

Bedbugs: A primer for the health-system pharmacist

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The number of bedbug infestations has risen dramatically due to increased travel and immigration and the diminishing use of and bedbug resistance to pesticides.¹ Today, bedbugs are putting locations with high occupant turnover such as hotels, hospitals, and low-income housing at risk.² The following review will highlight the life cycle and feeding habits of bedbugs; provide an overview of how to recognize, prevent, and eradicate bedbug infestations; and describe the best supportive treatment options for bedbug bites.

Background

Cimex lectularius (the “bedbug”) is a problem that has been around for many centuries. The mention of bedbugs in ancient Greek and Roman manuscripts dates back to 400 BCE.^{3,4} Specimens of bedbugs have been discovered in Egyptian tombs dating back at least 3550 years.⁵

C. lectularius, a member of the Cimicidae family, is known as the common bedbug in the United States. The tropical bedbug, *Cimex hemipterus*, is usually found in warmer climates outside of the United States, though it has been found in Florida.⁶ The two species can be

Purpose. The history and life cycle of bedbugs, the identification and supportive treatment of bedbug bites, and the eradication and prevention of bedbug infestations are reviewed.

Summary. *Cimex lectularius*, known commonly as the bedbug, is a growing problem in the United States. While the bedbug population declined between the 1950s and the late 20th century, recent increases in international travel and immigration, the banning of dichlorodiphenyltrichloroethane, and insecticide resistance have caused a resurgence of bedbug infestations. Infestations can be identified based on clinical presentation and situational indicators such as housing location and the presence of bedbug fecal smears and nests. Chronic infestation can lead to nervousness, anxiety, and insomnia arising from the inability to identify and eradicate the problem. Scratching at the bite site can lead to a secondary bacterial infection.

Because bedbugs continue to bite until the infestation is eradicated, treatment is not accomplished by one strategy alone. A team effort by different health care professionals is necessary. Because bedbugs are hardy insects, eradication can be a daunting task. Proper eradication plans should be in place at all health care facilities, and bedbug infestations should be reported to the state public health department to support the tracking and management of bedbugs.

Conclusion. Bedbug infestations are prevalent in locations with high occupant turnover, including hospitals and health systems. Bedbug bites can cause secondary infections and lead to discomfort and anxiety in affected individuals. Pharmacists should work with other health care providers to provide affected patients with supportive treatment and ensure appropriate eradication of the infestation.

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differentiated by the geographic location of the infestation. *C. lectularius* and *C. hemipterus* feed exclusively on birds and mammals, and their usual target is humans.⁶

The common bedbug is flattened dorsolaterally with an oval-shaped body (Figure 1).¹ It is a wingless insect with six legs, and adults average 4–6 mm in length.⁷ Bedbugs can

be seen even in the nymphal stages; however, a buildup of eggs and excrement is easier to identify. The color of a bedbug varies depending on the time since its most recent molting and meal. It is almost white immediately after molting, changes to a light brown, and is dark red-brown after feeding.² Immediately after a meal, the bedbug’s length can reach 8 mm

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and its weight can double, resulting in an engorged and round appearance.⁸ A long proboscis for feeding is concealed under the bedbug's head and thorax.

Life cycle

The life cycle of the bedbug includes five nymphal stages and five molts (Figure 2). The nymphs look like miniature adults and are approximately the size of a poppy seed.² All nymphs require a blood meal to molt, and the adult requires a blood meal to reproduce.¹ The entire maturation process takes six to eight weeks.¹ On average, adult bedbugs live 6–12 months; however, if the insect remains in cold conditions, its lifespan can reach up to two years.^{9,10} When a male bedbug is deprived of a blood source, his mating activity will cease after two weeks. Bedbugs can continue to live without blood for as long as 12 months.⁹ The hardiness of the bedbug is also demonstrated by its ability to survive in temperatures ranging from 7 to 45 °C.¹ The female lays approximately 200–400 eggs throughout her life, averaging 2–4 eggs per day.^{3,11} The eggs are usually laid in a dark crevice at room temperature, where they can remain hidden for the 6–10 days needed to hatch.¹

