

Bedbug Infestation

JAMES S. STUDDIFORD, MD, *Thomas Jefferson University Hospital, Philadelphia, Pennsylvania*

KATHRYN M. CONNIFF, MD, *University of Maryland School of Medicine, Baltimore, Maryland*

KATHRYN P. TRAYES, MD, *Thomas Jefferson University Hospital, Philadelphia, Pennsylvania*

AMBER S. TULLY, MD, *Cleveland Clinic, Rocky River, Ohio*

The significant resurgence of bedbugs in the past decade has been attributed to pesticide resistance, more frequent travel, lack of public awareness, and inadequate pest control programs. Bedbugs are obligate blood parasites (insect family Cimicidae). They can withstand a large range of temperatures but are attracted to warmth and carbon dioxide. They typically feed just before dawn. Cutaneous reactions to bedbug bites can include macules, papules, wheals, vesicles, bullae, and nodules. Bites may be confused with other skin conditions. Bedbug bite reactions are typically self-limited and resolve within one to two weeks without treatment. Bedbug infestation may cause significant psychological distress. The diagnosis of a bedbug infestation is based on history, appearance of bites, and inspection of sleeping quarters. Although there is no evidence that bedbugs transmit disease, systemic reactions may include asthma, angioedema, generalized urticaria, iron deficiency anemia, and, rarely, anaphylaxis. An integrated pest management strategy should be employed to eliminate infestation. Tactics include vacuuming, heat or cold treatment, trapping devices, and pesticides. (*Am Fam Physician*. 2012;86(7):653-658. Copyright © 2012 American Academy of Family Physicians.)

► **Patient information:**
A handout on this topic is available at <http://familydoctor.org/familydoctor/en/diseases-conditions/bedbugs.html>.

Infestations with bedbugs date back to ancient Egypt.¹ The incidence of bedbugs in developed countries decreased in the 1940s because of the availability of more effective pesticides (especially DDT) and improved economic and social conditions.² In the past decade, however, a significant resurgence of bedbug populations has occurred. This is attributed to a combination of factors, including increased pesticide resistance, more frequent travel, lack of public awareness, and inadequate pest control programs.³ In a 2010 survey, 95 percent of more than 500 U.S. pest management companies reported encountering a bedbug infestation during the preceding year, compared with only 25 percent of companies during 2000.⁴ Bedbugs spread actively by migrating from one infested room to another, often through ventilation ducts. They also spread passively, carried in the seams of travelers' luggage, bedding, or furniture.⁵ Bedbugs do not travel directly on human hosts.⁶

Biology and Habitat

Bedbugs are obligate blood parasites that belong to the insect family Cimicidae.

Cimex lectularius and *Cimex hemipterus*, the two bedbug species that feed primarily on humans, are oval, reddish-brown, flat, and wingless. Adults are typically 4 to 7 mm in length (*Figure 1*). Nymphs can be as small as 1 mm, and are translucent and lighter in color^{5,7} (*Figure 2*). Adult females produce 200 to 500 eggs in a typical six- to 12-month life span.^{5,8} Bedbugs can withstand temperatures from 44.6°F to 113°F (7°C to 45°C).⁸

To avoid light, bedbugs hide in the seams of mattresses and crevices of bed frames, walls, and furniture during the day.^{5,7} They are attracted to human hosts by warmth and carbon dioxide; these hosts generally sleep within 3 to 7 feet (1 to 2 meters) of the bedbugs' hiding places.^{8,9} Feeding usually takes place just before dawn.¹⁰ Bedbug saliva contains several anesthetic, vasodilatory, anticoagulant, and proteolytic compounds that allow the insects to feed undetected for five to 10 minutes. Three of these compounds have been identified as instigators of the subsequent hypersensitivity reactions that may be noticed when the host awakens.¹¹⁻¹⁴



Figure 1. Bedbug life cycle from nymph (left) to larval exoskeletons (right).

