

## Workplace related infections: Transmission and Prevention

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**Abstract:** Workplace or occupational infections are the human infections caused by professional association to pathogens, such as bacteria, virus, fungi, and parasites (protozoa). Veterinarian and animal handlers at risk of Zoonosis infections. Health care workers, laboratory workers are at increased risk of contracting hospital acquired or nosocomial infections, tuberculosis, hepatitis B, HIV/AIDS, and MRSA infections. MRSA is associated with high morbidity and mortality. Infected persons had an average three times longer hospital stay, three times greater charges and five times greater risk of hospital deaths. Many infections may be transmitted through close contact with infected person. Prevention of infections in the workplace includes transmission of pathogens, from person to person, personal hygiene, dealing with infectious materials, handling needles and sharps, and occupation exposure. Leptospirosis prevention involves rodents' control. Gold standard of prevention is the early detection and treatment. Employers are obliged to provide a safe workplace to their employees.

**Keywords:** Workplace infections, Tuberculosis, Hepatitis B, MRSA, Transmission

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### I. Introduction

Workplace or occupational infections are caused by the pathogens (bugs) such as bacteria, viruses, protozoa or fungi getting into or onto the body [1]. Occupation at times poses certain exposure risks, such as *Salmonella* species, *Vivrio* species and *Escherichia coli* in poultry, seafood, and beef processing industries. Veterinarian and other working with animals are at increased risk of various zoonosis. Health care workers are exposed to hospital or nosocomial infections. Recreational activities can expose to unexpected pathogens as seen in leptospirosis, brucellosis, and tularemia [2]. Health care and clinical laboratory workers are increased risk of infection by organisms whose natural host are humans, as the case of hepatitis, rubella, AIDS, tuberculosis, and *Staphylococcus* (methicillin resistant *staphylococcus aureus*-MRSA) disease. Some infections may be transmitted through close personal contact with infected patient. Exposure and infection caused by almost any of the viruses, bacteria, fungi, and parasites pathogenic for humans can result from direct contact with the organism in culture or in human tissue [3]. Tuberculosis is an example of a relatively common occupational infection resulting from repeated close contact with infected patient, and type B hepatitis exemplifies a serious and relatively frequent infection resulting from contact with infected human blood and inoculation by infectious virus particles [3]. It can take some time before the microbes (bugs) multiply enough to trigger symptoms of illness, which means an infected person unwittingly be spreading the disease during this incubation period. Workplace related bacterial, fungal, protozoal, and viral infections include: Anthrax, Brucellosis, Erysipeloid, Leptospirosis, Plague, Tetanus, Tuberculosis, Tularemia, Candidiasis, Dermatophytosis, Histoplasmosis, Helminthes, (echinococcosis), Hookworm, Encephalitis, Hepatitis B, AIDS, and Smallpox [3]. Prevention of infections include: transmission of pathogens (bugs) from person to person, personal hygiene, and workplace cleanliness, food hygiene, dealing with spills, infectious waste, handling needles and sharps and prevention of occupation exposure. Employers are obliged under the occupational Health and Safety Act, to provide a safe workplace for their employees [1]. The paper reviews the current literature on workplace infections, transmission, prevention and the effect of workplace infections on the individual health.

### II. Tuberculosis

*Mycobacterium tuberculosis* (MTB) was discovered in 1882 by Robert Koch, preceded by the discovery of leprosy bacilli by GA Hansen in 1878. There is evidence of spinal tuberculosis in Neolithic, pre-Colombian and early Egyptian remains. In the 17<sup>th</sup> and 18<sup>th</sup> centuries, tuberculosis caused one fourth of all deaths in Europe [4]. Humans are the only reservoir for the species *M. tuberculosis*, although many animals are susceptible to infection [5]. M.TB usually infects the lungs, with resulting pneumonia or granuloma formation, and may have other systemic effects. Medical house staffs have two to three times the tuberculosis infection rate of nonmedical personnel, and laboratory worker exposed to M.TB have three times the incidence of non-exposed workers. Staffs of necropsy rooms are estimated to be between 100 and 200 times more likely than general

public, to develop tuberculosis[3]. Other high prevalence work environments include most health care settings (especially hospitals, long-term care facilities, and dialysis centers) refugee-immigration centers, homeless shelters, substance abuse centers, and correctional institutions. After a downward trend from 1960 to 1985, the number of tuberculosis (TB) cases in the United States increased slightly beginning in 1986 and peaking in 1992. In 2000, there were 16,377 cases reported, a 39% decrease from 1992 peak. TB kills more people on the global scale than does any other infectious disease. In the year 2000, it is estimated that nearly one third of global population was infected with TB[3].

