

# HISTOPLASMOSIS:

## *Protecting Workers at Risk*

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### What is histoplasmosis?

Histoplasmosis is an infectious disease caused by inhaling the spores of a fungus called *Histoplasma capsulatum*. Histoplasmosis is not contagious; it cannot be transmitted from an infected person or animal to someone else.<sup>1</sup>

Histoplasmosis primarily affects a person's lungs, and its symptoms vary greatly. The vast majority of infected people are asymptomatic (have no apparent ill effects), or they experience symptoms so mild they do not seek medical attention and may not even realize that their illness was

histoplasmosis.<sup>2</sup> If symptoms do occur, they will usually start within 3 to 17 days after exposure, with an average of 10 days.<sup>1</sup> Histoplasmosis can appear as a mild, flu-like respiratory illness and has a combination of symptoms, including malaise (a general ill feeling), fever, chest pain, dry or nonproductive cough, headache, loss of appetite, shortness of breath, joint and muscle pains, chills, and hoarseness.<sup>1-4</sup> A chest X-ray can reveal distinct markings on an infected person's lungs.

Chronic lung disease due to histoplasmosis resembles tuberculosis and can worsen over months or years. Special antifungal medications are needed to arrest the disease.<sup>1,2,5</sup> The most severe and rarest form of this disease is disseminated histoplasmosis, which involves spreading of the fungus to other organs outside the lungs. Disseminated histoplasmosis is fatal if untreated,<sup>1,6</sup> but death can also occur in some patients even when medical treatment is received.<sup>5</sup> People with weakened immune systems are at the greatest risk for developing severe and disseminated histoplasmosis. Included in this high-risk group are persons with acquired immunodeficiency syndrome (AIDS) or cancer and persons receiving cancer chemotherapy; high-dose, long-term steroid therapy; or other immuno-suppressive drugs.<sup>2,5,7-11</sup>

Impaired vision and even blindness develop in some people because of a rare condition called "presumed ocular histoplasmosis."<sup>12</sup> The factors causing this condition are poorly understood. Results of laboratory tests suggest that presumed ocular histoplasmosis is associated with hypersensitivity to *H. capsulatum* and not from direct exposure of the eyes to the microorganism. What delayed events convert the condition from asymptomatic to symptomatic are also unknown.<sup>13</sup>

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## How is histoplasmosis diagnosed?

Histoplasmosis can be diagnosed by identifying *H. capsulatum* in clinical samples of a symptomatic person's tissues or secretions, testing the patient's blood serum for antibodies to the microorganism, and testing urine, serum, or other body fluids for *H. capsulatum* antigen. On occasion, diagnosis may require a transbronchial biopsy.<sup>7</sup>

### *H. capsulatum* Culturing of

Culturing clinical specimens is a standard method of microbial identification, but the culturing process for isolating *H. capsulatum* is costly and time-consuming.<sup>14</sup> To complicate matters, positive results are seldom obtained during the acute stage of the illness, except from clinical specimens from patients with disseminated histoplasmosis.<sup>2,5,7,14-16</sup> Research advances in polymerase chain reaction (PCR) technology suggest that a laboratory method may soon be available that will allow direct identification of pathogenic fungi in clinical samples without the need for culturing them.<sup>17,18</sup>

### Serologic tests

Most cases of histoplasmosis are diagnosed serologically.<sup>7</sup> Because of their convenience, availability, and utility, the most widely accepted serologic tests are the immunodiffusion test and the complement-fixation test.<sup>4,14-16</sup> Serologic test results are useful when positive. However, sometimes test results are negative even when a person is sick with histoplasmosis, a situation that arises especially in patients with weakened immune systems.<sup>2,7,15</sup>

The immunodiffusion test qualitatively measures precipitating antibodies (H and M precipitin lines or bands) to concentrated histoplasmin.<sup>4,7,19</sup> While this test is more specific for histoplasmosis (i.e., a person who is not infected with *H. capsulatum* is unlikely to have a positive test result) than the complement-fixation test, it is less sensitive (i.e., someone who is acutely infected can have a negative test result).<sup>4,7,14</sup> Because the H band of the immunodiffusion test is usually present for only 4 to 6 weeks after exposure, it indicates active infection.<sup>2,4,14</sup> The M band is observed more frequently, appears soon after infection, and may persist up to 3 years after a patient recovers.<sup>4,7</sup>

The complement-fixation test, which measures antibodies to the intact yeast form and mycelial (histoplasmin) antigen, is more sensitive but less specific than the immunodiffusion test.<sup>7</sup> Complement-fixing antibodies may appear in 3 to 6 weeks (sometimes as early as 2 weeks<sup>19</sup>) following infection by *H. capsulatum*, and repeated tests will give positive results for months.<sup>2,19</sup> The results of complement-fixation tests are of greatest diagnostic usefulness when both acute and convalescent serum specimens can be obtained. A high titer (1:32 or higher) or a fourfold increase is indicative of active histoplasmosis.<sup>4,15,16,19</sup> Lower titers (1:8 or 1:16), although less specific, may also provide presumptive evidence of infection,<sup>3,14</sup> but they can also be measured in the serum of healthy persons from regions where histoplasmosis is endemic.<sup>16</sup> Antibody titers will gradually decline and eventually disappear months to years after a patient recovers.<sup>2,4,14,19</sup>

**Detection of****antigen***H. capsulatum*

A radioimmunoassay method can be used to measure *H. capsulatum* polysaccharide antigen (HPA) levels in samples of a patient's urine, serum, and other body fluids.<sup>5,14,20,21</sup> The test appears to meet the important need for a rapid and accurate method for early diagnosis of disseminated histoplasmosis, especially in patients with AIDS.<sup>5,14,21</sup> HPA is detected in body fluid samples of most patients with disseminated infection and in the urine and serum of 25% to 50% of those with less severe infections.<sup>14</sup>

**Histoplasmin skin test**

A person can learn from a histoplasmin skin test whether he or she has been previously infected by *H. capsulatum*. This test, similar to a tuberculin skin test, is available at many physicians' offices and medical clinics. A histoplasmin skin test becomes positive 2 to 4 weeks after a person is infected by *H. capsulatum*, and repeated tests will usually give positive results for the rest of the person's life.<sup>15</sup> A previous infection by *H. capsulatum* can provide partial protection against ill effects if a person is reinfected.<sup>19</sup> Since a positive skin test does not mean that a person is completely protected against ill effects,<sup>19</sup> appropriate exposure precautions should be taken regardless of a worker's skin-test status. Furthermore, while histoplasmin skin test information is useful to epidemiologists, a positive skin test does not help diagnose acute histoplasmosis, unless a previous skin test is known to have been negative.<sup>1,2,4,7</sup>

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**Where are  
*H.  
capsulatum*  
found?**

