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Coccidioidomycosis and COVID-19 Co-Infection, United States, 2020

Appendix

Appendix Results

Coronavirus Disease Among Construction and Agricultural Workers

Construction, agriculture, and wildland firefighting are considered essential occupations under coronavirus disease (COVID-19) shelter-in-place guidelines for California and Arizona (*119*). Continued in-person work in these sectors poses challenges to maintaining physical distance and limiting contacts, resulting in higher risks for infection with severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) (*120,121*). For instance, ≈8% of persons in construction occupations across the United States are exposed to SARS-CoV-2 ≥1 time a month (*121*), and nearly 60% of the construction labor force in the United States has ≥1 factor (>65 years of age or preexisting medical condition) that is associated with higher risk for severe illness from COVID-19 (*122*). Outbreaks of COVID-19 have been documented at multiple construction sites across the United States (*123–126*), including a cluster of 10 confirmed cases and >30 exposures at a construction site in Santa Clara, California (*126*), and 75 confirmed cases among a construction crew in Salt Lake City, Utah (*125*).

Agricultural workers might also have heightened risk for COVID-19 because of high workforce mobility, shared transportation, and overcrowded living quarters, often shared with other workers, multigenerational families, or both (*127–129*). One study estimated that >133,000 agricultural workers across the United States had tested positive for COVID-19 by September 1, 2020 (*130*), and media reports have documented clusters of COVID-19 at farms in >17 states (*131*). Some of the largest COVID-19 clusters among agricultural workers have been documented in California counties to which coccidioidomycosis is endemic, including Merced (1 cluster involving 392 COVID-19 cases and 8 deaths) (*132*), Ventura (3 clusters with 201, 35, and 28 COVID-19 cases) (*133–135*), and Monterey (1 cluster involving 247 COVID-19 cases) (*136*).

COVID-19 within Carceral Facilities

Crowding, unsanitary conditions, and poor ventilation in prison environments is known to contribute to rapid spread of communicable respiratory diseases (*137*), including influenza and tuberculosis (*138–141*). As the introduction of 1 case of influenza into a prison setting has been found to be sufficient to spark a large outbreak (*139*), concerns surrounding the spread of COVID-19 among detainees and staff members at correctional facilities are high (*142*,*143*). During January 21–April 21, 2020, 82% (32/37) of reporting state and territorial health department jurisdictions reported confirmed COVID-19 cases among incarcerated or detained persons or staff members (*144*). As of April 21, 2020, a total of 4,893 cases and 88 deaths among incarcerated and detained persons and 2,778 cases and 15 deaths among staff members in these 37 jurisdictions have been reported to the Centers for Disease Control and Prevention (CDC) (*144*). Large COVID-19 outbreaks have been documented among incarcerated persons and staff working at carceral facilities in Lompoc Prison Complex in Lompoc, California (n = 1,111 cases) (*145*), San Quentin State Prison in California (n = 2,221) (*145*), Rikers Island in New York, New York (n = 1,711) (*146*), the Cook County Jail in Chicago, Illinois (n = 1,040) (*147*), and Marion Correctional Institution in Marion, Ohio (n = 2,168) (*148*). COVID-19 outbreaks have also been documented at training camps for fire-fighting crews comprising incarcerated persons in northern California (*149*).

Coccidioidomycosis within Carceral Facilities

In 1 review, 5/47 (11%) reported coccidioidomycosis outbreaks were among incarcerated populations (*150*). During 2007–2011, 19% of coccidioidomycosis cases in California were among incarcerated persons (*151*). Over a quarter of California Department of Corrections and Rehabilitation facilities, including Lompoc Prison Complex, where a COVID-19 outbreak of >1,000 cases occurred (*147*), are in regions with high coccidioidomycosis incidence (*152*). One study showed that *Coccidioides* spores were detected in 15% of air samples taken outside Avenal State Prison (*153*) in Kings County, California, where the incidence of coccidioidomycosis during 2007–2011 was nearly 6 times higher than that of the nearby city (2,195 vs. 411 cases/100,000 population) and 14 times higher than the surrounding county (155 cases/100,000) (*151*). Pleasant Valley State Prison in Fresno County, CA, recorded an incidence of 3,323 cases/100,000 persons in 2005, or 415 times higher than the incidence of the surrounding county (8 cases/100,000 persons) (*154*). Other prisons in endemic areas, such as those in 3 Kern County

cities of Delano, Wasco, and Taft, have reported incidence rates ≈2 times that of the surrounding county (*151*).