### Transmission

Spread of *M.tuberculosis* is almost exclusively by small particle aerosol termed droplet nuclei, or by close contact with the infected person. Airborne particles are generated by coughing, sneezing, and even speaking or singing, small droplets that may remain suspended in the air for several hours and then inhaled by susceptible persons [6,3]. Inhaled droplet nuclei, each containing two to three bacilli, are of sufficiently small size (1-5  $\mu\text{m}$ ) to be deposited into the alveolar space[6]. Transmission depends on the numbers of bacilli expelled, their concentration in the air over time, the duration of an exposure to contaminated air, and host immunity[6].

### Primary infection

Primary infection results from exposure to airborne organisms produced by someone with active tuberculosis. Organisms reach the alveoli (most often in the middle or lower lung zones) multiply intracellularly in alveolar macrophages, and silently spread through lymphatics to hilar or other regional lymph nodes then through bloodstream to many sites[8]. *M.tuberculosis* continues to grow at some of these sites for 2 to 12 weeks until, in an immunocompetent host, cell mediated immunity develops[6]. At this time granulomas are formed and growth of organisms is inhibited, but they are not killed. Consequently, organisms that have been dormant become reactivated. In approximately 5% of normal hosts the original infection cannot be contained, and clinical disease develops rapidly or within the first 2 years[6].

### Dormancy of tubercle bacilli

There is firm experimental foundation showing that tubercle bacilli may persist for long periods in vivo (in host) in a viable state but non-multiplying state. This state has been demonstrated in infected mice, either as a consequence of drug treatment or because of forces of cellular immunity[9,10]. Hart and Rees, in some ingenious experiment, have shown that the tubercle bacilli, which in vivo are non-multiplying, are still fully viable[11].

### Signs and symptoms

The individuals are moderately ill with anorexia, fatigue, productive cough, night sweats, fever, weight loss, and weakness. Sputum may be blood streaked. In some, the illness may be very severe, whereas in others with extensive parenchymal involvement, symptoms are minimal or non-existent. Physical findings are non-specific and abnormalities in the chest radiograph may be minimal despite extensive disease. Large cavities may produce amphoric breath sounds [6].

### Diagnosis and treatment

Gold standard of diagnosis is the presence of acid fast bacilli (AFB) on smear from sputum and other clinical specimens, and the isolation of *M.tuberculosis* on culture. Purified protein derivative (PPD) intradermal skin test, induration at 48 to 72 hours, with a reading of ten millimeter or more is considered positive. Directly observed therapy (DOT) for all patients. Chemotherapy with multidrug including isoniazid (INH), rifampin (RMP), pyrazinamide (PZA), and either ethambutol, for 6 to 9 months[12].

### Prevention

Centers for Disease Control and Prevention (CDC) recommends early diagnosis, effective treatment of infected patients, and preventing the transmission of *M.tuberculosis* to other persons in the community[13]. Occupational candidates for periodic PPD testing include those having contact with suspected or known infected patients. Before starting a prophylaxis, a chest radiograph should be taken on all skin test reactors. Any abnormalities found be thoroughly evaluated for evidence of clinically active disease [3].

## III. Hepatitis B

Hepatitis B virus (HBV) infects more than 500 million people worldwide. It is the leading cause of chronic hepatitis, cirrhosis, and hepatocellular carcinoma (HCC), and these sequelae of chronic infection account for one million deaths annually[14]. The first hint of viral etiology came from the studies of Blumberg, who reported the discovery of a human antigen in Australian Aborigines termed Australian (Au) antigen[15].

### **Transmission**

Hepatitis is a viral liver disease with three main forms, A, B and C. Those at risk include healthcare workers, sewage workers, police and emergency services, morticians and embalmers and others who come in contact with body fluids [16]. Hepatitis B virus (HBV) is easily contracted from close contact with infected individuals or ingesting contaminated food or feces. Hepatitis B is more infectious than HIV, and carried in blood, saliva, semen, urine and vaginal secretions. One third of those infected are without symptoms, and there are 50,000 symptomless carriers in UK [16]. Any parenteral or mucosal exposure to infected blood thus represents a potential risk for acquisition of hepatitis B, and accounts for the 100 times more efficient transmission of HBV compared to HIV needle stick exposure [17].

### **Signs and symptoms**

One third of the individuals suffer a mild flu-like illness and one third suffer severe illness for up to six months with nausea vomiting, fever, pain, fatigue and jaundice. Cirrhosis or cancer of the liver can develop [16]. The incubation period is from 50 to 180 days (average: 60 to 90 days). The disease has insidious onset with a gradual and prolonged rise in serum alanine aminotransferase (ALT, formerly SGPT), and are usually higher than serum aspartate transaminase (AST, formerly SGOT) [3].

### **Prevention and Treatment**

Prevention can be achieved by vaccination, good personal hygiene and avoiding contact with bodily fluids. Treatment of acute hepatitis B is generally supportive. Treatment with antiviral drugs is not indicated for acute hepatitis B [18]. In chronic hepatitis B the goals of antiviral therapy are reduction of the morbidity and mortality due to liver disease [19].