**spores**

*H. capsulatum* grows in soils throughout the world.<sup>7,22</sup> In the United States, the fungus is endemic and the proportion of people infected by *H. capsulatum* is higher in central and eastern states, especially along the valleys of the Ohio, Mississippi, and St. Lawrence rivers, and the Rio Grande.<sup>4,23</sup> The fungus seems to grow best in soils having a high nitrogen content, especially those enriched with bird manure or bat droppings. The organism can be carried on the wings, feet, and beaks of birds and infect soil under roosting sites or manure accumulations inside or outside buildings. Active and inactive roosts of blackbirds (e.g., starlings, grackles, red-winged blackbirds, and cowbirds) have been found heavily contaminated by

*H. capsulatum*.<sup>19,24-36</sup> Therefore, the soil in a stand of trees where blackbirds have roosted for 3 or more years should be suspected of being contaminated by the fungus.<sup>28,37</sup> Habitats of pigeons<sup>24-26, 38-40</sup> and bats,<sup>24, 41-56</sup> and poultry houses with dirt floors<sup>24, 57-62</sup> have also been found contaminated by *H. capsulatum*.

On the other hand, fresh bird droppings on surfaces such as sidewalks and windowsills have not been shown to present a health risk for histoplasmosis because birds themselves do not appear to be infected by

*H. capsulatum*.<sup>19,63</sup> Rather, bird manure is primarily a nutrient source for the growth of

*H. capsulatum* already present in soil.<sup>16</sup> Unlike birds, bats can become infected with *H. capsulatum* and consequently can excrete the organism in their droppings.<sup>16,46,49,64</sup>

To learn whether soil or droppings are contaminated with

*H. capsulatum* spores, samples must be collected and cultured. The culturing process involves inoculating mice with small portions of a sample, sacrificing the mice after 4 weeks, and streaking agar plates with portions of each mouse's liver and spleen.<sup>24</sup> Then for four more weeks, the plates are watched for the growth of

*H. capsulatum*. Enough samples must be collected so that small but highly contaminated areas are not overlooked. On several occasions, *H. capsulatum* has not been recovered from any of the samples collected from material believed responsible for causing illness in people diagnosed from the results of clinical tests as having histoplasmosis.<sup>25,26,45,58,65-67</sup>

Until a less expensive and more rapid method is available, testing field samples for *H. capsulatum* will be impractical in most situations. Consequently, when thorough testing is not done, the safest approach is to assume that the soil in regions where *H. capsulatum* is endemic and any accumulations of bat droppings or bird manure are contaminated with *H. capsulatum* and to take appropriate exposure precautions.

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### Who can get histoplasmosis and what jobs and activities put people at risk for exposure to *H. capsulatum* spores?

Anyone working at a job or present near activities where material contaminated with *H. capsulatum* becomes airborne can develop histoplasmosis if enough spores are inhaled. After an exposure, how ill a person becomes varies greatly and most likely depends on the number of spores inhaled and a person's age and susceptibility to the disease. The number of inhaled spores needed to cause disease is unknown. Infants, young children, and older persons, in particular those with chronic lung disease, are at increased risk for developing symptomatic histoplasmosis.<sup>7,68</sup>

The U.S. Public Health Service (USPHS) and the Infectious Diseases Society of America (IDSA) have jointly published guidelines for the prevention of opportunistic infections in persons infected with the human immunodeficiency virus (HIV).<sup>69,70</sup> The USPHS/IDSA Prevention of Opportunistic Infections Working Group recommended that HIV-infected persons "should avoid activities known to be associated with increased risk (e.g., cleaning chicken coops, disturbing soil beneath bird-roosting sites, and exploring caves)."<sup>70</sup> HIV-infected persons should consult their health care provider about appropriate exposure precautions that should be taken for any activity with a risk of exposure to *H. capsulatum*.

Below is a partial list of occupations and hobbies with risks for exposure to *H. capsulatum* spores. Appropriate exposure precautions should be taken by these people and others whenever contaminated soil, bat droppings, or bird manure are disturbed.

- Bridge inspector or painter<sup>47,56,67</sup>
- Chimney cleaner<sup>50</sup>
- Construction worker<sup>5,41,42,51,66,71</sup>
- Demolition worker<sup>3,41,57</sup>
- Farmer<sup>3,5,58-61,67</sup>
- Gardener<sup>3,62,72</sup>
- Heating and air-conditioning system installer or service person<sup>4,45</sup>

- Microbiology laboratory worker [13,39,48,67](#)
- Pest control worker
- Restorer of historic or abandoned buildings [45,48](#)
- Roofer [38](#)
- Spelunker (cave explorer) [43,44,52-55](#)

If someone who engages in these activities develops flu-like symptoms days or even weeks after disturbing material that might be contaminated with *H. capsulatum*, and the illness worsens rather than subsides after a few days, medical care should be sought and the health care provider informed about the exposure.

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### Should workers who might be exposed to *H. capsulatum* have pre-exposure skin or blood tests?

Workers at risk of exposure to *H. capsulatum* may learn useful information from a histoplasmin skin test. The results of skin testing would inform each worker of his or her status regarding either susceptibility to infection by *H. capsulatum* (a negative skin test) or partial protection against ill effects if reinfected (a positive skin test). However, a false-negative skin test result can be reported early in an infection or with persons with weakened immune systems. [2,4,7,15,19](#) A false-positive skin test can result from cross-reactions with antigens of certain other pathogenic fungi. [4,23](#) One drawback to routine pre-exposure skin testing is that a person with a positive skin test might incorrectly assume a false sense of security that he or she is completely protected against ill effects if reinfected. The work practices and personal protective equipment described in this booklet are expected to protect both skin-test positive and skin-test negative persons from excessive inhalation exposures to materials that might be contaminated with *H. capsulatum*.

Although a pre-exposure serum sample could be useful in determining whether a worker's post-exposure illness is histoplasmosis, routine collection and storage of serum specimens from workers is unnecessary and impractical in most work settings. Some employers, such as public health agencies and microbiology laboratories, have facilities for long-term storage of serum and do collect pre-exposure serum specimens from those employees who might be exposed to high-risk infectious agents. If a worker is to have blood drawn for this purpose and is to receive a histoplasmin skin test, the blood sample should be drawn first because the skin test may cause a positive complement-fixation test for up to 3 months and the appearance of the M band on an immunodiffusion test for

*H. capsulatum* [1,3,4,15](#).

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### What can be done to reduce exposures to *H. capsulatum*

## Excluding a colony of bats or a flock of birds from a building

Although a primary focus of this booklet is how to protect the health of workers cleaning up accumulated bat or bird manure, the best work practice is to prevent the accumulation of manure in the first place. Therefore, when a colony of bats or a flock of birds is discovered roosting in a building, immediate action should be taken to exclude the intruders by sealing all entry points. Any measure that might unnecessarily harm or kill a bat or bird should be avoided.