Feeding habits

Each blood meal is typically obtained during the night when bedbugs can navigate in the dark without being discovered. During the day, bedbugs can be found living in the dark cracks and crevices of walls, floors, and furniture as well as nests in mattress seams and behind loose wallpaper.³ While bedbugs normally hide in mattresses or crevices near a bed, they are able to travel to a host 20 feet away.¹ The insect is attracted to a host's body temperature and the carbon dioxide emitted from the host.^{2,12} Although bedbugs can survive up to 12 months without a blood meal, they feed for 4–10 minutes

every three to five days when living in optimal conditions.¹ Bedbugs' saliva contains physiological components to aid in blood feeding, including nitric oxide to dilate blood vessels, an anticoagulant that interferes with the coagulation cascade, and apyrase, which inhibits ADP-induced platelet aggregation.^{1,10,11}

Infestations

Although bedbugs have been a problem for centuries, the number of infestations in the United States declined between 1950 to the late 20th century due to the increased use of insecticides and better personal hygiene.¹ While the United States was experiencing a diminishing bedbug population, other countries in the world were still dealing with frequent infestations.¹³ The prevalence of bedbugs in other countries led to the resurgence of infestations in the United States around 1996, partly due to increased international travel.¹⁴ In addition, the banning of the insecticide dichlorodiphenyltrichloroethane in 1972 assisted in the bedbug's reemergence.^{2,10,15} Newer insecticides were less effective at eliminating bedbugs but more effective at eliminating its natural predators such as the cockroach and red ant.¹⁰ Due to improper eradication techniques and overuse of insecticides, some bedbugs have become resistant to common household insecticides called pyrethroids.¹⁶

Since the resurgence in the 1990s, bedbug infestations have been prevalent in locations with high occupant turnover, such as the hospitality industry, school housing, and health care facilities.¹³ Residential locations have not been immune to the bedbug resurgence. Bedbugs show no preference to a specific race, age, or economic status, making all populations vulnerable to an infestation.² While all populations are susceptible, poverty fosters infestations due to the decreased likelihood of identification and eradication in unclean conditions. In 2003, a total of 390 in-

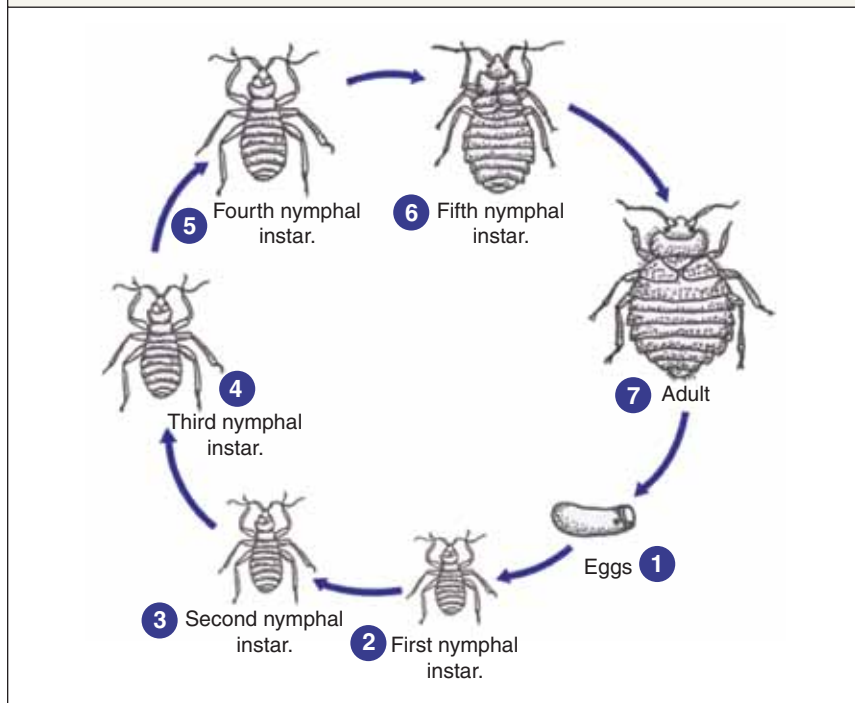
Figure 1. Photograph of the typical bedbug. Image courtesy of the Centers for Disease Control and Prevention (www.cdc.gov).



festations were reported in 33 states.⁶ Due to higher international travel rates, occurrences have been higher in densely populated cities and tourist destinations such as Florida, New York, and California.¹⁵ Because the reporting of infestations is anecdotal and not required by the World Health Organization or the Centers for Disease Control and Prevention, the number of cases is undoubtedly higher than recorded.^{2,17}