## **IV. HIV-AIDS**

Acquired immune deficiency syndrome (AIDS) is caused by the human immunodeficiency virus (HIV). The virus may be carried for many years before symptoms appear. A breakdown of the body's defenses can lead to serious infections and some cancers. Treatment with drugs can arrest the onset of symptoms. The virus is transmitted by infected blood, semen and vaginal fluid. Occupational groups at risk are healthcare and personal care workers through needle stick injuries or contact with infected blood through skin cuts and abrasions [16]. The concentration of virus is higher in blood, serum, cerebrospinal fluid, and semen, and much lower in AIDS patients saliva, tears, urine, breastmilk, amniotic fluid, and vaginal secretions [3]. The transmission is most likely to occur as the result of sexual contact with an infected partner, by parenteral exposure to infected blood or blood products, and by perinatal exposure of offspring of infected mothers [3].

*Casual contact, fomites (coffee cups, drinking fountains, telephone receivers, insects, etc have not been shown to be mechanisms or circumstances of transmission) [3].*

### **High risk groups**

Occupational groups that are at potential risk of contact with HIV-infected body fluids include blood bank technologists, dialysis technicians, emergency room personnel, morticians, dentists, medical technicians, surgeons, laboratory workers, and prostitutes [3].

### **Prevention and Treatment**

Prevention of exposure is achieved by good standards of cleanliness and hygiene [16]. Post-exposure prophylaxis with antibiotics is recommended based on exposure type and source material [3]. Centers for Disease Control and prevention (CDC) recommendations concerning general workplace exposure including those of health care workers, precautions during invasive procedures and precautions for laboratory workers are updated periodically in Morbidity and Mortality Weekly Reports. [20]. Highly active antiretroviral therapy (HAART) has exerted a profound effect on the epidemiology, natural history, clinical manifestations, and responses to treatment of HIV/AIDS and opportunistic infections. HAART is defined as at least three medications with activity against HIV, including either a protease inhibitor or a non-nucleoside reverse transcriptase inhibitor [21].

## **V. Zoonosis**

Zoonosis is defined as diseases transmitted from animals to humans. The common zoonosis in the United States include Rock mountain spotted fever, Lyme disease, brucellosis, leptospirosis, plague, psittacosis and rabies [3].

### **Leptospirosis**

Leptospirosis or Weil's disease was first discovered in Heidelberg in 1886, caused by *Leptospira*. A syndrome of severe multisystem disease, presenting with profound jaundice and renal function impairment. [22].

### Transmission

Infection occurs through direct or indirect contact with rat urine or tissues of infected animals. Direct contact is important in transmission to veterinarians, individuals working in milking sheds or dairy farms, abattoirs, butchers, hunters, children handling puppies, and dog handlers. Recreational exposures have become relatively more important often in association with adventure tourism to tropical endemic areas. Several large point-source waterborne outbreaks have occurred after athletic events [23,24].

### Human disease

Clinical manifestations of leptospirosis is associated with a very broad spectrum of severity ranging from subclinical illness followed by seroconversion to two clinically recognized syndromes, self-limiting in 90 % of infections, and a severe potentially fatal illness accompanied by any combination of renal failure, liver failure and pneumonitis and hemorrhagic diathesis [25]. Mortality rates in patients developing disease have ranged 5% to 40 % [25].

### Treatment and prevention

For mild leptospirosis doxycycline, ampicillin or amoxicillin. Treatment of moderate to severe leptospirosis, Penicillin G, ceftriaxone and amoxicillin. Jarish-Herxheimer reaction have been reported in patients treated with penicillin [26,27]. Prevention involves, vaccination in cattle, swine, and in dogs is important to eliminate domestic reservoirs. Risky activities should be avoided, particularly swimming in or drinking from potentially contaminated water. *Rodents control is important. Weekly doxycycline has been used for those who cannot avoid prolonged exposure* [28].

## VI. Legionnaires Disease

Legionnaires disease or legionellosis is caused by a bacterium *Legionella pneumophila*. A bacterial respiratory disease, mainly the pneumonias, which can be fatal. It is contracted by inhaling droplets of water contaminated with legionella bacteria emanating from cooling towers air conditioning, humidifiers, showers and other water system [16]. Legionnaires disease was first recognized when it caused an epidemic of pneumonia at a Pennsylvania State American Legion convention in Philadelphia in 1976; 221 people were affected and 34 died [28].

Legionellosis usually presents as a patch, interstitial pneumonia that progresses to an alveolar infiltrate. Any appearance is possible, cavitation has been described [29].

