

Pathogens

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Pathogens, or in this case better to say, infectious agents are ubiquitous. Some of them are obligatory pathogens, cause of severe diseases and therefore are well-known. Some of them are well-known but they are considered to be either less risky or it is believed that they are under control. Some of them are facultative pathogens, causing fewer infections and therefore mostly are unknown. All of them should cause health problems indoors as the indoor environment is very special:

- People spent indoors most of their life, ill people with higher probability
- Air exchange is mostly inadequate, especially where ill people are concentrated
- Poor maintenance of ventilation/air exchange systems is rather common, so the infectious dosage could be reached easily, if the source of infectious agent is indoors
- Direct & indirect transmission infectious agents is easy in overcrowded interior

A PIECE OF HISTORY

Outbreaks of several infectious diseases occurred during the previous centuries and all of them reduced the population of the civilized countries. People gave them poetic names as “black death” or “red death”. Last such devastating outbreak, with probably higher number of death people than any of the previous, was “Spanish flu” at the beginning of 20th century causing the death of more than 40 million people.

All of these outbreaks, as far as we know, were caused mainly by the airborne infections – transmission from man to man directly or indirectly via droplets. There are some exceptions from this rule: plague is transmitted from man via vector (flea) to other man. Medium for distribution *Vibrio cholerae* is (drinking) water.

Other “plagues” like smallpox or pulmonary plague are distributed by droplets in air.

INFECTION AGENTS

Many people believe that most infectious diseases are under control due to vaccination or/and antibiotics. Unfortunately the reality is less positive. Antibiotics don't affect viral infections and research and development of new vaccines is not quick enough. Moreover, evolution of the pathogens is probably at least of the same speed as the vaccine development. When people moved from outside in indoor

environment brought also some new problems, arising slowly for centuries. And our “friends” (or pets?) moved with us.

So who share our indoor environment with us? Are these “guests forever” welcomed or even invited? Probably not and we have to change our environment or our way of maintenance, even our way of use of the built environment to protect ourselves against these unwelcome guests.

Infectious agents can be divided according to different points of view. For the purposes of indoor environment and discussion with non-medical professionals, I prefer to combine them according to the source localisation & characteristics.

Exposure /causal agents: infectious agents (optional or obligatory) – viruses, germs, fungi/yeasts

Classification of the agents:

According to the source localisation of (potential) infection:

1. in indoor environment, removable
2. in indoor environment, “removable”
3. source is not indoors (this is not matter of this article)

According to the origin:

1. airborne
2. waterborne

According to the transmission:

1. direct (from man to man)
2. indirect (via droplets)
3. transmissive (via vector, mostly insect)

According to the outbreaks (at healthy people):

1. Severe, life threaten infections
2. Mild infections, mostly without complications
3. Dangerous only for immunocompromised people

Table 1: Leading Causes of Death due to Infectious Diseases in 2002 (WHO, 2004).

	No. of death in millions
Lower respiratory infections	3,9
HIV/AIDS	2,8
Diarrheal diseases	1,8
Tuberculosis	1,6
Malaria	1,3
Measles	0,6
Pertusis	0,29
Meningitis	0,17

INDOOR SOURCE OF PATHOGENS

An infectious agent could be a “permanent” part of the environment e.g. in the case of a contaminated ventilation/airconditioning/watersupply systems. An example could be the well-known microorganism *Legionella pneumophila*, which still can cause problems. *Legionella* is waterborne agent, living in cooling towers or humidifiers of AC or in (drinking) water supplies. Via droplets could be transmitted to people, dangerous are mostly for immunocompromised people. Anyway the infection dose has to be high.

The only chance how to avoid this risk is maintenance and disinfection of ventilation/AC and water supply systems.

Poor maintenance of ventilation/AC systems could be the cause of spreading of *Aspergillus sp.*, common mould indoors (also outdoors). For healthy people the risk of developing aspergilosis is low, the risk is getting higher for small children but especially for immunocompromised people. Nevertheless moulds are often the cause of allergic problems and aspergillus sp. and thus are a very pottent allergen.

Airborne infections, the main topics when discussing indoor environment risks of infections, are all of the same origin. **Source** of these infections is a person (ill or in incubation period), so the source is “removable”. Even when source is indoors, but room is well ventilated and not overcrowded, transmission of infection is not likely to healthy people. Without the host most of these agents do not survive long in the environment (of course with some exception, as usual).

Typically are airborne infections represented by viruses, e.g. those causing (common) cold (Adenovirus, Coronavirus, parainfluenza virus, Respiratory Syncytial Virus, Rhinovirus, Echovirus etc.). Most of them are not causing severe illnesses (in healthy people).