Copyright © Thomas Jefferson University

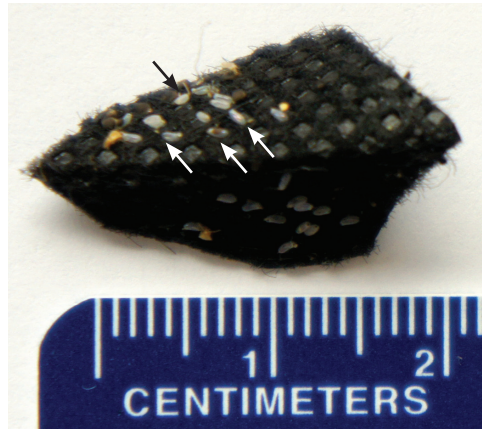


Figure 2. Multiple bedbug eggs hidden in a piece of furniture.

Copyright © Thomas Jefferson University

Clinical Manifestations

Cutaneous reactions to bedbug bites can vary widely and are easily confused with other conditions (Table 1).¹⁵⁻¹⁹ A typical lesion is a 2- to 20-mm, pruritic, erythematous maculopapule with a central hemorrhagic crust or

vesicle.^{5,8} Macules, papules, wheals (Figure 3), vesicles, bullae, and nodules have all been reported,²⁰ as have asymptomatic lesions with a barely visible punctum as the only evidence of a bite.⁸ Bites vary in number and are preferentially distributed in unclothed areas (e.g., face, neck, extremities). Unlike many other arthropod and insect bites, bedbug bites are rarely located in the popliteal fossae or axillae.²¹ Lesions can be noticeable immediately when waking up or several days later, with the reaction often progressing from delayed to immediate with subsequent exposures²²⁻²⁶ (Table 2). The classic bedbug rash is referred to as “breakfast, lunch, and dinner” because it commonly presents as several bites in a row or cluster²⁰ (Figure 4).

Scratching can cause superinfection, leading to impetigo, cellulitis, or folliculitis.²⁷⁻³² Reactions typically resolve within one to two weeks without treatment.³² Systemic reactions have been described, including asthma, generalized urticaria, angioedema, iron deficiency anemia, and, very rarely, anaphylaxis.³³⁻³⁶ Although bedbugs have been suspected to be vectors of more than 40 microorganisms, there is no evidence that they are involved in the transmission of disease.⁵

Psychological Impact

In addition to the physical manifestations of bedbug bites, patients can experience significant psychological distress. The stigma that



Figure 3. Bedbug bites resulting in wheals.

Copyright © Thomas Jefferson University

Table 1. Differential Diagnosis of Bedbug Bites

Pest	Clinical characteristics of typical bite
Bedbugs	Pruritic maculopapules in clusters or lines in unclothed areas
Fleas	Irregular groups of erythematous wheals with a central hemorrhagic punctum, located under loose areas of clothing, (e.g., lower legs, waist)
Lice	Excoriations, identified by examining clothing seams and hair for lice and nits
Mosquitoes	Soft, pale, pruritic wheals or plaques scattered in unclothed areas
Scabies mite	Pruritic burrows or vesicles in intertriginous areas and regions under tight clothing
Spiders	Single lesion in an area where clothing binds tightly; thin skin is more likely to be envenomed than calloused skin
Ticks	Painless red papule with or without pruritus, usually discovered in protected sites (e.g., intertriginous or hair-covered regions) during the spring and summer

Information from references 15 through 19.

Table 2. Progression of Cutaneous Reactions to Bedbug Bites

Initial reaction

Erythematous, pruritic macules with central hemorrhagic puncta in linear or grouped distribution

Subsequent reactions

Common: wheals, papules, vesicles

Uncommon: bullae, nodules, secondary infection, systemic signs



Figure 4. Bedbug bites grouped in a characteristic row or cluster.

Copyright © Thomas Jefferson University

bedbugs are related to poor hygiene (however inaccurate) can lead to poor self-esteem, avoidance of family and friends, and suspension from work.³⁷⁻³⁹ Management of an infestation can be stressful, costly, and disruptive to everyday life. Worry can lead to insomnia, depression, anxiety, and even delusional parasitosis.³⁷

Diagnosis and Management

The diagnosis of a bedbug infestation should be based on the clinical history and appearance of bites. A thorough inspection of sleeping quarters by the patient, a family member, or a pest control expert may demonstrate the telltale signs of an infestation¹⁵ (i.e., specks of blood-tinged insect feces and exoskeleton casts [Figure 5]). With the aid of a magnifying glass, special attention should be given to cracks and crevices of furniture, baseboards, electrical boxes, curtains, carpet, luggage, bed frames and headboards, picture frames, wall hangings, mattress and box spring seams, peeling wall paper, clothes, and linens.³⁷ Live bedbugs can sometimes be caught by turning on a flashlight just before dawn, when bedbugs are most active, larger in appearance, and slower to scatter because of recent feeding.⁴⁰