Knowledge of bedbugs among health care workers is pertinent because of the imminent risk of infestations in health care facilities such as hospitals and nursing homes. In 2009, a hospital maternity unit identified a bedbug infestation that affected patients and their families and staff members.¹⁸ Other hospital infestations have also been reported.^{19,20} The cost of an outbreak to a health care facility goes beyond money spent on supportive treatment and eradication. Fear of an outbreak in a health care facility could cause mistrust in the health care system, and patients may choose to avoid the facility. Lawsuits could be filed against infested health care facilities due to the detrimental effects to patients and their families. A social stigma commonly ensues after the discovery of bedbugs. This stigma affects both

Figure 2. The life cycle of a bedbug. Image courtesy of the Centers for Disease Control and Prevention (www.cdc.gov).



the facility and patients, causing fear in others who believe avoidance is required even after eradication. Therefore, all health care professionals should be able to recognize signs of a bedbug infestation, and an eradication plan should be in place for every health care facility.

Bedbugs as carriers of infectious disease

Bedbugs have potential to be a vector for infectious diseases. While the bedbug has not been found to be capable of transmitting infection to a human host, they have been found to be carriers of more than 40 microorganisms.^{21,22} Human immunodeficiency virus (HIV) and hepatitis B virus have been detected in bedbugs, but they have been shown to be an inefficient vector for these infections.^{1,23} The theory behind the lacking competency of the bedbug to be an HIV vector is the inability of HIV to replicate in the bedbug.¹

Bedbugs have been found to be carriers of microorganisms such as *Coxiella burnetii* and *Wolbachia* species among bacteria, *Trypanosoma cruzi* among parasites, and *Aspergillus* species among fungi; transmission of any of these microorganisms has not been discovered.¹¹

Clinical manifestations of a bedbug bite

In order to identify and eradicate bedbug infestations, it is important for health care professionals, including pharmacists, to be able to identify a bedbug bite based on a review of symptoms. The initial reaction to the bite is due to the physiological components of the bedbug saliva. Depending on the individual, the bite may elicit a response or remain asymptomatic. Symptoms typically appear one to two days after the bite.²⁴ Bite lesions typically appear as pruritic, erythematous papules on areas uncovered by clothing, commonly

the face, neck, and extremities.^{1,12} A small hemorrhagic punctum may be visualized at the center of the lesion, indicating the exact location of the bite. In some individuals, the bite can result in an allergic reaction from the development of immunoglobulin G antibodies to the components of bedbug saliva. Wheals, which are most prominent in the morning, are a type 1 hypersensitivity reaction and can reach 20 cm in diameter.^{6,10} Although rare, anaphylactic reactions to bedbug bites have been reported.¹⁰ It should be noted that multiple bites commonly appear in linear groups of three to represent the different feedings of the bedbug (Figure 3).^{1,6} The diagnosis of bedbug bites is confirmed by a physical examination as well as a history of exposure.⁶ Flecks of blood may be present on a patient's skin, and bedbug fecal smears may be found on bed linens.³ Fecal smears are rust-colored or black and can be found as several spots clustered together.¹³ When wiped with a wet rag, the feces will smear. If the bedbug infestation is severe, the room may contain a sweet pungent odor.¹ While bedbug bites may look similar to other insect bites, it is important to closely assess the clinical presentation, especially the presence of a reaction in the morning and linear groups of three bites, to identify the bedbug as the culprit.

In a situation where bedbugs are not identified and eradicated, chronic infestation can lead to additional problems. Vigorous scratching of the bites may lead to a secondary skin infection such as scabies, impetigo, ecthyma, or ectopic dermatitis.¹⁰ Repeated bites may leave welts and can cause hyperpigmentation due to inflammation at the site of the bites. Chronic infestation can cause psychiatric symptoms such as nervousness, anxiety, and insomnia due to the inability to identify the cause of symptoms.¹⁴ Repeated blood loss can result in pallor and eventual iron deficiency in infants and children.²⁵

Supportive treatment

Pharmacists can collaborate with other health care professionals when treating patients by identifying bedbug bites based on their clinical presentation and providing recommendations for proper pharmacotherapy. Simple supportive treatment can reduce bite-site inflammation, erythema, and pruritus in as little as two days; the symptoms of bites may last for two weeks without such treatment.⁶

