Occupational Respiratory Infections

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KEYWORDS

• Tuberculosis • Psittacosis • Influenza • Coccidioidomycosis • Valley fever • Pneumonia
• Occupational • Respiratory infection

KEY POINTS

- Workers in specific settings are at increased risk for occupational respiratory infections, including tuberculosis, influenza, coccidioidomycosis, psittacosis, and other bacterial pneumonia.
- Clinicians should recognize that respiratory infections can be occupationally acquired.
- Considering occupational risk factors for infection, such as workplace factors and worker factors can help in implementing prevention and control strategies.
- Controlling exposures among workers according to the hierarchy of controls will help prevent disease transmission in the workplace.

INTRODUCTION

Occupational lung diseases caused by exposures to gases, chemicals, and dusts at work have been long recognized. However, recent experiences with occupationally acquired respiratory infections, including Middle East respiratory syndrome coronavirus, influenza, measles, and coronavirus disease 2019 (COVID-19) have highlighted the importance of understanding transmission of respiratory infections in the workplace.[1–3] Workplace exposures have been demonstrated to contribute substantially to the burden of community-acquired pneumonia, with an occupational population attributable fraction as high as 10% in 1 recent review.[4] Any infectious agent that is transmitted by airborne particles or by droplets can be acquired in the workplace.[5] Occupational respiratory infections can be caused by bacterial, viral, and fungal pathogens. Transmission in occupational settings can occur from other humans (such as co-workers or patients), animals, or the environment and occur in various occupations and industries. Factors that can facilitate transmission of infectious pathogens in the workplace include disease factors (such as mode of transmission), workplace factors (such as workplace conditions or work practices), and worker factors (such as impaired immunity).[6]

Occupational health and safety specialists have long used the hierarchy of controls (**Fig. 1**) as an approach to determine how to implement feasible and effective control solutions, and this can be applied to infectious agents.[6,7] Elimination (removing the hazard) and substitution (replacing the hazard) are the most effective ways to reduce occupational hazards but can be difficult to implement for infectious agents. Engineering controls are physical changes to work processes to remove the hazard or place a barrier between workers and hazards. They can effectively protect workers without placing the primary responsibility of

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Clin Chest Med 41 (2020) 739–751
https://doi.org/10.1016/j.ccm.2020.08.003
0272-5231/20/Published by Elsevier Inc.

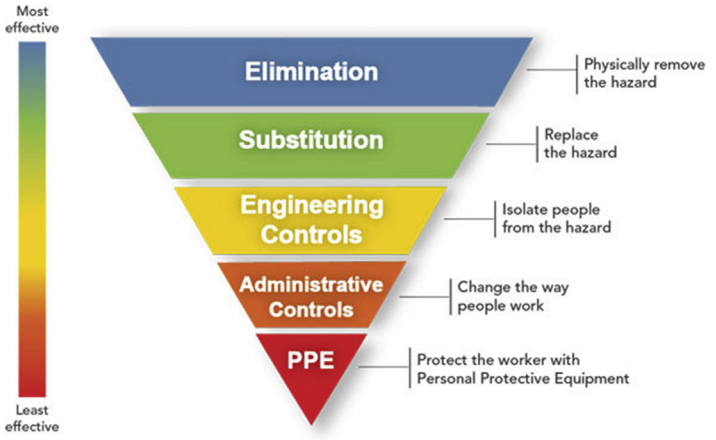

Fig. 1. Hierarchy of controls. (*From* The National Institute for Occupational Safety and Health (NIOSH). Hierarchy of Controls. Center for Disease Control. Available at: https://www.cdc.gov/niosh/topics/hierarchy/default.html With permission).

implementation on the worker. Ventilation is the most common engineering control, especially for airborne pathogens. Administrative controls are methods that change the way the work is performed, such as triaging and isolating ill patients or influenza vaccination of workers. Their effectiveness depends on the availability of the control and worker acceptance and commitment. Finally, use of personal protective equipment (PPE) provides a physical barrier between the worker and the hazard. PPE is considered the least effective control measure because it requires a comprehensive program and a high level of worker involvement and commitment for proper use.[7]

