European Module EMUTOM for Undergraduate Teaching of Occupational Medicine

Chapter 2.3 : Biological agents

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Objectives

Knowledge:

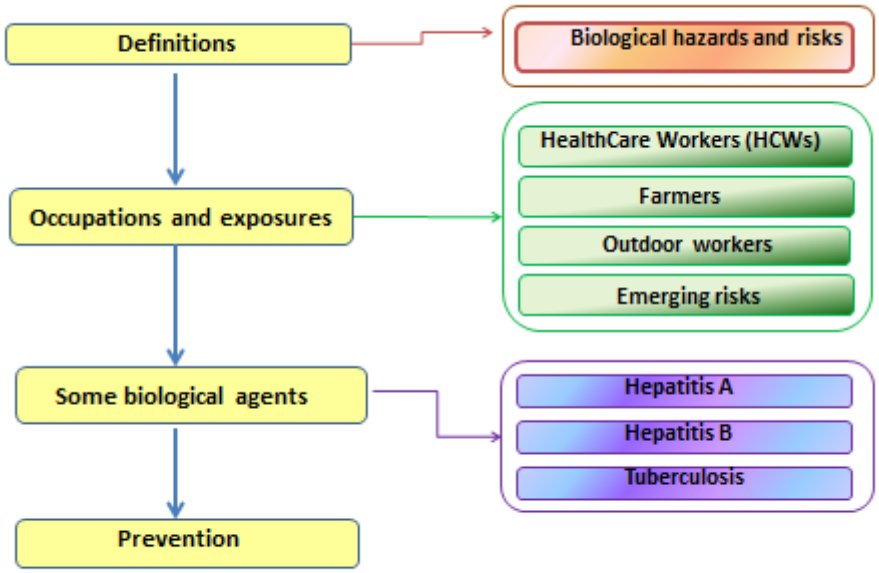
- The student gives the definition of a biological agent
- The student explains the transmission ways of biological agents
- The student defines the notion of susceptibility to biological agents
- The student defines the main biological risks in the workplace
- The student lists the different way of prevention of biological risks

Skills:

- The student evaluates the need for a vaccination according to the biological risks faced at work
- The student appraises appropriate personal protective equipment for biological hazards in the healthcare setting

Concept Map

Framework



Glossary

HBV : Hepatitis B virus
HCV: Hepatitis C virus
HCWs : Health care workers
HIV: Human immunodeficiency virus
HSV: Herpes simplex virus
MRSA: Methicilin resistant *Staphylococcus aureus*

1. Definitions and general principles

1.1. Biological hazards and risks

Sources of biological hazards include bacteria, viruses, insects, plants, birds, animals, and humans. These hazards can cause a variety of health effects ranging from skin irritation and allergies to infections (e.g., tuberculosis, AIDS), cancer (liver cancer and HBV or HCV infection) and so on.
We will focus mainly on infection in this chapter.

Several classes of pathogens can cause infection, including bacteria, viruses, fungi, parasites, and prions. The modes of transmission vary by type of organism and some infectious agents may be transmitted by more than one route: some are transmitted primarily by direct or indirect contact, (e.g., HSV, respiratory syncytial virus, *Staphylococcus aureus*), others by the droplet, (e.g., influenza virus, *Bordetella pertussis*) or airborne routes (e.g., *Mycobacterium tuberculosis*). Other infectious agents, such as bloodborne viruses (e.g., HBV, HCV and HIV) are transmitted via percutaneous or

mucous membrane exposure. Importantly, not all infectious agents are transmitted from person to person.

Infection is the result of a complex interrelationship between a potential host and an infectious agent. Most of the factors that influence infection and the occurrence and severity of disease are related to the host. However, characteristics of the host-agent interaction as it relates to pathogenicity, virulence and antigenicity are also important, as are the infectious dose, mechanisms of disease production and route of exposure. There is a spectrum of possible outcomes following exposure to an infectious agent. Some persons exposed to pathogenic microorganisms never develop symptomatic disease while others become severely ill and even die. Some individuals are prone to becoming transiently or permanently colonized but remain asymptomatic (MRSA). Still others progress from colonization to symptomatic disease either immediately following exposure, or after a period of asymptomatic colonization (e.g. tuberculosis).

2. Occupations and exposures

Many occupations may expose the workers to biological agents. You can find a complete picture on the website of Haz-map: http://www.haz-map.com/infect.htm

We will focus in this chapter on some specific occupations.

2.1. HealthCare Workers (HCWs)

Infectious agents transmitted during healthcare derive primarily from human sources but inanimate environmental sources also are implicated in transmission. Human reservoirs include patients, healthcare personnel, and household members and other visitors. Such source individuals may have active infections, may be in the asymptomatic and/or incubation period of an infectious disease, or may be transiently or chronically colonized with pathogenic microorganisms, particularly in the respiratory and gastrointestinal tracts.
Single cases of infection of HCWs have been described for many infectious agents. Outbreaks of pertussis, measles, influenza, hepatitis A or scabies are regularly reported among HCWs. Nevertheless, in developed countries, only tuberculosis and hepatitis B have been reported to be significantly more frequent among HCWs than in the general population.
A comprehensive guide of prevention and control of Occupational Infections in Health Care was published in 2002 by Health Canada. It is accessible at
http://dsp-psd.pwgsc.gc.ca/Collection/H12-21-3-28-1E.pdf
(orhttp://dsp-psd.tpsgc.gc.ca/Collection/H12-21-3-28-1F.pdf in French)

2.2. Farmers

Farmers are exposed to infectious agents (brucella), but also to organic dust, spores and endotoxins (toxins built of polysaccharide and phospholipid substances that are integral parts of the outer cell wall of bacteria).