Before excluding a colony of bats or a flock of birds from a building, attention should be given to the possibility that flightless young may be present. In the United States, this is an especially important consideration for bats from May through August.<sup>73</sup>

Ultrasonic devices and chemical repellents are ineffective for eliminating bats from a roosting area.<sup>73,74</sup> While there may be several openings in a building, bats will typically use only one or two.<sup>75</sup> Therefore, after observing the bats leaving a building on several nights, all openings except the ones used by the bats should be sealed. Because some bats are so small that they can squeeze through an opening smaller than the diameter of a dime,<sup>37</sup> even the smallest hole should be sealed. Exclusion valves – flaps made of polypropylene bird netting that allow bats to leave but not enter – should then be placed over the remaining openings.<sup>73,75</sup> If these openings are inaccessible, installing and maintaining lights in a roosting area will force bats to seek another daytime roosting site. Because of concerns for the welfare of evicted bats, constructing bat houses near former roosts has become a common practice of some pest control companies.<sup>75</sup>

In some buildings, extensive bat exclusion measures may be more successful in the late fall or winter months after a colony has migrated to a warmer habitat or to another location for hibernation. In some regions of the United States, bats may not migrate, but rather will hibernate in the same building. Consequently, any work on a building that might disturb such a colony should be delayed until spring. Disturbing bats during hibernation is likely to result in their death.

Excluding birds from a building also involves sealing entry points. Because their food source is usually nearby, birds prevented from reentering a building will often complicate an exclusion by beginning to roost on window sills and ledges of the building or others nearby. Visual deterrents (e.g., balloons, flags, lights, and replicas of hawks and owls) and noises (e.g., gun shots, alarms, gas cannons, and fireworks) may scare birds away, but generally only temporarily.<sup>76</sup>

Nontoxic, chemical bird repellents are available as liquids, aerosols, and nondrying films and pastes. Disadvantages of these antiroosting materials are that some are messy and none are permanent. Even the most effective ones require periodic reapplication. More permanent repellents include mechanical antiroosting systems consisting of angled and porcupine wires made of stainless steel. These systems may require some occasional maintenance to clear nesting material or other debris from the wires.<sup>76</sup>

Live trapping of birds to relocate them is seldom effective when traps are put in a roosting site, but this method can be effective when used in a feeding area. Shooting birds, using contact poisons, and baiting with poisoned food should be used as last resorts and should only be done by qualified pest control specialists. Using such methods to kill nuisance birds may also require a special permit.

## Posting health risk warnings

If a colony of bats or a flock birds is allowed to live in a building or a stand of trees, their manure will accumulate and create a health risk for anyone who enters the roosting area and disturbs the material. Once a roosting site has been discovered in a building, exclusion plans should be made, and the extent of contamination should be determined. When an accumulation of bat or bird manure is discovered in a building, removing the material is not always the next step. Simply leaving the material alone if it is in a location where no human activity is likely may be the best course of *action*.

Areas known or suspected of being contaminated by *H. capsulatum*, such as bird roosts, attics, or even entire buildings that contain accumulations of bat or bird manure, should be posted with signs warning of the health risk. Each sign should provide the name and telephone number of a person to be contacted if there are questions about the area. In some situations, a fence may need to be built around a property or locks put on attic doors to prevent unsuspecting or unprotected individuals from entering.

## Communicating health risks to workers

Before an activity is started that may disturb any material that might be contaminated by *H. capsulatum*, workers should be informed in writing of the personal risk factors that increase an individual's chances of developing histoplasmosis. Such a written communication should include a warning that individuals with weakened immune systems are at the greatest risk of developing severe and disseminated histoplasmosis if they become infected. These people should seek advice from their health care provider about whether they should avoid exposure to materials that might be contaminated with *H. capsulatum*. The [fact sheet](#) in the appendix is one way of conveying information about histoplasmosis; it can be distributed to workers during their hazard communication training.

## Controlling aerosolized dust when removing bat or bird manure from a building

The best way to prevent exposure to *H. capsulatum* spores is to avoid situations where material that might be contaminated can become aerosolized and subsequently inhaled. A brief inhalation exposure to highly contaminated dust may be all that is needed to cause infection and subsequent development of histoplasmosis. Therefore, work practices and dust control measures that eliminate or reduce dust generation during the removal of bat or bird manure from a building will also reduce risks of infection and subsequent development of disease. For example, instead of shoveling or sweeping dry, dusty material, carefully wetting it with a water spray can reduce the amount of dust aerosolized during an activity. Adding a surfactant or wetting agent to the water might reduce further the amount of aerosolized dust. Once the material is wetted, it can be collected in double, heavy-duty plastic bags, a 55-gallon drum, or some other secure container for immediate disposal. An alternative method is use of an industrial vacuum cleaner with a high-efficiency filter to *bag* contaminated material. Truck-mounted or trailer-mounted vacuum systems are recommended for buildings with large accumulations of bat or bird manure. These high-volume systems can remove tons of contaminated material in a short period. Using long, large-diameter hoses, such a system can also remove contaminated material located several stories above its waste hopper. This advantage eliminates the risk of dust exposure that can happen when bags tear accidentally or containers break during their transfer to the ground.

The removal of all material that might be contaminated by *H. capsulatum* from a building and immediate waste disposal will eliminate any further risk that someone might be exposed to aerosolized spores. Air sampling, surface sampling, or the use of

any other method intended to confirm that no infectious agents remain following removal of bat or bird manure is unnecessary in most cases. However, before a removal activity is considered finished, the cleaned area should be inspected visually to ensure that no residual dust or debris remains.

## Disinfecting contaminated material

Disinfectants have occasionally been used to treat contaminated soil and accumulations of bat manure when removal was impractical or as a precaution before a removal process was started.<sup>27,34-36,45,51</sup> Formaldehyde solutions are the only disinfectants proven to be effective for decontaminating soil containing *H. capsulatum*.<sup>27,34-36</sup> Because of the potentially serious health hazards associated with formaldehyde exposures, this chemical should be handled only by persons who know how to apply it safely.<sup>42</sup> If a disinfectant is applied to land known to be contaminated by *H. capsulatum*, the soil should be thoroughly saturated so that the disinfectant penetrates deeply enough to contact all the soil containing *H. capsulatum*. While *H. capsulatum* was found in a blackbird roost at a depth of more than 12 inches,<sup>77</sup> soil saturation to a depth of 6 to 8 inches will be sufficient for most disinfectant applications.<sup>24,34</sup> To ensure a disinfectant's effectiveness, soil samples should be collected before and after an application and analyzed for *H. capsulatum*. The appropriate number of samples to be collected will vary depending upon the size of the property.<sup>24,78</sup> Each sampling location should be flagged or marked in a way that will ensure that the same locations will be sampled after application of the disinfectant. A map of the treated area showing the approximate location of each sampling site will also be useful in the event flags or markings are lost. After a disinfectant's effectiveness has been documented – more than one application may be necessary – additional tests for *H. capsulatum* should be done periodically if the land remains idle.