The National Institute for Occupational Safety and Health (NIOSH) Health Hazard Evaluation (HHE) program responds to requests from workers, employers, and public health agencies and conducts investigations of hazards, including infectious diseases, that occur in workplaces.[8] In this article, we describe 4 occupationally acquired respiratory infections at the focus of NIOSH investigations over the last decade: tuberculosis (TB), influenza, coccidioidomycosis, and psittacosis.[9–14] We describe their epidemiology, clinical manifestations, occupational risk factors, and prevention measures according to the hierarchy of controls. These examples demonstrate the breadth of infectious pathogens (bacterial, viral, and fungal) and transmission (from human, animals, and the environment) in the workplace.

TUBERCULOSIS

Tuberculosis (TB) is caused by *Mycobacterium tuberculosis*, an acid-fast bacillus that is most often transmitted from person to person through the air in contaminated respiratory droplets. These droplets can dry into tiny particles called droplet nuclei that remain suspended in air for long periods of time. Pulmonary TB often presents with a prolonged cough of 2 or more weeks' duration. While pulmonary TB is the most common form of disease, TB can affect other organs, such as the larynx, abdomen, meninges, and spine. Patients with TB involving any organ system often have nonspecific symptoms, such as fatigue, weight loss, loss of appetite, chills, and night sweats. Whereas some people become ill with TB soon after inhaling droplets contaminated with *M tuberculosis*, most do not. Approximately 20% to 30% of contacts develop latent TB infection (LTBI) with *M tuberculosis*.[15,16] Persons with LTBI are not infectious, and most persons with LTBI will have positive tests for TB infection (ie, the tuberculin skin test [TST] or an interferon-gamma release assay [IGRA]). Treating LTBI is an effective way of preventing symptomatic, potentially contagious TB.[17,18] Overall, among untreated persons with LTBI approximately 5% to 10% will develop symptomatic TB during their lifetimes; approximately half of those who develop TB will do so within 2 years of initially becoming infected with *M tuberculosis*.[15,16] The risk for progression from LTBI to TB is markedly higher among those living with HIV, young children less than 5 years, and persons with certain immune-suppressing medical conditions or those taking certain immune-suppressing medications.[15]

TB is extremely common worldwide; approximately one-fourth of the world's population is thought to have LTBI and approximately 10 million became ill with TB during 2018.[19] In the United States, TB incidence is very low; overall LTBI

prevalence has been estimated at approximately 5%, and 9025 TB cases were reported during 2018, a 73% decline compared with 1991.[16,17] Just as is the case globally, TB is unevenly distributed in the United States; since 2001, most cases have occurred in persons born outside of the United States in countries with comparatively higher TB incidence.[20] Many cases among non-US-born persons likely represent infection acquired outside the United States in the remote past.[16] TB in the United States also disproportionately affects people experiencing homelessness, incarcerated persons, and persons with weakened immune systems.[16,20]

To maximize the predictive value of tests for TB infection and focus resources on evaluating and treating persons at risk for LTBI and TB given the relatively low LTBI prevalence and TB incidence in the United States, the Centers for Disease Control and Prevention (CDC) recommends testing only for persons with TB symptoms, epidemiologic risk factors for LTBI (eg, birth in a country with higher TB incidence), or medical risk factors for progression to TB.[17,21] To evaluate for TB, medical providers should perform a thorough diagnostic evaluation on all persons with positive tests for TB infection; this diagnostic evaluation should include a medical history and physical examination, chest radiography, and, in certain circumstances, acid-fast bacilli smear microscopy, culture, and nucleic acid amplification tests.[22]