Once an infestation is confirmed, an integrated pest management strategy should be employed. Promoted by the Environmental Protection Agency (EPA) and the Centers for Disease Control and Prevention, an integrated pest management strategy is a multifaceted, comprehensive strategy that relies on knowledge of bedbug biology and habits,

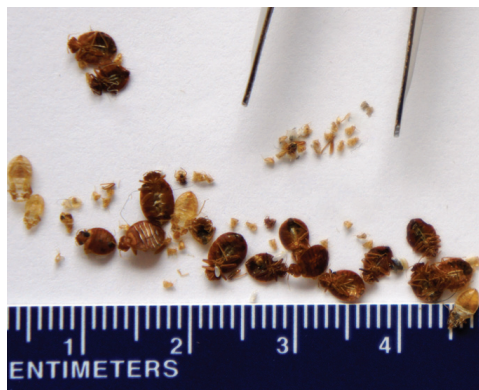


Figure 5. Bedbug infestation; bedbugs are in various stages of development.

Copyright © Thomas Jefferson University

and the most up-to-date pest control methods.³ An integrated pest management strategy minimizes economic, environmental, and health hazards, and is most effective for small bedbug populations.

In most infestations, consultation with a professional exterminator is advised because elimination is more likely to be effective if multiple pest management methods are used. These include monitoring devices, canine detection, clutter removal, vacuuming, heat or cold treatment, sealing cracks and crevices, and judicious use of nonchemical and chemical pesticides. Monitoring devices include moat-like devices (e.g., Climbup Insect Interceptor) that trap bedbugs ascending and descending furniture legs,

If a bedbug infestation is confirmed, an integrated pest management strategy should be employed.

Bedbug Infestation

Table 3. Care of Bedbug-Infested Items

Contaminated item	Action to take
Dry cleaning	Make dry cleaners aware of infestation so that items are not removed until ready for cleaning
Washable items	Machine washer and dryer: use highest settings that clothing can withstand
Nonwashable items	Heat treatment: 120°F (48.9°C) or hotter for at least two hours or Cold treatment: 23°F (−5°C) or colder for five days (alternatively, −15°F [−26°C] kills eggs instantly)
Luggage	Hand wash with hot water (goal temperature of 120°F) and soap, and scrub seams with a brush
Mattress, box springs, and pillows	Plastic encasements to trap bedbugs and prevent migration to and from hiding places

Information from reference 6.

SORT: KEY RECOMMENDATIONS FOR PRACTICE

Clinical recommendation	Evidence rating	References
Physicians should recognize that patients can experience significant psychological distress from bedbug exposure.	C	37, 38
Bedbug bite reactions are self-limited and typically resolve within one to two weeks without treatment.	C	15
No treatment regimen has been shown to improve the natural history of bedbug dermatitis.	C	8
Nonwashable items infested with bedbugs should be treated at 120°F (48.9°C) or hotter for at least two hours or 23°F (−5°C) or colder for five days.	C	6

A = consistent, good-quality patient-oriented evidence; B = inconsistent or limited-quality patient-oriented evidence; C = consensus, disease-oriented evidence, usual practice, expert opinion, or case series. For information about the SORT evidence rating system, go to <http://www.aafp.org/afpsort.xml>.

and emitting devices that use carbon dioxide, heat, and/or chemicals (e.g., Nightwatch monitor) that attract and trap bedbugs. Specially trained dogs are reported to detect bedbugs with 97 percent accuracy and are able to differentiate live bedbugs and viable eggs from debris remaining from previous infestations.⁴¹ Vacuuming is a highly effective

method for removing bedbugs, but not eggs because these adhere to surfaces.⁴² High-efficiency particulate air filters eliminate bedbug allergens and debris.⁴² Nonchemical treatments include petroleum jelly (which can be applied to legs of furniture to prevent bedbugs from ascending), heating, and freezing (see Table 3⁶ for effective killing temperatures).