## Disposing of waste

Any material that might be contaminated with *H. capsulatum* that is removed from a work site should be disposed of or decontaminated properly and safely and not merely moved to another area where it could still be a health hazard. Before an activity is started, the quantity of material to be removed should be estimated. (If the approximate volume of dry bat or bird manure in a building is known, the approximate weight can be calculated using a conversion factor of 40 pounds per cubic foot.) Requirements established by local and state authorities for the removal, transportation, and disposal of contaminated material should be followed. Arrangements should be made with a landfill operator concerning the quantity of material to be disposed of, the dates when the material will be delivered, and the disposal location. If local or state landfill regulations define material contaminated with *H. capsulatum* to be infectious waste, incineration or another decontamination method may also be required.

## Controlling aerosolized dust during construction, excavation, and demolition

Dusts containing *H. capsulatum* spores can be aerosolized during construction, excavation, or demolition. Once airborne, spores can be carried easily by wind currents over long distances. Such contaminated airborne dusts can cause infections not only in persons at a work site, but also in others nearby. Such activities were suggested as the causes of the three largest outbreaks of histoplasmosis ever recorded. All three outbreaks took place in Indianapolis, Indiana.<sup>14,66,68</sup> During the first outbreak, in the fall of 1978 and spring of 1979, an estimated 120,000 people were infected, and 15 people died. The second outbreak, in 1980, was similar to the first in the number of people affected. AIDS patients accounted for nearly 50% of culture-proven cases during the third outbreak, in 1988.<sup>14</sup>

Water sprays or other dust suppression techniques should be used to reduce the amount of dust aerosolized during construction, excavation, or demolition in regions where *H. capsulatum* is endemic. During windy periods or other times when typical dust suppression techniques are ineffective, earthmoving activities should be interrupted. All earthmoving equipment (e.g., bulldozers, trucks, and front-end loaders) should have cabs with air-conditioning (if available) to protect their operators. Air filters on air-conditioners should be inspected on a regular schedule and cleaned or replaced as needed. During filter cleaning or replacement of exceptionally dusty air filters, respiratory protection should be worn by the maintenance person if there is a potential for the dust to be aerosolized. Beds of all trucks carrying dirt or debris from a work site should be covered, and all trucks should pass through a wash station before leaving the site. When at a dump site, a truck operator should ensure that all individuals in the vicinity are in an area where they will not be exposed to dust aerosolized while the truck is emptied.

Water sprays and other suppression techniques may not be enough to control dust aerosolized during demolition of a building or other structure. Consequently, removal of accumulations of bird or bat manure before demolition may be necessary in some situations. Factors affecting decisions about pre-demolition removal of such accumulations include the quantity and locations of the material, the structural integrity or soundness of the building, weather conditions, proximity of the building to other buildings and structures, and whether nearby buildings are occupied by persons who may be at increased risk for developing symptomatic histoplasmosis (e.g., schools, day-care facilities, hospitals, clinics, jails, and prisons.)

City or county governments in regions where *H. capsulatum* is endemic should establish and enforce regulations concerning work practices that will control dust aerosolization at construction, excavation, and demolition sites. However, even in regions where *H. capsulatum* is not considered endemic, dust aerosolized during work activities in bird roosts has also resulted in outbreaks of histoplasmosis.<sup>26,31</sup> Consequently, regardless of whether a work site is in an endemic region, precautions should be taken at active and inactive bird roosts to prevent dust aerosolization.

## Wearing personal protective equipment

Because work practices and dust control measures to reduce worker exposures to *H. capsulatum* have not been fully evaluated, using personal protective equipment is still necessary during some activities. During removal of an accumulation of bat or bird manure from an enclosed area such as an attic, dust control measures should be used, but wearing a NIOSH-approved respirator and other items of personal protective equipment is also recommended to reduce further the risk of *H. capsulatum* exposure.

For some jobs involving exposures to airborne dusts, working conditions have changed little over the years despite improvements in other aspects of the industry. For example, inhalation of dust aerosolized from the dirt floors of chicken coops that contained *H. capsulatum* spores was reported more than 30 years ago as the cause of clinical cases of histoplasmosis in workers.<sup>57-61</sup> As the poultry industry has grown (there are now approximately 120,000 poultry farms in the United States<sup>79</sup>), the old-style chicken coop has been replaced by larger housing facilities. However, the floors of poultry houses are still dirt covered and provide an excellent medium for the growth of *H. capsulatum*. Ventilation systems in poultry houses are not primarily intended to reduce poultry workers' exposures to aerosolized dust, and dust measurements made during growing and catching chickens show that inhalation exposures of poultry workers to dust can be excessive.<sup>80</sup> Since ventilation systems designed especially to reduce airborne dust to "safe" levels in poultry houses would likely be economically and mechanically impractical, wearing a respirator is probably the most feasible method for protecting poultry workers.

Recommendations for selecting respirators to protect workers against inhalation exposures to airborne dust and *H. capsulatum* are described next. Following that, recommendations for personal protective equipment other than respirators are provided.

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## What are the advantages and disadvantages of various kinds of respirators for protecting workers against exposure to *H. capsulatum*

### Assigned protection factors

Respirators provide varying levels of protection, and people have developed histoplasmosis after disturbing material contaminated with *H. capsulatum* despite wearing respirators that they assumed would protect them.<sup>55,81</sup> Such unfortunate events demonstrate that when a respirator is needed, it must be carefully selected with an understanding of the circumstances associated with exposure to an airborne contaminant and the capabilities and limitations of the various kinds of respirators.

Because respirators provide different levels of protection, they are divided into classes, and each respirator class has been assigned a protection factor to help compare its protective capabilities with other respirator classes. An assigned protection factor is a unitless number determined statistically from a set of experimental or workplace data. This factor is the minimum level of protection expected for a substantial proportion (usually 95%) of properly fitted and trained respirator users.<sup>82</sup> When the effectiveness of a respirator is evaluated in

a workplace, a protection factor is calculated for each respirator wearer and respirator combination by dividing the air concentration of a challenge agent by the air concentration of that agent inside the respirator wearer's facepiece, hood, or helmet. For example, if air sampling measurements show equal concentrations of a contaminant inside and outside a respirator wearer's facepiece, then the respirator provided no protection, and a protection factor of 1 would be calculated. Likewise, a protection factor of 5 means that a respirator wearer was exposed to one-fifth (20%) of the air concentration to which he or she would have been exposed if a respirator had not been used, a reduction of 80%. Similarly, a protection factor of 10 represents a one-tenth (10%) exposure (a 90% reduction), 50 represents a one-fiftieth (2%) exposure (a 98% reduction), and so on.