M tuberculosis transmission is possible in any workplace with contagious persons; workplace-associated transmission has been described in health care settings, such as hospitals, long-term care facilities, and laboratories,[8,23] correctional facilities,[24] homeless shelters,[25] and even a refuge and zoo that housed elephants.[11,26] When pulmonologists, occupational medicine practitioners, or other health care providers identify workers with TB symptoms, they should collaborate with local and state public health programs to facilitate prompt TB diagnoses among workers. These collaborations should also facilitate worksite-based contact investigations, and focused efforts to identify persons exposed to infectious TB, so that they can be tested and treated for LTBI and TB.[15] Public health programs can use clinical, epidemiologic, and molecular data to determine whether LTBI and TB diagnoses among workers represent a cadre of workers with a high prevalence of risk factors for LTBI and TB or a workplace with *M tuberculosis* transmission.

M tuberculosis transmission in health care settings deserves special attention. Health care-associated transmission used to be common, and LTBI prevalence among health care personnel was higher than the overall population.[5] Recognizing the importance of preventing health care-associated transmission, CDC has published guidelines for preventing *M tuberculosis* transmission in health care settings since the 1980s.[27] The most recent version of these guidelines, published in 2005, promotes 3 categories of infection control measures: administrative, engineering (or environmental), and respiratory protection. The occupational health and safety hierarchy of controls typically prioritizes engineering controls over administrative controls. However, for TB, administrative controls, which are designed to reduce the risk of exposures to infectious TB, are prioritized over engineering controls and are the foundation of TB infection control and prevention strategies.[27] Examples of TB prevention measures according to the hierarchy of controls are shown in **Table 1**.

In the context of declining overall TB incidence in the United States, limited specificity of TSTs and IGRAs, and no TB cases identified in large cohorts of health care personnel despite widespread routine testing, CDC amended guidance for TB screening, testing, and treatment of health care personnel in 2019.[28] **Table 2** depicts the amended guidance for testing of health care personnel alongside the 2005 guidance. In the absence of ongoing transmission or exposure to infectious TB, CDC no longer recommends serial testing of health care personnel for LTBI or TB.[28] Current guidance recommends baseline screening for all health care personnel; screening includes assessing for TB symptoms, assessing for LTBI and TB risk factors, and performing a test for TB infection.[28] Those with positive tests should have a thorough diagnostic evaluation for TB; health care personnel with LTBI should be encouraged to take LTBI treatment to prevent TB unless medically contraindicated. Using the same test for TB infection (ie, a TST or IGRA) helps facilitate results interpretation for individuals and making inferences about whether transmission is occurring among cohorts of workers.[28] Recommendations regarding other aspects of infection control and prevention in health care settings remain unchanged from the 2005 guidelines.[27]

INFLUENZA

Influenza infections are thought to spread mainly through droplet transmission, although evidence for airborne transmission and transmission by direct contact also exists. Seasonal and pandemic influenza are important causes of morbidity and mortality in humans. Transmission occurs mostly from human to human. However, swine and poultry are 2 key reservoirs of influenza viruses

Table 1
Occupations at risk and examples of prevention measures according to the hierarchy of controls

