bronchitis often **does** not **require antibiotic** therapy, **antibiotics can** be given to patients with acute exacerbations of chronic bronchitis.





The modified WHO case management guideline for acute respiratory illness.

Check for general danger signs

Ask:
- Is the child able to drink or breastfeed?
- Does the child vomit everything?
- Has the child had convulsions?

Look:
- See if the child is lethargic or unconscious.

A child with any general danger sign needs URGENT attention: give first dose of IM chloramphenicol immediately and refer URGENTLY to hospital.

If referral is NOT possible:
- Give IM chloramphenicol for 5 days followed by 5 days of oral antibiotic therapy.

Does the child have cough or difficult breathing?

If yes, ask:
- For how long?

Look, listen, feel:
- Count the breaths in one minute.
- Look for chest indrawing.

CHILD MUST BE CALM

Classify COUGH or DIFFICULT BREATHING →

If the child is: — **Fast breathing is:**
- 2 months up to 12 months ► 50 breaths per minute or more
- 12 months up to 5 years ► 40 breaths per minute or more

Signs	Classify as	Treatment
• Chest indrawing	SEVERE PNEUMONIA	• Give first dose of amoxicillin • Refer URGENTLY to hospital. If referral is NOT possible: • Give oral amoxicillin 3 times daily for 7 days
• Fast breathing	PNEUMONIA	• Give oral cotrimoxazole twice daily for 5 days • Soothe the throat and relieve the cough with a safe remedy • Advise mother when to return immediately • Follow up in 2 days
• No signs of pneumonia or other very severe disease	NO PNEUMONIA: COUGH OR COLD	• If coughing more than 30 days, refer for assessment if possible • Soothe the throat and relieve the cough with a safe remedy • Advise mother when to return immediately

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7151775/ 4.5.21

How can lower respiratory infections be prevented?

- Washing your hands regularly and thoroughly, particularly after touching your nose or mouth, and before handling food.
- ***Sneezing and coughing into tissues.***
- This will help prevent the virus-containing droplets from your nose and mouth entering the air where they can infect others.

In summary-1; *Epidemiology of Respiratory Transmitted Infections*

- Acute respiratory tract infections are the most common illnesses in all individuals, regardless of age or gender.
- *Epidemiologic surveys and community-based studies conducted since the beginning of the 20th century have determined the rates of illness and the pathogens involved in such infections.*
- These studies have shown that rhinoviruses cause the great majority of these respiratory illnesses, and their findings have examined the means of transmission of respiratory illness.
- *More recently, advances in diagnostic techniques have enabled more complete identification of the viruses involved in respiratory infections, which has aided in the ability to direct specific therapeutic agents at the causative pathogens.* *https://doi.org/10.1016/S0002-9343(01)01058-0* 4.5.21

In summary-2; *Epidemiology of Respiratory Transmitted Infections*

- Acute respiratory tract infections (ARI) are the main cause of morbidity and mortality among children aged <5 years in the developing world.
- *Respiratory viruses cause up to 80% of ARI.*
- Respiratory viruses are spread via three different transmission routes: contact, droplet, and aerosol transmission.
- *Host population size, density, immune status, age structure, and contact rates affect the transmission patterns of viruses causing acute predominantly self-limiting infections, such as respiratory viruses.*
- Residents of resource-limited communities such as slums may be particularly vulnerable to virus-associated ARI.
- Hypothetically, virus transmission may be facilitated in these dense populations, characterized by frequent interindividual contact, crowded housing, improper sanitation systems, **poor** education, and **poor** nutritional status, exemplified by *inversely correlated* influenza virus prevalence and **family income**. *https://doi.org/10.1002/jmv.25636* 4.5.21

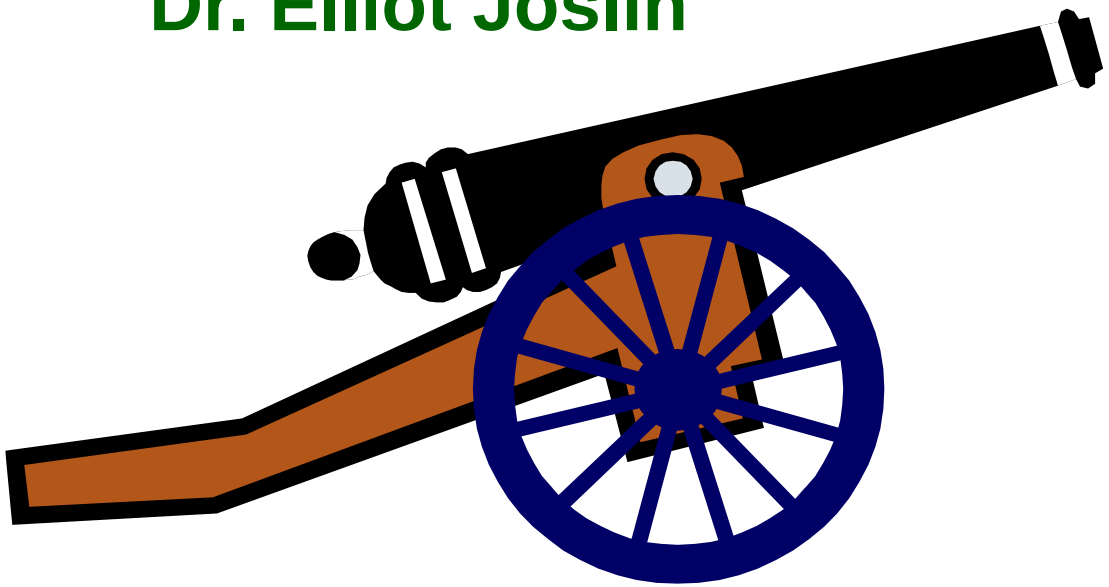
In summary-3; *Epidemiology of Respiratory Transmitted Infections*

- Human respiratory virus infections lead to a spectrum of respiratory symptoms and disease severity, contributing to substantial morbidity, mortality and economic losses worldwide, as seen in the COVID-19 pandemic.
- Belonging to diverse families, respiratory viruses differ in how easy they spread (transmissibility) and the mechanism (modes) of transmission. Transmissibility as estimated by the **basic reproduction number (R0)** or *secondary attack rate* is heterogeneous for the same virus.
- Respiratory viruses can be transmitted via **4 major modes of transmission**: direct (physical) contact, indirect contact (fomite), (large) droplets and (fine) aerosols. We know little about the relative contribution of each mode to the transmission of a particular virus in different settings, and how its variation affects transmissibility and transmission dynamics. Discussion on the ***particle size*** threshold between droplets and aerosols and the importance of aerosol transmission for severe acute respiratory syndrome coronavirus 2 (**SARS-CoV-2**) and influenza virus is ongoing.
- Mechanistic evidence supports the efficacies of non-pharmaceutical interventions with regard to virus reduction; however, more data are needed on their effectiveness in *reducing transmission*. Understanding the relative contribution of different modes to transmission is crucial to inform the effectiveness of ***non-pharmaceutical interventions*** in the population. Intervening against multiple modes of transmission should be more effective than acting on a single mode.
  https://www.nature.com/nrmicro 22.03.2021

Lifestyle Factors

"Genes load the gun.
Lifestyle pulls the trigger"

Dr. Elliot Joslin



Thank you for your participation…