The assigned protection factors of respirators available for protecting workers against exposures to airborne materials contaminated with

*H. capsulatum* range from 5 to 10,000.<sup>83</sup>

Most disposable respirators represent the low end of the protection-factor scale. Self-contained breathing apparatuses operated in the pressure-demand mode, like those worn by firefighters, represent the high end. Within this range is a variety of negative-pressure, powered air-purifying, and supplied-air respirators that are available with half-facepiece, full facepiece, loose-fitting facepiece, hood, or helmet. Later in this section, the advantages and disadvantages of these various respirators are described.

## Respirator selection

Before the specific types of respirators are described, it is important to understand the information that is usually needed to select a respirator for a particular activity. First, air concentration estimates of a contaminant measured during a work activity should be compared with the contaminant's occupational exposure limits. When these air concentrations are available, a minimum level of respiratory protection is calculated by dividing the highest exposure measurement of a contaminant by its most protective exposure limit. A respirator from the respirator class having an assigned protection factor equal to or exceeding the minimum level of protection should be chosen. For example, assume a set of air samples collected during a particular job resulted in exposure estimates ranging from 8 to 50 milligrams per cubic meter ( $\text{mg}/\text{m}^3$ ) of sampled air for a contaminant having occupational exposure limits of 5  $\text{mg}/\text{m}^3$  and 10  $\text{mg}/\text{m}^3$ . Given this information, a respirator with an assigned protection factor of at least 10 ( $50 \text{ mg}/\text{m}^3 \div 5 \text{ mg}/\text{m}^3 = 10$ ) should be selected.

Unfortunately, published air sampling data on

*H. capsulatum* spores are either outdated or

too limited,<sup>52-54,60,64,84,85</sup> and no numerical exposure limit exists for

*H. capsulatum*. For these reasons, selecting a respirator to protect against these spores is based, first, on the characteristics of jobs and activities known to involve risks for exposure to materials that might be contaminated by *H. capsulatum*

and second, on knowledge of and experience with the performance, advantages, and disadvantages of various respirators as they were used in other work environments. Such information should be sufficient for most situations where respirators are needed to protect workers against aerosolized

*H. capsulatum* spores. Respirators are described in order of increasing assigned protection factors. The assigned protection factors listed here are from Table 1 of the NIOSH Respirator Decision Logic.<sup>83</sup>

Regardless of which respirator is selected, the device should be NIOSH-certified and used in the context of a respiratory protection program. Important components of such a program are facepiece fit testing, respirator

maintenance, user training, medical evaluation of users, respiratory protection program evaluation, and recordkeeping. [86,87](#)

### Disposable and elastomeric, half-facepiece, air-purifying respirators (assigned protection factor: 5–10)



A half-facepiece respirator covers the wearer's nose and mouth. Because inhalation creates a slight negative pressure inside the facepiece of non-powered, air-purifying respirators with respect to outside, these respirators are also called negative-pressure respirators. During inhalation, contaminated air can easily enter the facepiece of a negative-pressure respirator at gaps between the facepiece and the respirator wearer's face. Therefore, a complete face-to-facepiece seal is essential for good protection. Getting a seal at the nose is difficult for some people, and it is probably the most frequent location of leaks. Facial hair (even the stubble of a few days' growth), absence of one or both dentures, and deep facial scars can also prevent a complete seal.

Whereas elastomeric half-facepiece respirators consist of a reusable elastomeric or rubber facepiece and replaceable filters, most disposable respirators are filtering facepieces in which the facepiece is the dust filter. Disposable respirators and replaceable filters can be used until they are difficult to breathe through, damaged, or malodorous.

A disadvantage of any negative-pressure, air-purifying respirator is that resistance to inhalation increases as the filters load with dust. For disposable respirators without exhalation valves, filter loading increases resistance during exhalation as well as inhalation. This effect, combined with the warm, moist air inside the facepiece, is so uncomfortable for some people that they do not wear a respirator as frequently as they should, or they stop wearing one entirely.

When selecting air-purifying respirators (either negative-pressure or powered air-purifying), the particulate filters selected for these devices should be high-efficiency or equivalent. As of July 10, 1995, NIOSH began certification of negative-pressure, air-purifying particulate filters under new regulations (42 CFR Part 84). [88](#) After July 10, 1998, all particulate-filtering respirators certified by NIOSH under previous regulations (30 CFR Part 11) will no longer be sold, and only Part 84 particulate respirators will be available. Until July 10, 1998, both Part 11 and Part 84 respirators can be used. Part 11 particulate respirators (disposable and elastomeric half-facepiece respirators) have NIOSH approval numbers with the prefix TC-21C; Part 84 particulate respirators have the prefix TC-84A. NIOSH-approved respirators with chemical cartridges for protecting against vapor exposures have the prefix TC-23C. Part 84 particulate filters are divided into nine classes, and filters from any class can be selected for protection against inhalation of spores.

The type of head straps on the various disposable and elastomeric half-facepiece respirators is an important but frequently overlooked consideration. Head strap tension is important for achieving a complete face-to-facepiece seal without sacrificing comfort. Elastomeric facepieces have adjustable straps, which should allow a respirator wearer to make a complete, yet comfortable, facepiece seal. On the other hand, not all disposable respirators have adjustable straps; some simply have fixed-length elastic bands. Most dust,

fume, and mist and high-efficiency disposable respirators certified under Part 11 have adjustable straps, but most dust and mist disposable respirators certified under Part 11, and most disposable respirators certified under Part 84, do not have adjustable straps, only elastic bands. Research has not been done to evaluate whether the facepiece fits of respirators with adjustable straps differ significantly from those of respirators with elastic bands. However, a respirator user should be aware that the fit and comfort of a disposable respirator with elastic bands might differ from one with adjustable straps.

In dusty conditions, repeated exposure of the eyes to dust increases the risk for injury and disease. Most dust particles entering a person's eyes will be washed out by tears, but some particles can be retained, particularly within the margin of the upper eyelid. Depending on their size, shape, and composition, these particles can become embedded in the surface of the cornea or sclera, where they cause irritation and then reddening of the surface. If not removed, such particles may produce an ulcer and infection.<sup>89</sup> Therefore, a half-facepiece respirator is a poor choice for use in dusty conditions. While wearing eyecup goggles may provide some eye protection, they are not airtight and do not completely prevent dust exposure. Furthermore, goggles may interfere with a respirator's fit. For these reasons, a full-facepiece respirator is a better alternative when a person's eyes are at risk of exposure to airborne dusts.