	Tuberculosis[a]	Influenza	Coccidioidomycosis	Psittacosis
Example occupations at risk	Health care personnel Laboratory workers Correctional workers Homeless shelter workers	Health care personnel Swine and poultry farmers Veterinary personnel Meat processing workers	Agricultural workers Construction workers Archeological workers Military personnel Laboratory workers	Veterinary personnel Bird breeders Poultry processing workers Pet shop workers
Control type				
Elimination/substitution	Exclusion of infectious workers	Exclusion of ill workers from work Biosecurity/biosafety measures at farms, plants, live markets	Reduction in grading or need for trenching of land	Quarantine of newly acquired birds or birds exposed to ill birds Isolation of ill birds
Engineering controls	General ventilation to reduce concentrations in air Airborne infection isolation rooms (AIIRs) High efficiency particulate air filtration Ultraviolet germicidal irradiation	Partitions in triage areas Maintenance of air-handling systems Closed suctioning systems for airway suction Use of AIIRs for aerosol-generating procedures	Frequent, effective soil wetting Use of enclosed cabs Planting of vegetation, ground cover	Exhaust ventilation Cleaning/disinfection of cages Repair of malfunctioning tools
Administrative controls	Written TB control plan Prompt identification, isolation of persons with TB Treatment of TB and latent TB infection TB screening of exposed or at-risk workers Thorough and efficient contact investigations	Influenza vaccination Non-punitive sick leave policies Infection prevention training Triage, isolation of infectious patients Hand hygiene Cull infected animals	Suspension of work during excessive dust/wind Training workers about risks, symptoms Have onsite monitoring personnel to implement additional control measures	Maintain accurate records of bird-related transactions Good animal husbandry practices Educating workers about risks Hand hygiene Appropriate cleaning, disinfection protocols for cages

Personal protective equipment	Airborne precautions Use of NIOSH-approved filtering facepiece respirators[b]	Droplet precautions: surgical masks Standard precautions: gowns, gloves as needed Use of NIOSH-approved filtering facepiece respirators[b] for aerosol-generating procedures and for novel strains	Use of NIOSH-approved filtering facepiece respirators[b] for workers at high risk of exposure	Use of NIOSH-approved filtering facepiece respirators[b] for workers at high risk of exposure (ie, handling ill birds or cleaning cages) Gloves, eye protection as needed based on job duties

[a] For the hierarchy of controls for tuberculosis, administrative controls take priority over engineering controls.
[b] Respirators for employees must be used within an Occupational Safety and Health Administration (OSHA)-compliant respiratory protection program that includes medical clearance, fit testing, training, and procedures for disposing, cleaning, and maintaining respirators.

Table 2
CDC recommendations for tuberculosis screening, testing, and treatment of US health care personnel[a]

Category	2005 Recommendations[27]	2019 Recommendations[28]
Baseline (preplacement) screening and testing	• Symptom evaluation • Test for TB infection (eg, TST or IGRA) for those without documented history of TB or LTBI[b]	• Symptom evaluation • Test for TB infection (eg, TST or IGRA) for those without documented history of TB or LTBI[b] • Individual risk assessment[c] ○ Previous residency ≥1 mo in country with high TB rates[d] ○ Current or planned immune suppression[e] ○ Close contact with someone with infectious TB
Serial screening and testing for health care personnel without LTBI	Varies according to facility and setting risk assessment • Potential for ongoing transmission: ○ Test for TB infection every 8–10 wk until effective infection controls implemented and no additional evidence for ongoing transmission • Medium risk: ○ Annual symptom evaluation ○ Annual test for TB infection • Low risk: ○ None in the absence of exposure to *M tuberculosis*	Not routinely recommended except for: • Selected groups who might be at increased occupational risk of exposure (eg, pulmonologists or respiratory therapists) • Certain settings if transmission has occurred in the past (eg, selected emergency departments) • Contact investigations[f] • Exposure to infectious TB outside of workplace • Evidence for ongoing TB transmission[f]
Annual TB education for health care personnel	Recommended	Recommended, with emphasis on: • Risk factors • Signs and symptoms of TB • Discussing occupational and nonoccupational TB exposures with primary care and occupational health providers as soon as practical after exposure
Evaluation and treatment of positive test results	Referral to determine whether LTBI treatment is indicated	Encouraged for all with untreated LTBI unless medically contraindicated

Abbreviations: IGRA, interferon-gamma release assay; LTBI, latent tuberculosis infection; TB, tuberculosis; TST, tuberculin skin test.