Many chemical pesticides are available, with more than 300 registered by the EPA. Pesticides should be applied to walls, floors, cracks in furniture, and seams and buttons of mattresses.²¹ The EPA's Bed Bug Products search tool (Web site: <http://cfpub.epa.gov/oppref/bedbug/>) allows users to search by product name, company, EPA registration number, location of intended use, and pesticide type. The National Pesticide Information Center (Web site: <http://npic.orst.edu/>; telephone: 800-858-7378) is another useful resource. Silica gel dusts are a safer alternative to traditional pesticides, because they are less concentrated and less toxic.²¹ Plastic mattress and pillow encasements can help trap bedbugs and restrict spread.⁴² Regardless of the integrated pest management strategy used, a follow-up inspection 10 to 21 days after extermination is advised to detect and manage a persistent infestation.⁴²

Management of an infestation can be costly because it often requires multiple treatments by pest control experts. The National Pest Management Association quotes an average price of \$200 to \$500 per treatment session.⁴³

Treatment of Bites

Bedbug bite reactions are self-limited and typically resolve within one to two weeks without intervention.¹⁵ There is no evidence that any treatment alters the natural history of bedbug dermatitis.⁸ If pruritus is present, nonprescription topical antipruritic preparations containing the active ingredient doxepin, or intermediate potency corticosteroids may be beneficial. Mupirocin (Bactroban) and/or systemic antibiotics should be considered in the treatment of superinfected bites.⁸

Prevention

Avoidance is the best means of preventing bedbug infestation.⁸ While traveling,

sleeping quarters and bedding should be closely inspected for signs of bedbugs. Suitcases should be placed on metal racks away from walls and furniture. Frequent travelers might consider obtaining a portable heating unit for luggage and clothing (e.g., Packtite) as an additional precaution. Items at yard sales and secondhand stores should also be carefully examined before purchase.⁸ All potentially infested items should be sorted and sealed in plastic bags and removed only when ready to be disinfested (see *Table 3*⁶ for instructions regarding effective care of infested items). Wearing long-sleeved nightclothes can minimize exposed skin, and although insect repellants have not been shown to be reliably effective, oil of lemon eucalyptus or diethyltoluamide (DEET) might help deter bites.^{44,45}

Figures 1 through 5 are from the Jefferson Clinical Image Database of Thomas Jefferson University.

Data Sources: A PubMed search was completed in Clinical Queries using the key terms bedbug, rash, bites, and infestation. The search included meta-analyses, randomized controlled trials, clinical trials, case reports, and reviews. We also searched the online databases of the Environmental Protection Agency, Centers for Disease Control and Prevention, and Jefferson Clinical Images. Lastly, we used Essential Evidence Plus. Search dates: February through June 2011.

The Authors

JAMES S. STUDDIFORD, MD, is a professor in the Department of Family and Community Medicine at Thomas Jefferson University Hospital, Philadelphia, Pa.

KATHRYN M. CONNIFF, MD, is an assistant professor in the Department of Family Medicine at the University of Maryland School of Medicine, Baltimore.

KATHRYN P. TRAYES, MD, is an assistant professor in the Department of Family and Community Medicine, and assistant dean of student affairs and career counseling at Thomas Jefferson University Hospital.

AMBER S. TULLY, MD, is an assistant professor in the Department of Family Medicine at the Cleveland Clinic in Rocky River, Ohio. At the time this article was written, she was an assistant professor in the Department of Family and Community Medicine at Thomas Jefferson University Hospital.

Address correspondence to James S. Studdiford, MD, Thomas Jefferson University Hospital, 1015 Walnut St., Ste. 401, Philadelphia, PA 19107. Reprints are not available from the authors.

Author disclosure: No relevant financial affiliations to disclose.