One of the most frequent (2-10% of farmers) consequence of such exposure is the farmer's Lung, also known as "extrinsic allergic alveolitis", "hypersensitivity alveolitis" or more generally "hypersensitivity pneumonitis". It is an allergic disease usually caused by breathing in the dust from moldy

hay. However, dust from any moldy crop--straw, corn, silage, grain, or even tobacco--can also cause Farmer's Lung.

2.3. Outdoor workers

People working outdoor can be exposed to different diseases.

Leptospirosis

Leptospirosis is a disease caused by bacteria. These bacteria are carried in the urine of infected animals. If an infected animal urinates in a body of fresh water (e.g., lake, river, stream) or soil, the disease can live there for weeks to months. Leptospirosis exists all over the world, but it is more likely to be found in tropical climates. The bacteria can enter the body through the eyes, nose, mouth or broken skin. Performing outdoor activities, for leisure or work, increases the risk of infection. About one third of all cases are occupational. A vaccine is available in some countries. It protects against *Leptospiraicterohaemorrhagiae*, and a booster dose is needed every 2 years.

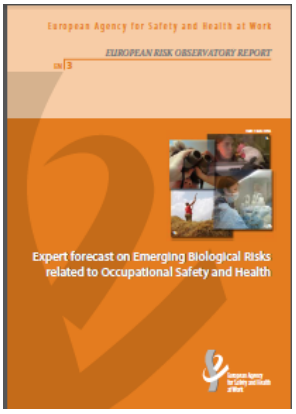
Lyme disease.

Lyme disease is a commonly reported tick-borne disease. Lyme disease is passed to humans by the bite of ticks infected with the bacterium *Borreliaburgdorferi*. The Lyme disease bacterium normally lives in mice, squirrels, and other small mammals. Workers at risk of Lyme disease include, but are not limited to, those working in construction, forestry, farming ... To avoid tick bites, workers should wear light-colored long-sleeved shirts, long pants, socks, and hat when possible and should use repellents. They should check their skin and clothes for ticks every day.

To learn more about Lyme disease, you can look at the session organize in May 2011 by the CDC. The session gave a rare glimpse into the front lines of those battling and treating Lyme disease while addressing the data gaps, unmet needs, and overall challenges and opportunities for its prevention and control. (Click on the image) This long (58 mn) provides a wide overview on diagnosis, treatment and prevention of Lyme disease and is not mandatory for this module.

2.3. Emerging risks

In 2007, the European Agency for Safety and Health at Work has performed a study, based on expert advice and literature review, on emerging biological risks, defined as any biological occupational risk that is both new and increasing.



The top emerging biological risks identified were, by decreasing order:

- Occupational risks related to global epidemics (e.g. H1N1 in 2009).
- Risks resulting from poor risk assessment, since the state of knowledge on biohazards is still relatively immature and, in practice, proper assessment of biological risks is difficult.
- The lack of information on biological risks in the workplace, especially in the office workplace and the agriculture sector.
- The poor maintenance of water and air systems, which puts workers, and the general population, at risk of legionella.

- Endotoxins, which can be found in high concentrations in all occupational settings where organic dust is present.
- Indoor moulds, as airborne moulds are ubiquitous in the indoor environment, workers in any indoorworkplace, such as offices, schools, hospitals, homes and commercial buildings, may be exposed.
- The occupational risks linked to waste treatment.

You must download a synthesis of this document at :
http://osha.europa.eu/en/publications/factsheets/68
and read it !
If you are interested, the full document can be downloaded at :
http://osha.europa.eu/en/publications/reports/7606488/view

3. Some biological agents

In this chapter, we will emphasize the occupational aspects of the diseases, and not the diagnosis or treatment, which is not the scope of this module.

3.1. Hepatitis A

Hepatitis A virus (HAV) is a small, non-enveloped RNA virus belonging to the Picornaviridae, for which only one serotype has been identified.
The hepatitis A virus is found in the feces of infected persons. The virus is usually spread from person to person by putting something in the mouth that has been contaminated with the feces of a person with hepatitis A. The most classical way of contamination is drinking contaminated water or eating raw and undercooked shellfish harvested from contaminated water. Although this is not per se an occupational risk, it can become so for those who travel for their work, mostly in low-income countries.
There is little evidence of risk for hepatitis A infection in the workplace. Health care workers are not considered to be at increased risk when they follow standard infection control procedures. Workers in the food-handling sector may be at risk if exposed to contaminated food or water. Several studies, even in developed countries, have demonstrated that sewage workers may be at increased risk. Apart from standard infection control procedures (washing hands for health care workers, wearing gloves for sewage workers), a vaccine is available. It needs two injections but provides long-term immunity.Combined inactivated vaccineeffectiveness is 86%.