[a] Recommendations outside of the scope of health care personnel screening, testing, treatment, and education, including facility risk assessments for guiding infection control policies and procedures, remain unchanged from the 2005 guidelines.[27,28]

[b] Asymptomatic health care personnel who have positive tests are unlikely to be infected with *M tuberculosis*, and are at low risk for progression based on their risk assessment, should have a second test (either an IGRA or a TST) as recommended in the TB diagnostic guidelines of the American Thoracic Society, Infectious Diseases Society of America, and CDC.[22] These health care personnel should be considered infected with *M. tuberculosis* only if both the first and second tests are positive.

[c] CDC's Health care personnel baseline individual TB risk assessment found at: https://www.cdc.gov/tb/topic/infectioncontrol/pdf/healthCareSettings-assessment.pdf.

[d] This includes any country other than Australia, Canada, New Zealand, the United States, and those in western or northern Europe.

[e] Includes human immunodeficiency virus (HIV) infection, receipt of an organ transplant, treatment with a TNF-alpha antagonist, chronic steroids (equivalent of prednisone ≥15 mg/d for ≥1 mo), or other immunosuppressive medication.

[f] Consultation with the local or state health department is encouraged in making these determination.

Data from Refs.[22,27,28]

and cause zoonotic infection. Influenza A viruses cause the most morbidity in both humans and animals among influenza viruses.[29] CDC has estimated that the number influenza-related illnesses that have occurred during influenza season in the United States has ranged from 9.2 to 35.6 million, including 140,000 to 710,000 influenza-related hospitalizations.[30] The seasonal incidence of symptomatic influenza has been estimated at 8.9% for adults aged 18 to 64 years.[31]

Symptoms of influenza infection include fever, cough, sore throat, runny or stuffy nose, body aches, headache, chills, and fatigue. Some patients have vomiting and diarrhea, whereas others have respiratory symptoms without a fever. Influenza illness can range from mild to severe. Health conditions known to increase the risk of serious complications from influenza include pregnancy, asthma, and other chronic lung disease; diabetes mellitus; heart, neurologic, and kidney disease; and immunocompromising conditions.[32]

Health care personnel are considered to be at risk for influenza infections from both seasonal and pandemic influenza through exposure to patients with influenza and may also transmit influenza to patients and other health care personnel.[32] A meta-analysis of 15 studies demonstrated a significantly increased odds for influenza A (H1N1) for health care personnel (odds ratio = 2.08, 95% CI, 1.73, 2.51) during the 2009 H1N1 influenza epidemic.[33] Influenza has caused outbreaks of severe respiratory illness in hospitals and long-term care facilities.[34] For pandemic influenza, the Occupational Safety and Health Administration (OSHA) considers health care personnel performing aerosol-generating procedures on known or suspected influenza patients and laboratory personnel handling specimens from these patients to be at very high exposure risk. Other health care personnel involved in health care delivery and support or transport are considered at high exposure risk. Workers with high-frequency contact with the general population, such as those in schools, high population density work environments, and some high volume retail settings are considered at medium exposure risk.[35]

Studies have shown that occupational risk factors have been associated with infection among health care personnel including job type (ie, physicians and nurses), number of patient contacts, vaccination history, inadequate hand hygiene, and inadequate PPE use.[33] These occupational risk factors highlight the need for comprehensive infection prevention strategies in health care settings. Institutional strategies, primarily engineering and administrative controls, to prevent transmission of influenza among health care personnel and patients are shown in **Table 1**.[36,37]

Employer influenza vaccination requirements are associated with higher coverage rates, and, although controversial, mandatory influenza vaccination is supported by many health care personnel and multiple health care professional societies.[38–40] Mandatory influenza vaccination is increasingly common in health care settings, and multiple states have established influenza vaccination requirements for hospital health care personnel.[41] However, concerns have been raised related to the variable effectiveness of the vaccine and the ethical and legal impact of these policies.[41–43] The duty of health care personnel to protect the health of individual patients and the public competes with their right to personal autonomy. Mandates also invoke legal issues, including the applicability of state and federal constitutional laws and statutes.[41–43]