Because their assigned protection factors are lower than those of other respirator types, the use of disposable or elastomeric half-facepiece respirators should be limited to situations where risks are low for inhaling material that might be contaminated with *H. capsulatum* spores. Situations that could be considered low risk include site surveys of bird roosts, collecting soil samples, or maintenance on filters of earthmoving equipment. However, during earthmoving activities at bird roosts or other work sites where the soil is known to be heavily contaminated by *H. capsulatum*, air-purifying, half-facepiece respirators should be worn by equipment operators to supplement dust suppression methods and the use of equipment with cabs.

**Powered air-purifying respirators with hood, helmet, or loose-fitting facepiece and continuous-flow, supplied-air respirators with hood or helmet(assigned protection factor: 25)**

A powered air-purifying respirator uses a small battery-operated blower to draw dusty air through attached filters and provides clean air at a constant flow rate of 170 liters per minute (L/min). This flow rate is usually greater than a wearer's breathing rate. Consequently, gaps in a face-to-facepiece seal will leak air outward rather than inward. Another advantage of these respirators is that hoods, helmets, and loose-fitting facepieces provide built-in eye protection. They are also the only respirators that adequately protect bearded workers. Because powered air-purifying respirators cause almost no breathing resistance, the discomfort that some people experience while wearing a negative-pressure respirator is reduced. Interviews with 117 agricultural workers (53 swine farmers, 46 grain handlers, and 18 poultry farmers), found that powered air-purifying respirators with loose-fitting helmets were rated best over disposable and elastomeric half-facepiece respirators for breathing ease, communication ease, skin comfort, and in-facepiece temperature and humidity.<sup>90</sup> Disposable respirators were rated best for weight and convenience.

Powered air-purifying respirators approved by NIOSH under 30 CFR Part 11 for protection against airborne particulate exposures have the prefix TC-21C. The three categories of TC-21C filters are dust and mist; dust, fume, and mist; and high efficiency. Powered air-purifying respirators with particulate filters approved by NIOSH under the regulations of 42 CFR Part 84 have the prefix TC-84A. Only powered air-purifying respirators with high-efficiency filters are approved by NIOSH under Part 84.

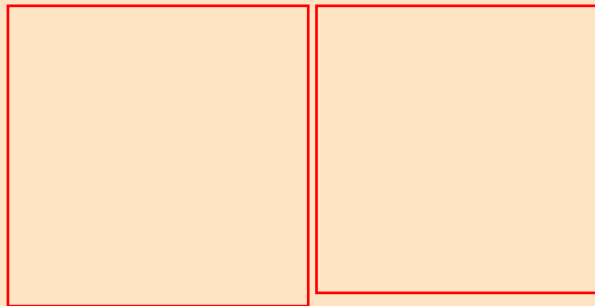
Supplied-air respirators are not air-purifying types, but deliver breathing air

from an air compressor or compressed air cylinder through a pressurized hose to the facepiece, hood, or helmet. Continuous-flow, supplied-air respirators with hoods, helmets, or loose-fitting facepieces also provide a minimum air flow rate of 170 L/min. The maximum air flow rate of a continuous-flow supplied-air respirator may not exceed 425 L/min. Air supply hoses are available in a variety of lengths up to a maximum of 300 feet. All NIOSH-approved, supplied-air respirators have the prefix TC-19C.

An advantage of a supplied-air respirator is that the source of the breathing air does not depend upon filters to purify ambient air. An advantage of continuous-flow, supplied-air respirators is that when an activity involves work in a hot environment, such as an attic or a chicken house in the summer, a vortex tube can be added to the device that will cool the air flowing to the respirator wearer. A disadvantage of a supplied-air respirator is that if its air supply hose is too short, then mobility of the respirator wearer will be restricted. Also, in some situations (in attics or on elevated structures for example), the trailing hose of a supplied-air respirator can be a tripping hazard.

While the respirators described in this section have higher assigned protection factors than disposable or elastomeric half-facepiece respirators, they may not provide enough protection in extremely dusty conditions where air concentrations of *H. capsulatum* spores may be high, especially in enclosed spaces. Examples of activities for which respirators with higher assigned protection factors may be more important include cleaning chimneys<sup>50</sup> and working in attics<sup>42,45,51</sup> and poultry houses.<sup>58-61</sup>

**Air-purifying, full-facepiece respirators; powered air-purifying respirators with half-facepiece or full facepiece; and continuous-flow, supplied-air respirators with half-facepiece or full facepiece (assigned protection factor: 50)**



A full-facepiece respirator extends from the forehead to under the chin. It also has the built-in benefit of providing eye protection as well as respiratory protection. As with other negative-pressure respirators, a complete face-to-facepiece seal is essential for good protection. However, partly because a good fit is easier with a full-facepiece, negative-pressure respirator, this type has a higher assigned protection factor than half-facepiece types. Fogging of a full-facepiece lens can obstruct vision, but this problem is preventable by adding a noseclip inside the facepiece. Antifogging agents in sticks and sprays are also available, but vary in their effectiveness. Most respirator manufacturers sell, but seldom advertise, packages of thin plastic covers for protecting the lens of a full-facepiece respirator. Available at a minimum charge, these replaceable covers prevent scratching of the permanent lens and prolong its life. NIOSH-approved, air-purifying, full-facepiece respirators for protection against particulate exposures have either the prefix TC-21C or the prefix TC-84A.

The minimum air flow rate for both a powered air-purifying respirator and a continuous-flow, supplied-air respirator with a half-facepiece or full facepiece is 115 L/min. As with other continuous-flow, supplied-air respirators, the maximum air flow for these devices may not exceed 425 L/min. An air flow of 115 L/min is probably sufficient for most work activities involving possible exposures to aerosolized *H. capsulatum* spores. However, breathing rates during activities requiring heavy exertion may produce peak inhalation air flows exceeding 115 L/min. Consequently, someone

doing heavy work could intermittently overbreathe the respirator's air flow, resulting in brief periods when contaminated air could enter the facepiece at gaps in the face-to-facepiece seal.

The full-facepiece respirators described in this section are recommended as the minimum respiratory protection in extremely dusty conditions where high concentrations of *H. capsulatum* spores could be aerosolized, especially in enclosed areas. Air-purifying, full-facepiece respirators have been recommended for poultry workers based on the results of air sampling during chicken-catching activities inside poultry houses.<sup>80</sup> As mentioned earlier, half-facepiece respirators provide no eye protection, and even the concurrent use of eyecup goggles is probably impractical in extremely dusty working conditions. Unless the results of quantitative tests suggest that a person wearing an air-purifying, full-facepiece respirator can achieve an outstanding facepiece seal, a powered air-purifying respirator with a full facepiece should be chosen for extremely dusty work.