Inflammation around a bite can be treated with low-potency topical corticosteroids such as triamcinolone or desonide creams due to their vasoconstrictive effect.^{1,2} Low-potency topical corticosteroids such as hydrocortisone acetate 0.1% and dexamethasone 0.01% creams can be applied to sensitive areas, including the face. Higher-potency topical corticosteroids including hydrocortisone butyrate 0.1% and beclomethasone 0.025% creams can be used to treat more severe reactions for a limited amount of time.² Topical corticosteroids should be avoided if the affected skin is broken due to pruritus. Products with higher water content such as lotions can be used for intertriginous areas to lessen the risk of secondary fungal infection. When using a topical corticosteroid, it is important to counsel patients to apply only a thin layer, massage the product into the skin, refrain from applying an occlusive dressing to the skin, and avoid use longer than two weeks to prevent systemic absorption of the corticosteroid.²

If the bite is pruritic or if the patient develops an allergic reaction to the bedbug bite, oral antihistamines can be used to antagonize capillary permeability and lessen itching.⁸ Second-generation antihistamines such as loratadine, fexofenadine, and cetirizine are preferred agents during the day because they are administered once daily and their risk of causing drowsiness or dizziness is lower than that of first-generation

Figure 3. The typical linear three-bite pattern of bedbugs (right). Allergic reactions to bedbug saliva (left) can lead to wheals up to 20 cm in diameter. Image courtesy of the Centers for Disease Control and Prevention (www.cdc.gov).



antihistamines. A patient can be advised to use a first-generation antihistamine such as diphenhydramine or dimenhydrinate if he or she experiences insomnia due to the infestation. Antihistamines can be especially useful if topical corticosteroids cannot be used due to broken skin. If the pruritus does not respond to antihistamines, medications including topical pramoxine or doxepin (administered orally) can be used.⁸ To prevent a secondary bacterial infection, patients should be advised to avoid bite-site scratching and to use proper hygiene. Topical antibiotics and antiseptics (e.g., creams containing sulfacetamide, erythromycin, bacitracin, neomycin, or pramoxine) can be used to further prevent a secondary infection.¹

Prevention of infestation

If there is a possibility of a bedbug infestation, preventive measures can be taken. Individuals can wear clothing that covers a majority of the body, leaving a minimal amount of skin exposed.¹ Because nymphs cannot mature without feeding and bedbugs are unable to pierce clothing, covering most of the body with

clothing helps to reduce the bedbug population. Wooden bedposts can be switched with metal posts to minimize the number of crevices that bedbugs can inhabit. In addition, the bedposts can be lubricated with petroleum jelly to prevent the bedbugs from climbing to the mattress.¹ Frequent cleaning with a vacuum that uses a high-efficiency particulate air (HEPA) filter can help eradicate nymphs and adults. The mattress, crevices, and headboard also should be inspected for fecal and blood spots.

Eradication of infestation

The eradication of bedbugs requires an integrated process, including prevention, cleaning, chemical treatments, and follow-up. It is not advisable to use commercial insecticides alone to eliminate an infestation.¹⁶ Most commercial insecticides contain pyrethroids or pyrethrins. Although these insecticides have the ability to kill bedbugs, improper technique can lead to dispersion and a more-difficult eradication process in the future. In addition, the overuse of insecticides can lead to pyrethroid resistance among bedbugs.¹⁶

If an infestation occurs in a health care facility, eradication is imperative in order to minimize the effect of a bedbug infestation. The room should be immediately isolated to prevent the infestation from spreading to other areas within the facility.²⁴ Equipment and medical supplies in the infested room should be bagged and marked as contaminated.²⁴ Bedbugs are able to live for one year without feeding; therefore, the contents of the bags must be individually decontaminated to ensure eradication. Because bedbugs cannot tolerate temperatures above 45 °C, the equipment and the contaminated room can be heated to 60 °C using infrared heaters to properly eradicate the pests.² Bed linens should be removed and washed at a temperature of 60 °C followed by at least 20 minutes of low-heat drying.¹ The furniture in the room should be cleaned with a vacuum that uses a HEPA filter. It should be noted, however, that vacuuming alone does not eradicate bedbug eggs.¹ Therefore, it may be optimal to contact a professional exterminator to ensure the eradication of both adult bedbugs and their eggs. Since bedbugs also prey on other mammals and birds if a human source of blood is not available, neighboring bird and bat habitats should be eliminated to prevent reinfestation.^{10,26} A follow-up inspection should be conducted within 10–21 days, allowing ample time for eggs to hatch if eradication was flawed.¹ Infestations should be reported to the local health department to help facilitate the tracking and management of bedbugs.