Provision of appropriate PPE with adequate training and an expectation of consistent use may also prevent transmission of influenza to health care personnel (see **Table 1**).[37] N95 filtering facepiece respirators have been demonstrated to have a protective advantage over surgical masks in laboratory settings.[44] However, 2 meta-analyses and multiple newer studies have concluded mixed results about the difference between surgical masks and N95 respirators in the incidence of laboratory-confirmed influenza, influenza-like illness, and acute respiratory infection.[44–47]

Animal workers have also been shown to be at higher risk for zoonotic transmission of influenza viruses. Influenza transmission from pigs was first recognized during the Spanish influenza pandemic of 1918 to 1919.[48] Swine farmers, swine production workers, veterinarians, and meat processing workers have been shown to have higher risk of infection from swine influenza virus.[49,50] In addition, there is significant evidence of zoonotic transmission of avian influenza viruses from birds to humans with the 1997 outbreak of human H5N1 infections in Hong Kong and the 2013 outbreak of human H7N9 infections primarily in China.[2] H7 and H5 strains are the avian influenza viruses that have most commonly infected humans and often cause severe disease after exposures to infected or dead birds.[29] Poultry farmers and cullers, veterinarians, commercial poultry workers, and poultry vendors at live animal markets are considered at higher risk of infection with avian influenza viruses.[3,5,29] Poultry contact involving mass culling during outbreaks, slaughtering and preparing of ill or deceased birds, and burial of

carcasses have been implicated as modes of transmission.[3] More recently, transmission of influenza A (H7N2) infection has been documented from felines to humans in a city animal shelter.[51,52]

Measures to prevent animal-to-human transmission of influenza involves a OneHealth approach that includes comprehensive biosecurity and biosafety measures and training at the farms, processing plants, and live markets, surveillance for influenza viruses, culling infected animals, and vaccination of poultry and swine.[28,30] Strategies to minimize risk among individual workers include training on their risk and preventive measures, annual influenza vaccination, and appropriate hand hygiene (see **Table 1**).[2,50]

COCCIDIOIDOMYCOSIS

Coccidioidomycosis, also known as Valley fever, is caused by inhalation of spores of the fungus *Coccidioides* spp, which grows in soil in semiarid areas. The infection is an example of transmission from the environment, and it is not generally spread from to person to person, or from animals to people. Coccidioidomycosis is endemic in the southwestern United States, particularly parts of Arizona and California, Mexico, and parts of Central and South America.[53] During 2011 to 2017, a total of 95,371 cases of coccidioidomycosis were reported to CDC from 26 states and the District of Columbia, with greater than 95% of cases reported from Arizona and California.[54] An estimated 150,000 new infections occur annually in the United States,[55] although only approximately 10,000 cases are reported annually, suggesting that the disease is greatly underdetected and underreported.[56]

About 60% of coccidioidomycosis infections are asymptomatic.[53] People who develop symptoms, typically after a 1 to 3 week incubation period, may experience a flu-like illness. The infection can be clinically indistinguishable from community-acquired pneumonia caused by other pathogens, which can lead to inappropriate treatment.[54] A small percentage of infected persons (<1%) may develop widespread disseminated infection.[53] People at greater risk for developing disseminated infection include people of African American and Asian (particularly Filipino) descent, pregnant women during their third trimester, and immunocompromised persons.[53] Coccidioidomycosis has been shown to be costly and debilitating, with nearly 75% of patients in whom the disease has been recognized missing work or school because of their illness and more than 40% requiring hospitalization.[57]