### Prevention and Treatment

Prevention is design location, maintenance and cleaning of water towers and other system. Bacteria can be killed by biocides or raising the temperature to over 60°C [16]. A second generation quinolone should be started empirically because of the difficulty in confirming the diagnosis and given for 21 days. Late relapse can occur. Rifampin 600 mg orally twice daily may be added in severe or refractory cases [30]. Prevention is design location, maintenance and cleaning of water towers and other system. Bacteria can be killed by biocides or raising the temperature to over 60°C [16].

## VII. Methicillin resistant *Staphylococcus aureus* (MRSA)

Methicillin resistant *Staphylococcus aureus* (MRSA) refers to types of bacteria that are resistant to antibiotic methicillin. MRSA is often resistant to other antibiotics, as well. While 33% of the population is colonized with *S. aureus*, (bacteria are present without causing infection), approximately 1 % colonized MRSA. *S. aureus* is present on the skin or in the nose of healthy people. *S. aureus* can cause an infection [31]. Semisynthetic methicillin became available in the late 1950s. First MRSA was described at the same time [32]. In the United States the prevalence rate to MRSA increased from 2.1% in 1975 to 35 % in 1991 [33]. MRSA prevalence ranged 23.6% in Australia to more than 70% in Japan and Hong Kong, in China 89.2 %. In European centers, these percentages varied from less than 2 % in Netherland to 54.4% in Portugal [34,35].

### Community acquired MRSA (CA-MRSA)

CA-MRSA is different from health care-acquired MRSA (HCA-MRSA), from both epidemiological and molecular points of views. Case definition studies showed HCA-MRSA and CA-MRSA represent different organisms that produced different clinical syndromes [36]. Researchers in Sabah, Malaysia in a series of 947 primary school children, the nasal carriage of MRSA was higher for children living in rural area (4.1 %) than in urban area (2.3 %), children aged 7-9 years (4.3 %) than aged 10-12 years (2.7 %) [37]. CA-MRSA has now become the most frequent cause of skin soft tissue infections acquired in the community (in the

workplaces). These include those in the hospitals and healthcare facilities, correctional facilities, day care facilities, livestock settings and veterinary clinics [31]. CA-MRSA also can cause severe sometimes fatal invasive disease, necrotizing pneumonia, bacteremia, or necrotizing fasciitis [38]. Moreover CA-MRSA has started to spread from the community into hospital, where outbreaks of healthcare-associated hospital onset infections with typical CA-MRSA have occurred [39].

### Transmission

CA-MRSA-MRSA is transmitted most frequently by direct skin-to-skin contact or contact with shared items or surfaces (e.g., towels, used bandages) that has come in contact with someone else's infected site. Animals with MRSA can also transfer the infection to people [31]. Workplace settings have factors that make it easier for MRSA to be transmitted that include (a) Crowding (b), frequent skin-to-skin contact (c) Compromised skin (i.e., cuts or abrasions) (d) Contaminated items and (e) lack of cleanliness [31].

### Signs and symptoms

*S. aureus* (Staph. bacteria), including MRSA, can cause skin infections that may look like a pimple or boil and be red, swollen, painful, or have pus or other drainage. Most serious infections may cause pneumonia, bloodstream infections, or skin and soft tissue wound infections [31]. In the U.S. hospitals HCA-MRSA is associated with substantial morbidity and mortality. Infected patients had an average, three times longer hospital stay, three times greater charges, and five times greater risk of hospital death (11.2% versus 2.3%). The annual impact in the United States at least 12,000 deaths and \$9.5 billion excess cost [40].

### Prevention

Spreading Staph. or MRSA skin infections to others by simple precautions: (a) cover your wound (b) clean your hands, hand washing is the gold standard of infection prevention (c) not to share personal items with other person(s) (d) seek professional help [31]. ***Decolonizations of MRSA nasal carriage is one important part of MRSA dissemination*** [36].

## VIII. Transmission of Infection In The Workplace

Infectious agents (bacteria) can spread in various ways that include: [1].

1. Airborne-coughs or sneezes release airborne pathogens, which are then inhaled by others.
2. Contaminated objects or food-the pathogens in a person's feces may be spread to food or other objects, if their hands are dirty.
3. Skin-to-skin contact-the transfer of some pathogens can occur through touch or by sharing personal items, clothing or objects.
4. Contact with body fluids-pathogens in saliva, urine, feces or blood can be passed to another person's body via cuts or the mucus membranes of mouth and eyes.

## XI. Conclusion

During the course of daily work individuals are exposed to disease causing bacteria (pathogens). Health care and laboratory workers are at high risk of acquiring workplace or occupational infections. Frequent occupational infections include: Tuberculosis, Hepatitis B, HIV/AIDS, and hospital acquired (nosocomial) infections. Prevention includes transmission of infection, personal hygiene, and workplace cleanliness, dealing with spills, and prevention of exposure to infection.

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