Another group of airborne infections are viruses of so called “children’s exanthema diseases” like Measles Virus, Mumps Virus, Rubella Virus and also Varicella-Zoster Virus (HHV3). In childhood also these diseases are less life threatening, in particular because in most countries there is a vaccination programme against these infections. The main risk occurs in adults people, who meet this infection for the first time. To avoid this risk is, except vaccination, isolation of sick people not to contaminate the environment. It means mostly at home, only exceptionally it is necessary to admit those people to hospital.

Bacterial airborne infectious of upper respiratory tract are caused also by bacteria like *Streptococcus pneumoniae*, *Staphylococcus epidermidis*, *Staphylococcus aureus*, *Haemophilus influenzae*, *Chlamydia pneumoniae*, *Mycoplasma pneumoniae* etc. Many of them caused infections in childhood, can complicate viral infections of upper respiratory tract and also are often cause of illnesses of lower respiratory tract as pneumonia etc. *Bordetella pertussis*, *Corynebacterium diphtheriae*, are examples of high risky airborne agents. There is a vaccination programme against all of them but still time to time in some part of the world an epidemic occurs. In this case the only chance is isolation, good ventilation (and of course vaccination is the best prevention). Avoidance of risk is again difficult as those bacteria are ubiquitous. So isolation of sick people and good air exchange are probably the most suitable recommendations. In the recent years in many countries especially among teenagers severe meningitis caused by *Neisseria meningitidis* has appeared (tabl.1). Occurrence was noticed mainly in barracks or students dormitories with overcrowded rooms and poor ventilation.

Airborne transmission is known to be the route of infection for diseases such as aspergillosis. It has also been implicated in nosocomial outbreaks of MRSA (Methicillin-resistant *Staphylococcus aureus*); *Acinetobacter* spp. and *Pseudomonas* spp., *Bacillus cereus* or Rotavirus caused problems in different parts of human body including digestive tract.

There are several agents more dangerous than others either due to severity of the disease they can cause, high infectiousness & quick progress or lack of knowledge of treatment.

Probably most common and best known is *Mycobacterium* (tabl.1), and never mind if *Mycobacterium tuberculosis*, *Mycobacterium avium intracellulare* or any other. *Mycobacterium* is resistant, can survive in the environment for several months. Treatment of tuberculosis takes at least a month, sometimes years.

Influenza Virus (Flu Virus) is discussed very often in last several years. Epidemiologists warn against (pandemic) flu as it used to occur every ten years. Focus of infection was traditionally in Asia. Knowing this, there is a chance to avoid spreading infection to other continents.

Notes: The first European influenza epidemic occurred between 1556 and 1560, with an estimated mortality rate of 20%. The Influenza Pandemic of 1918 (or the Spanish Flu) killed 25-50 million people (about 2% of world population of 1.7 billion). Today Influenza kills about 250,000 to 500,000 worldwide each year.

Great lessons we have learned from story of SARS. First outbreaks occurred in hospital personal and family members of patients in 2003 in China but one of the first outbreaks was in hotel in Hong Kong and one of the last was in housing estate also in Hong Kong. Transmission was mediated probably via AC/ventilation system in hotel, but in single building the transmission could be mediated via sewage system. So transmission of this coronavirus is typically orofecal as other coronaviruses and also via direct contact and probably droplets.

Very special role can be played by *Bacillus anthracis* and *Smallpox Virus* (Variola). Variola is nowadays eradicated and anthrax is not common in developed countries but both could be abused for bioterrorist purposes. These pathogens can only be dealt with in isolated high security laboratories.

Special cases are transmissible infections. Source of infection is sick person but these infections cannot be transmitted from person to person. The main condition is a specific vector, which is necessary to transmit the infection agent. These vectors are mostly sucking insects. The best chance to avoid these diseases is source & vector control indoors.

Typical vectors are **fleas** (e.g. *Yersinia pestis*, cause of plague), **mosquitos** (e.g. *Plasmodium malarie*, cause malaria), sucking **louse** (e.g. *Rickettsia prowazeki*, rickettsia, typhi etc. cause typhus or Rocky Mountains Fever), **fly** (especially tse-tse in some part of the world), **heteropters** and some other vectors, which can transmit tropical diseases caused by *Leishmanias*, *Trypanosoma* etc.

CONCLUSIONS

The main problem of transmission infections agents in indoor environment is poor design and/or maintenance of ventilation/AC/water/sewage systems, also inadequate air exchange and overcrowded spaces.

REFERENCES

www.who.int; www.cdc.gov