This disease has important occupational risk factors. First, laboratory-acquired coccidioidomycosis has been documented, mostly arising from accidental laboratory exposure to *Coccidioides* spp.[58,59] Second, environmental exposures exist through disruption of soil or strong dust-raising winds, which can aerosolize spores. Therefore, in *Coccidioides*-endemic areas, persons who work outdoors are at particular risk for coccidioidomycosis when their duties include soil-disruptive work or when working in dusty or windy conditions. Workers in endemic areas involved in soil disturbance, including but not limited to agricultural, construction, and archeological workers, military personnel, and workers in mining, quarrying, and oil and gas extraction industries have been shown to be at higher risk for coccidioidomycosis.[6,60,61] A review of 47 coccidioidomycosis outbreaks during 1940 to 2015 revealed that 25 (53%) were associated with occupational exposures, including the military, construction, archaeology or other field studies, and laboratory activities.[62] Clusters of infections have also been found among employees and inmates at state prisons located in endemic areas.[11,63] Another paper reviewed 4 occupational coccidioidomycosis outbreaks from 2007 to 2014 in California, involving construction workers in several excavation projects and an outdoor filming event involving cast and crew.[64] It is important that health care providers consider a diagnosis of coccidioidomycosis in patients who live or work in or have traveled to areas with known geographic risk for *Coccidioides*.

The 4 occupational outbreaks in California illustrated multiple factors that facilitated transmission, including operating heavy equipment without enclosed cabs or closed windows, inconsistent soil-wetting practices, little or no risk communication to workers, and infrequent use of respiratory protection.[64] Reducing the risk of coccidioidomycosis among workers in endemic areas can be accomplished through the hierarchy of controls approach (see **Table 1**).[64] However, the efficacy of engineering and administrative methods in preventing infection can be difficult to measure.[62] In addition, prevention can be challenging because of the limited understanding of the distribution of *Coccidioides* spp in the environment, the effect of weather patterns, and the effectiveness of environmental mitigation efforts and respiratory protection.[54,62] In 2019, the state of California passed a bill requiring construction employers in highly endemic areas to provide awareness training on coccidioidomycosis for employees.[65]

PSITTACOSIS

Psittacosis refers to human infection by the bacteria *Chlamydia psittaci*. Psittacosis is most commonly associated with atypical pneumonia but can cause manifestations in multiple organ systems, including hepatic, central nervous system, cardiac, renal, and rheumatic disease.[66] Patients may develop mild illness with abrupt onset of fever, chills, headache, malaise, and myalgia after an incubation period of 5 to 14 days.[67] Dry cough is often present. Although rare, severe illness can occur.[68] *C psittaci* can infect birds, humans, and other mammals; most human infections occur from exposure to infected birds, such as psittacines, pigeons, or poultry.[69] Eighteen psittacosis outbreaks were investigated by the CDC's Epidemic Intelligence Service officers during 1946 to 2005. Of those, pet psittacine birds and turkeys were identified as frequent causes of outbreaks, affecting psittacine bird handlers and workers in turkey-processing plants.[70]

C psittaci is transmitted to humans through inhalation of aerosolized dried droppings or secretions of infected birds.[67] Transmission can also occur through direct contact with feathers, tissues, secretions of infected birds, or by mouth-to-beak contact.[67,69] Human-to-human transmission has been reported but is thought to be rare.[68] Workers in occupations that involve contact with live birds or bird carcasses, such as veterinarians,[71] bird breeders,[72] poultry handlers,[14,73,74] and pet shop workers[75] are at increased risk of infection. Prevention can be challenging, as infected birds may be asymptomatic or have few signs of illness.[69] Stress factors, such as transportation, relocation, crowding, injury, and illness may exacerbate shedding from infected birds.[67,76] In addition, workers who develop psittacosis may remain undiagnosed because symptoms are often mild and nonspecific and patients may not seek medical care. Moreover, the widely available serologic test for psittacosis diagnosis requires acute and convalescent serum samples collected a few weeks apart, and can cross-react with other *Chlamydia* species.[67] Currently in the United States, a real-time polymerase chain reaction assay for human specimens (more sensitive and specific than serology) is only available at CDC.[67] Psittacosis is a reportable condition in most jurisdictions in the United States, and cases are voluntarily reported to CDC. However, during 2008 to 2017, only 60 cases (6 cases per year on average) were reported,[77] which likely represents under detection.