3.2. Hepatitis B

Hepatitis B virus (HBV) is the prototype member of the Hepadnaviridae (hepatotropicDNA virus) family.
Blood is the major source of the hepatitis B virus in the workplace. It can also be found in other tissues and body fluids, but in much lower concentrations. The risk of transmission varies according to the specific source. The virus can survive outside the body for at least 7 days and still able to cause infection.
The risk of acquiring HBV from the workplace depends on the amount of exposure to human blood or body fluids and tissues contaminated by blood. Such contact can occur during skin contact (rescuers), wounds (human bites for police officers), needlestick injuries or other puncture injuries from sharp instruments contaminated with blood (HCWs) or close contact with people who carry the hepatitis B

virus in family or institutional residence settings. In case of needlestick injuries with a patient who carries HBV in his blood, the risk of contamination for the HCW is between 5 and 45%, depending on the viral load in the blood of the index patient.

Hepatitis B vaccines provide safe, reliable protection from hepatitis B. Vaccination requires 3 injections and has an efficacy of 95-97%. Nevertheless, an age higher than 40, being overweight, active smoker or a man are independent factors of low or non response to the vaccine. In people exposed in occupational settings, the level of Hbs antibodies should be measured 4-6 weeks after the 3rd dose of vaccine. People achieving a level of Hbs antibodies > 10 UI/L are considered protected for life. For the others, new injections (up to 6 or 9 depending of the country) are needed.

Click on the image to see a interview of Baruch Blumberg, MD, 1976 Nobel Laureate in Physiology or Medicine, who talks with History of Vaccines about getting started in the field of research that led to the discovery of the Australia antigen -- the basis for vaccine against hepatitis B. (6mn video) You must look at this video.

3.3. Tuberculosis

Tuberculosis is caused by a bacterium called Mycobacterium tuberculosis. The bacteria usually attack the lungs, but TB bacteria can attack any part of the body such as the kidney, spine, and brain. About one third of the world's population has latent tuberculosis, caused by *Mycobacterium tuberculosis* infection. (*for a summary on tuberculosis, click on the image, 3mn video*) *This video is mandatory.*

Tuberculosis is transmitted through the air from exposure to germs in the saliva of infected persons and sputum coughed up from their lungs. When an infected person breezes, coughs or sneezes, tiny droplets which contain the germs are released and can be inhaled by employees or anyone in the area. It must be emphasize that the droplets are very small, don't settle easily and can remain in the air for hours. They can be transported by airflow to several meters from the index case.

In the workplace employees of institutions or hospitals can contract tuberculosis from persons who have not yet been diagnosed. Safe work procedure should include screening programs that will identify persons who have been exposed to the germs causing tuberculosis.

Tuberculosis is an occupational risk for HCWs, but also for those who work with migrants from endemic countries or with homeless people.

When an infectious person is identified all isolation precautions should be implemented. An infectious person should be placed in a private room. Employees entering the room should wear a protective respiratory device (the surgical mask is not protective enough).

The mask will protect the wearer only if it fits closely to the face. A fit test must therefore be performed. This video, which you must see, gives an example on how must this test be performed (click on the image, 4mn video).

The isolation room must be at negative air pressure and it must have adequate ventilation to dilute the concentration of contaminants within the room. The air from the isolation room must be directly exhausted outside.
A vaccine (BCG) is required in some countries for HCWs. However, its efficacy in preventing latent infection does not exceed 50%.

4. Prevention

The prevention of biological risk in the workplace is based on good hygiene and sanitation.

Infection control precautions are the first line of defense to protect workers from hepatitis B and other diseases. For this reason, most countries have developed a uniform approach called "standard precautions". Originally developed for hospitals, standard precautions have been adapted to a wide range of workplaces. They apply to all situations where workers have risk of exposure to blood or certain body fluids and aim at preventing exposure to blood-borne diseases transmitted by needlestick accidents or fluid contact with an open wound, non-intact skin, or mucous membranes.

Education programs for workers about personal hygiene practices should emphasize that careful hand washing is extremely important in the prevention of diseases. Workers should be informed about using appropriate protective clothing and about removing it at the end of the shift. They should also be informed about the necessity of washing hands frequently, and before eating, drinking, or smoking; they should also avoid nail biting.
Many vaccines are available. Some of them are mandatory in many countries, for specific occupational groups (HBV vaccine for HCWs). Some are sometimes mandatory (BCG for HCWs) and some are just recommended (tetanus for construction workers).

Further reading

Siegel JD, Rhinehart E, Jackson M, Chiarello L, and the Healthcare Infection Control Practices Advisory Committee, 2007 Guideline for Isolation Precautions: Preventing Transmission of Ifnectious Agents in Healthcare Settings, June 2007 http://www.cdc.gov/ncidod/dhqp/pdf/isolation2007.pdf

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