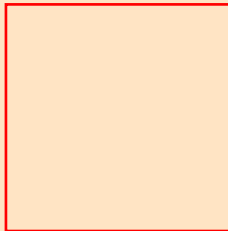
A powered air-purifying respirator with a full facepiece should also be the minimum respiratory protection worn by someone entering an enclosed area in which the amount of bat and bird manure contamination is unknown. A less protective respirator should be worn only when a site has been evaluated as having a low risk for inhalation exposure to material that might be contaminated with *H. capsulatum*.

**Pressure-demand, supplied-air respirators with full facepiece (assigned protection factor: 2,000)**



The air regulator of a pressure-demand, supplied-air respirator is designed to maintain positive facepiece pressure even during heavy physical activity. This type of respirator has the same advantages and disadvantages as other supplied-air respirators, except that a vortex tube cannot be used to cool the air delivered to the respirator wearer.

**Pressure-demand, self-contained breathing apparatuses (SCBA) and combination pressure-demand, supplied-air respirators with auxiliary SCBA (assigned protection factor: 10,000)**



Because the wearer of a self-contained breathing apparatus (SCBA) carries his or her own air supply, a pressure-demand SCBA has an advantage of allowing greater mobility than a supplied-air respirator. However, not everyone may agree that this is a significant advantage, since these devices can weigh as much as 40 pounds. Open-circuit SCBAs, like those worn by firefighters, are available with rated service lives of 15, 30, 45, and 60 minutes. Auxiliary SCBAs for combination units are available that have service lives ranging from 3 to 60 minutes. Closed-circuit SCBAs, like those worn by members of mine rescue teams, are available with rated service lives from 1 to 4 hours.

SCBAs have been recommended for use by workers in areas contaminated with

spores,<sup>78</sup> but they are too impractical for most situations where respirators are needed to protect against the inhalation of *H. capsulatum* spores. Another disadvantage, particularly during removal jobs that may take a long time, is that SCBA can be used for only 30 to 60 minutes. Thus, frequent work stoppages are needed to change air cylinders. Also, an adequate supply of full cylinders is needed at a work site.

Combination pressure-demand, supplied-air respirators with auxiliary SCBA would be useful for very dusty work environments. The auxiliary SCBA could be used to escape to an area of fresh air whenever delivery of breathing air is interrupted. All NIOSH-approved SCBA and combination SCBA and supplied-air respirators have the prefix TC-13F.

## Summary

Because of the need for mobility, most decisions concerning the appropriate respirator for protecting against inhalation exposure to material that might contain *H. capsulatum* spores will involve choosing the most appropriate air-purifying respirator. To help the reader with this decision, the following table summarizes the advantages and disadvantages of air-purifying respirators and their costs.

Air-Purifying Respirators				
Respirator type	NIOSH assigned protection factor <sup>(83)</sup>	Advantages	Disadvantages	Cost range (1997 dollars)
Disposable	5 - 10	<ul style="list-style-type: none"> <li>light weight</li> <li>no maintenance</li> <li>no effect on mobility</li> </ul>	<ul style="list-style-type: none"> <li>no eye protection</li> <li>can add to heat burden</li> <li>breathing resistance increases with use</li> <li>inward leakage at gaps in facepiece seal</li> <li>some do not have an exhalation valve</li> <li>some do not have adjustable head straps</li> </ul>	\$1 to \$10
Elastomeric half-facepiece	10	<ul style="list-style-type: none"> <li>low maintenance</li> <li>reusable facepiece</li> <li>no effect on mobility</li> <li>all have an exhalation valve</li> </ul>	<ul style="list-style-type: none"> <li>no eye protection</li> <li>can add to heat burden</li> <li>inhalation breathing resistance increases with use</li> <li>inward leakage at gaps in facepiece seal</li> </ul>	facepiece: \$10 to \$30 filters: \$4 to \$8 each
Powered with hood, helmet, or loose-fitting facepiece	25	<ul style="list-style-type: none"> <li>protection for people with beards, missing dentures, or facial scars</li> <li>eye protection</li> <li>low breathing resistance</li> <li>airflow creates cooling effect</li> <li>leakage is outward</li> </ul>	<ul style="list-style-type: none"> <li>added weight of battery and blower</li> <li>awkward for some tasks</li> </ul>	unit: \$400 to \$1000 filters: \$15 to \$40

Elastomeric full facepiece	50	<ul style="list-style-type: none"> <li>reusable facepiece</li> <li>no effect on mobility</li> <li>eye protection</li> <li>more reliable seal than disposable or elastomeric half-facepieces</li> </ul>	<ul style="list-style-type: none"> <li>can add to heat burden</li> <li>inhalation breathing resistance increases with use</li> <li>inward leakage at gaps in facepiece seal</li> <li>facepiece lens can fog without nose cup or treatment</li> </ul>	facepiece: \$90 to \$200 filters: \$4 to \$8 each nose cup: \$30
Powered with half-facepiece or full facepiece	50	<ul style="list-style-type: none"> <li>eye protection</li> <li>low breathing resistance</li> <li>facepiece leakage is outward</li> <li>airflow creates cooling effect</li> <li>full facepiece does not fog</li> </ul>	<ul style="list-style-type: none"> <li>added weight of battery and blower</li> <li>awkward for some tasks</li> <li>no eye protection with half-facepiece</li> </ul>	unit: \$400 to \$900 filters: \$15 to \$40

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### What personal protective equipment other than respirators should workers wear?

Disposable protective clothing and shoe coverings should be worn whenever regular work clothing and shoes might be contaminated with dust containing *H. capsulatum* spores.<sup>30,41,42</sup> Wearing such clothing can reduce or eliminate the likelihood of transferring spore-contaminated dust to places away from a work site, such as a car or home. When spore-contaminated material is likely to fall from overhead, workers should wear disposable protective clothing with hoods.<sup>42</sup> Workers should wear disposable shoe coverings with ridged soles made of slip-resistant material to reduce the likelihood of slipping on wet or dusty surfaces. After working in a spore-contaminated area and before removing respirators, workers should remove all protective clothing and shoe coverings and seal them in heavy-duty plastic bags to be disposed of in a landfill.<sup>91</sup>

Since the personal protective equipment described above can be more insulating than regular work clothing, sweat evaporation may be impeded during some work activities. Therefore, precautions may need to be taken to control heat stress. Workers should know the symptoms of heat-stress-related illnesses and be able to take appropriate measures to ensure that such illnesses do not occur. Some jobs may have such a significant risk of heat stress that they should be scheduled only when ambient temperatures are relatively cool.

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### What other infectious agents are health risks for workers who disturb accumulations of bat droppings or bird manure?