Exposure to *C psittaci* in the workplace varies by occupation. The OSHA does not have a workplace standard for *C psittaci* exposure[78]; however, professional organizations provide recommendations to prevent transmission to humans.[67] Basic principles can be categorized following a hierarchy of controls to prevent occupational exposures to *C psittaci* (see **Table 1**). These include quarantine procedures of newly acquired birds or birds exposed to ill birds and other animal husbandry practices.

A REEMERGING OCCUPATIONAL RESPIRATORY INFECTION

Several studies have shown increased risk of pneumonia (defined as bacterial, lobar, and pneumococcal) and mortality among welders and other workers exposed to metal fumes and mineral dusts.[79–84] A recent review demonstrated that the median population attributable fraction was 10% for the occupational burden of pneumonia. The review also demonstrated that metal fumes/welding exposures had a median occupational attributable fraction of community-acquired pneumonia of 52% in cohort studies.[4] Several hypotheses have been posed that might explain this increased occupational risk. Theories have included that metal fumes (or iron) act as a growth nutrient for bacteria, enhance the binding of bacteria to lung tissues, or impair immune responses in the lung through oxidative stress.[79,83–85] Therefore, it is hypothesized that the occupational risk of this infection is not primarily from exposures to the pathogen at work but rather that the occupational exposure (metal fumes) is a risk factor for infection and subsequent disease. While further research is needed to establish this association and quantify the dose response relationship, a preventive approach using the hierarchy of controls has already been implemented at workplaces and corporations in some countries, including the United Kingdom. Engineering controls have consisted of methods to minimize fume inhalation through local exhaust ventilation. Administrative measures have included offering welders the 23-valent pneumococcal polysaccharide vaccination and cleaning workpieces to remove contaminants before welding.[86,87]

AN EMERGING OCCUPATIONAL RESPIRATORY INFECTION

In the United States, SARS-CoV-2, the novel coronavirus that causes COVID-19, was first detected during January 2020.[88] Since then, more than 2.1 million cases have been reported in the United States, including more than 116,000 associated deaths as of June 17, 2020.[89]

Data suggest that close-range aerosol transmission by droplet is the primary mode of transmission.[90] However, contact transmission is also possible following self-delivery to the eyes, nose, or mouth.[90] Transmission by asymptomatic and presymptomatic individuals has been described.[91–93]

In their occupational risk pyramid similar to the one for influenza, OSHA has divided jobs into 4 risk exposure levels for COVID-19: very high, high, medium, and lower risk. These categories are based on the industry type and the need for contact within 6 feet of people with suspected or confirmed COVID-19[94] and form the basis of recommendations for preventing transmission in the workplace. Health care personnel are considered to be at very high or high risk of exposure.[94] Characteristics of health care personnel with COVID-19 reported to CDC from February 12 to April 9 have been summarized.[95] As of June 17, more than 78,000 COVID-19 cases and 422 deaths have been reported among health care personnel.[89] In the first several months of the COVID-19 pandemic, COVID-19 outbreaks occurred in several types of medium-risk and high-risk workplaces, including long-term care facilities, meatpacking plants, correctional facilities, and homeless shelters.[93,96–99] Efforts to characterize the occupational burden of COVID-19 are ongoing, and prevention measures in workplaces have emphasized the use of engineering and administrative controls and PPE.

SUMMARY

Emerging and reemerging work-related infectious diseases will continue to threaten workers' health. It is important for clinicians to recognize that respiratory infections can be occupationally related. Communication and cooperation between clinicians and public health practitioners is important to identify work-related clusters of respiratory infections. Considering occupational risk factors and controlling exposures among workers according to the hierarchy of controls will help prevent disease transmission in the workplace.

DISCLOSURE

The authors have nothing to disclose.

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