Conclusion

Bedbug infestations are prevalent in locations with high occupant turnover, including hospitals and health systems. Bedbug bites can cause secondary infections and lead to discomfort and anxiety in affected individuals. Pharmacists should work with other health care providers to provide affected patients with supportive treatment and ensure appropriate eradication of the infestation.

References

- Kolb A, Needham GR, Neyman KM et al. Bedbugs. *Dermatol Ther*. 2009; 22:347-52.
- Sutton D, Thomas DJ. Don't let the bedbugs bite. *Nurse Pract*. 2008; 38:24.
- Anderson AL, Leffler K. Bedbug infestations in the news: a picture of an emerging public health problem in the United States. *J Environ Health*. 2008; 70:24-7,52-3.
- Hartnack H. Unbidden house guests. Tacoma, WA: Hartnack; 1943.
- Usinger RL. Monograph of Cimicidae (Hemiptera, Heteroptera). College Park, MD: Entomological Society of America; 1966.
- Cleary CJ, Buchanan D. Diagnosis and management of bedbugs: an emerging U.S. infestation. *Nurse Pract*. 2004; 29:46-8.
- Steen CJ, Carbonaro PA, Schwartz RA. Arthropods in dermatology. *J Am Acad Dermatol*. 2004; 50:819-42.
- Goddard J, DeShazo R. Bed bugs (*Cimex lectularius*) and clinical consequences of their bites. *J Am Med Assoc*. 2009; 301:1358-66.
- Siljander E, Gries R, Khaskin G et al. Identification of the airborne aggregation pheromone of the common bed bug, *Cimex lectularius*. *J Chem Ecol*. 2008; 34:708-18.
- Ter Poorten MC, Prose NS. The return of the common bedbug. *Pediatr Dermatol*. 2005; 22:183-7.
- Delaunay P, Blanc V, Del Giudice P et al. Bedbugs and infectious diseases. *Clin Infect Dis*. 2011; 52:200-10.
- Stucki A, Ludwig R. Images in clinical medicine: bedbug bites. *N Engl J Med*. 2008; 359:1047.
- Chalupka S. Preventing bedbug infestation. *AAOHN J*. 2010; 58:500.
- Eddy C, Jones SC. Bed bugs, public health, and social justice: part I: a call to action. *J Environ Health*. 2011; 73:8-14.
- Benac N. Bedbug bites becoming bigger battle. *Can Med Assoc J*. 2010; 182:1606.
- Romero A, Potter MF, Potter DA et al. Insecticide resistance in the bed bug: a factor in the pest's sudden resurgence? *J Med Entomol*. 2007; 44:175-8.
- Anderson A. The decade of bedbugs and fear. *Environ Health Insights*. 2011; 5:53-4.
- Adeyeye A, Adams A, Herring L et al. Bed bug infestation on a maternity unit in a tertiary care center. <http://shea.confex.com/shea/2010/webprogram/Paper2453.html>.00 (accessed 2012 Sep 20).
- Conneen M. Bed bugs found at D.C. hospital. www.wjla.com/articles/2011/05/bed-bugs-found-at-d-c-hospital-61261.html (accessed 2012 Sep 20).
- Wainscott K. Bedbugs reported at Milwaukee hospitals. www.batzner.com/docs/In-The-News/bed_bugs_in_hospitals.pdf (accessed 2012 Sep 20).
- Burton GJ. Bedbugs in relation to transmission of human diseases. Review of the literature. *Pub Health Rep*. 1963; 78:513-24.
- Lowe CF, Romney MG. Bedbugs as vectors for drug-resistant bacteria. *Emerg Infect Dis*. 2011; 17:1132-4.
- Silverman AL, Qu LH, Blow J et al. Assessment of hepatitis B virus DNA and hepatitis C virus RNA in the common bedbug (*Cimex lectularius* L.) and kissing bug (*Rodnius prolixus*). *Am J Gastroenterol*. 2001; 96:2194-8.
- Leininger-Hogan S. Bedbugs in the intensive care unit. A risk you cannot afford. *Crit Care Nurs Q*. 2011; 34:150-3.
- Venkatachalam PS, Belavady B. Loss of haemoglobin iron due to excessive biting by bed bugs. A possible aetiological factor in the iron deficiency anaemia of infants and children. *Trans R Soc Trop Med Hyg*. 1962; 56:218-21.
- Lefferts A, Parkhill A, Cadigan D et al. Community health nurses battle an ancient nuisance. *Home Healthc Nurse*. 2009; 27:598-606.

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