In addition to *H. capsulatum*, inhalation exposure to *Cryptococcus neoformans* may also be a health risk for workers in environments containing accumulations of bat droppings or bird manure. Inhalation exposures to *Chlamydia psittaci* have occurred occasionally in environments containing the manure of certain birds, and exposure to the rabies virus is a health risk for workers who must handle dead bats.

*Cryptococcus neoformans*

*C. neoformans* is the infectious agent of the fungal disease cryptococcosis. Formerly a rare disease, the incidence of cryptococcosis has increased in recent years because of its frequent occurrence in AIDS patients.<sup>69,92-95</sup> *C. neoformans* and *H. capsulatum* are only two of the more than 100 microorganisms that have been reported with increased frequency among HIV-infected persons, and cryptococcosis and histoplasmosis are both classified as AIDS-indicator opportunistic infectious diseases.<sup>69</sup> The USPHS/IDSA Prevention of Opportunistic Infections Working Group recommends that HIV-infected persons should avoid "sites that are likely to be heavily contaminated with *C. neoformans* (e.g., areas heavily contaminated with pigeon droppings)."<sup>70</sup> However, evidence is lacking that contaminated bird manure is the primary environmental source of exposure to *C. neoformans* in most cases of cryptococcosis among HIV-infected persons.<sup>94</sup> An HIV-infected person should consult his or her health care provider about the appropriate exposure precautions to be taken for any activity having a risk of exposure to *C. neoformans*.

*C. neoformans* uses the creatinine in avian feces as a nitrogen source. It gains a competitive advantage over other microorganisms and multiplies exceedingly well in dry bird manure accumulated in places that are not in direct sunlight.<sup>24,92</sup> This microorganism is commonly associated with old pigeon manure, but it has also been recovered from dried excreta of chickens, sparrows, starlings, and other birds.<sup>92</sup> As with *H. capsulatum*, *C. neoformans* has not been found in fresh bird droppings, but it has been cultured from the beaks and feet of pigeons.<sup>92</sup> Bats have been shown to be infected with *C. neoformans*,<sup>96</sup> and both *C. neoformans* and *H. capsulatum* have been recovered from bat dropping samples collected at the same site.<sup>50,51</sup> However, it should not be assumed that a worker's illness is cryptococcosis when only *C. neoformans* is recovered from environmental samples collected from suspected sources of exposure. *C. neoformans* has been recovered from environments where *H. capsulatum* was not recovered, even though sick workers were diagnosed from the results of clinical tests as having histoplasmosis.<sup>45,67</sup>

Unlike outbreaks of other mycoses, outbreaks of cryptococcosis traced to environmental sources have not been described, and it is presumed that most people can overcome most inhalation exposures to *C.*

*neoformans*.<sup>93</sup> More detailed information about *C. neoformans* and cryptococcosis is available in other reports.<sup>92,93,97,98</sup> Work practices described previously in this document for controlling exposures to *H. capsulatum*, including the use of personal protective equipment, will also protect against inhalation exposures to *C. neoformans* and other microorganisms.

*Chlamydia psittaci*

While psittacosis is caused by a bacterium (*C. psittaci*) rather than a fungus, it is another infectious disease that people can develop after disturbing and inhaling contaminated bird manure. While *C. psittaci* has been isolated from 129 avian species, most human infections result from inhalation exposures to aerosolized urine, respiratory secretions, or dried manure of infected psittacine birds (e.g., parakeets, parrots, macaws, and cockatiels).<sup>99</sup> The disease is also occasionally associated with exposures to infected pigeons, turkeys, chickens, ducks, and geese, or their manure.<sup>100-102</sup>

>From 1985 to 1995, 1,132 cases of psittacosis in humans were reported to CDC, but this number may be an underestimation because diagnosis of the disease can be difficult.<sup>99</sup> The severity of disease experienced by an infected person can range from asymptomatic to severe systemic disease with pneumonia; death occurs in less than 1% of properly treated patients.<sup>99</sup>

*Rabies*

Rabies is an infectious viral disease that can affect wild and domestic animals and humans. In the United States, wild animals (e.g., raccoons, skunks, bats, and foxes) are the most important sources of rabies infection.<sup>103,104</sup> Rabid bats have been reported from every state except Alaska and Hawaii,<sup>104,105</sup> and 17 of the 32 cases of human rabies diagnosed in the United States from 1980 to 1996 resulted from infections with bat-related rabies virus variants.<sup>106</sup>

Rabies is transmitted via an infected animal's bite or contamination of scratches, abrasions, open wounds, or mucous membranes by infectious material such as saliva.<sup>103</sup> Contact with the blood, urine, or manure of a rabid animal is not a risk factor for contracting rabies.<sup>103</sup> Consequently, workers exposed to accumulations of bat droppings in environments from which bats have been excluded have no rabies risk. Although spelunkers seldom have direct contact with bats, they are included in a frequent-risk category by CDC because of potential for exposure to the rabies virus in bat saliva aerosolized when bats squeak.<sup>103</sup> Two fatal cases of rabies in humans have been associated with probable exposure to aerosolized bat saliva in humid caves containing millions of bats.<sup>74,103</sup> In addition, a bite was documented in only one of the 17 bat-related human rabies cases in the United States since 1980, suggesting "that limited or seemingly insignificant physical contact with rabid bats may result in transmission of virus."<sup>106</sup> While aerosol transmission of the rabies virus from bats to people is theoretically possible under extraordinary conditions, the risk is otherwise negligible.

The percentage of rabid bats in any colony is probably low (0.5% or less<sup>74</sup>). However, a dead bat should still never be picked up with bare hands since its death may have been caused by an infectious agent. If a dead bat must be handled, wearing heavy work gloves should minimize the risk of disease transmission because of an accidental scratch from the bat's teeth or by contamination of existing scratches or abrasions on a worker's hands.

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**Where can I get more information about infectious diseases and answers to questions about worker health and safety issues?**

This guidance document was prepared by the National Institute for Occupational Safety and Health (NIOSH) and the National Center for Infectious Diseases (NCID), both of the Centers for Disease Control and Prevention. For more information about histoplasmosis or other infectious diseases, please contact your physician, your local health department, or NCID in Atlanta, Georgia, at (404) 639-3158. NCID's Internet address is <http://www.cdc.gov/ncidod/ncid.htm>. For more information about worker health and safety precautions during disturbances of soil, bat droppings, or bird manure that might be contaminated with *H. capsulatu* m spores, call NIOSH in Cincinnati, Ohio, at (513) 841-4374. A list of non-powered, air-purifying respirators that have been tested and approved by NIOSH under 42 CFR Part 84 regulations can be found on the [NIOSH home page](http://www.cdc.gov/niosh/), <http://www.cdc.gov/niosh/>.

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