COVID-19 and Particulate Matter

Persons living in environments with high concentrations of dust, which is an important constituent of particulate matter with diameter ≤10 μm (PM10) or ≤2.5 μm (PM2.5), might be at elevated risk for infection with *Coccidioides* and SARS-CoV-2, as well as increased severity of COVID-19 infection. Exposure to PM10 and PM2.5 has been recognized as a risk factor for disease and death from viral respiratory infection (*155*), including severe acute respiratory syndrome coronavirus (*156*). Macrophages laden with fine particles might have reduced ability to induce immune responses leading to increased disease severity (*157*,*158*), and PM2.5 has been shown to exacerbate underlying health conditions such as diabetes and chronic lung disease (*159*), that can complicate the course of viral respiratory infections. Evidence from several countries suggests that both acute and chronic exposure to fine particulate matter is associated with increased COVID-19 disease and death (*160*). For example, 1 study found that a 1 $\mu g/m^3$ increase in long-term exposure to PM2.5 was associated with an 8% increase in the COVID-19 death rate in counties across the United States (*161*). In a study of 120 cities in China, elevated particulate matter in the previous 2 weeks was associated with a 2.2% increase in daily confirmed COVID-19 cases (*162*). In Italy, the number of days in the previous 4 years that had exceeded regulatory limits for atmospheric pollutants such as PM2.5 and PM10 was significantly associated with increased COVID-19 cases (*163*).

Diagnostic Tests for Coccidioidomycosis

Laboratory confirmation is necessary to distinguish coccidioidomycosis from other conditions (*45*), and serologic detection of anticoccidiodal antibodies is the most common method to diagnose coccidioidomycosis infection, partly because of the low sensitivity (≈46%–67%) of culture-based methods in respiratory samples (*164–166*). Newer serologic assays for IgM antibodies have sensitivities ranging from 68% to 88% (*167*,*168*), but IgM antibodies are not typically detectable until 7–21 days after symptom onset, and IgG antibodies even later (*164*,*165*,*169*). As a result, a coccidioidomycosis diagnosis might occur ≥1 month after symptom onset. The high rate of false negatives (≤32%) in coccidioidomycosis testing (*165*) further complicate the situation. Given the low sensitivities, experts recommend repeated testing if the original test is negative and symptoms persist (*98*,*170*). COVID-19 might make patients less

likely to return to their healthcare providers for a second test due to fear of exposure to SARS-CoV-2 in medical facilities.

Prevalence of Severe Disease in COVID-19 and Coccidioidomycosis Patients

Among coccidioidomycosis patients, ≈5% develop severe chronic infections, and 1% progress to disseminated disease in which the infection spreads beyond the pulmonary system (*68*). Disseminated disease can lead to meningitis, bone and skin lesions, swollen joints, hospitalization, and death (*56*). An estimated 80% of COVID-19 cases are mild (no or mild pneumonia), 15% are severe (severe pneumonia and respiratory distress), and 5% are critical (respiratory failure, septic shock, organ dysfunction/failure) (*82*).

COVID-19 Risk among Black/African American Persons

Growing evidence points toward higher risk for severe disease and death from COVID-19 among Black persons living in the United States. Compared with White persons, the age-adjusted COVID-19 death rate on August 4, 2020 was 3.7 times higher among those who identify as Black (80.4 deaths/100,000 persons vs. 35.9 deaths/100,000 persons) (*171*). This trend is reflected across coccidioidomycosis endemic states, such as California and Arizona. In Arizona, the age-adjusted death rate from COVID-19 among Black populations is 2.1 times higher than among White populations. In California, the age-adjusted death rate from COVID-19 among Black populations is 3.0 times higher than among White populations (*171*).

COVID-19 and Cloth Masks

The CDC has recommended that all Americans wear cloth face coverings in public settings to reduce transmission of SARS-CoV-2 (*99*). Although cloth masks are inadequate for filtering out the SARS-CoV-2 virus (which is only 70–90 nm in size) and do not protect the wearer from inhaling viral particles (*172*), masks can protect wearers from virus suspended in large droplets and can prevent wearers from spreading droplets by coughing, sneezing, or breathing. Mask use is recommended for the entire population because persons are believed to be most infectious before the onset of COVID-19 symptoms (*173*). Models suggest that if 80% of the American population wore cloth face masks consistently, COVID-19 transmission would decrease significantly, even if lock-down restrictions were loosened (D. Kai, unpub. data, https://arxiv.org/abs/2004.13553v1), but 1 national survey found that only 60% of respondents follow CDC mask recommendations (*174*).

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