REFERENCES

1. Usinger RL. *Monograph of Cimidae (Hemiptera: Heteroptera)*. Vol. 7. College Park, Md.: Entomological Society of America; 1966:50.
2. Paul J, Bates J. Is infestation with the common bedbug increasing? *BMJ*. 2000;320(7242):1141.
3. Centers for Disease Control and Prevention; National Center for Environmental Health; Environmental Protection Agency. *Joint Statement on Bed Bug Control in the United States from the U.S. Centers for Disease Control and Prevention (CDC) and the U.S. Environmental Protection Agency (EPA)*. Atlanta, Ga.: National Center for Environmental Health; 2010.
4. Potter MF, Rosenberg B, Henriksen M. Bugs without borders—executive summary. Defining the global bed bug resurgence. July 2010. <http://www.npmapestworld.org/documents/BBSurveyexecsummaryjuly26.pdf>. Accessed December 2, 2011.
5. Delaunay P, Blanc V, Del Giudice P, et al. Bedbugs and infectious diseases. *Clin Infect Dis*. 2011;52(2):200-210.
6. Kells SA, Hahn J. Help! I stayed at a place that had bedbugs! What can I do to prevent bringing them home? Department of Entomology, University of Minnesota. August 25, 2006. <http://www.extension.umn.edu/distribution/housingandclothing/components/M1196.pdf>. Accessed December 2, 2011.
7. Reinhardt K, Siva-Jothy MT. Biology of the bed bugs (Cimicidae). *Annu Rev Entomol*. 2007;52:351-374.
8. Goddard J, deShazo R. Bed bugs (*Cimex lectularius*) and clinical consequences of their bites. *JAMA*. 2009;301(13):1358-1366.
9. Raoult D, Marrie T, Mege J. Natural history and pathophysiology of Q fever. *Lancet Infect Dis*. 2005;5(4):219-226.
10. Kinnear J. Epidemic of bullous erythema on legs due to bed-bugs. *Lancet*. 1948;2(6515):55.
11. Ter Poorten MC, Prose NS. The return of the common bedbug. *Pediatr Dermatol*. 2005;22(3):183-187.
12. Valenzuela JG, Ribeiro JM. Purification and cloning of the salivary nitrophorin from the hemipteran *Cimex lectularius*. *J Exp Biol*. 1998;201(pt 18):2659-2664.
13. Valenzuela JG, Guimaraes JA, Ribeiro JM. A novel inhibitor of factor X activation from the salivary glands of the bed bug *Cimex lectularius*. *Exp Parasitol*. 1996;83(2):184-190.
14. Valenzuela JG, Charlab R, Galperin MY, Ribeiro JM. Purification, cloning, and expression of an apyrase from the bed bug *Cimex lectularius*. A new type of nucleotide-binding enzyme. *J Biol Chem*. 1998;273(46):30583-30590.
15. Cleary CJ, Buchanan D. Diagnosis and management of bedbugs: an emerging U.S. infestation. *Nurse Pract*. 2004;29(6):46-48.
16. Erickson TB. Arthropod envenomation and parasitism. In: Auerbach PS, ed. *Wilderness Medicine*. 5th ed. Philadelphia, Pa.: Mosby Elsevier; 2007.
17. Hsia RY. Mosquitoes and mosquito-borne diseases. In: Auerbach PS, ed. *Wilderness Medicine*. 5th ed. Philadelphia, Pa.: Mosby Elsevier; 2007.
18. Boyer LV, Binford GR, McNally JT. Spider bites. In: Auerbach PS, ed. *Wilderness Medicine*. 5th ed. Philadelphia, Pa.: Mosby Elsevier; 2007.

Bedbug Infestation

19. Steen CJ, Carbonaro PA, Schwartz RA. Arthropods in dermatology. *J Am Acad Dermatol*. 2004;50(6):819-842.
20. Cohen PR, Tschen JA, Robinson FW, Gray JM. Recurrent episodes of painful and pruritic red skin lesions. *Am J Clin Dermatol*. 2010;11(1):73-78.
21. Kolb A, Needham GR, Neyman KM, High WA. Bedbugs. *Dermatol Ther*. 2009;22(4):347-352.
22. Ryckman RE. Dermatological reactions to the bites of four species of triatominae (Hemiptera: Reduviidae) and *Cimex lectularius* L. (Hemiptera: Cimicidae). *Bull Soc Vector Ecol*. 1985;10:122-125.
23. Churchill TP. Urticaria due to bedbug bites. *JAMA*. 1930;95(26):1975-1976.
24. Elston DM, Stockwell S. What's eating you? Bedbugs. *Cutis*. 2000;65(5):262-264.
25. Ryckman RE. Host reactions to bug bites (Hemiptera, Homoptera): a literature review and annotated bibliography, part I. *California Vector Views*. 1979;26:1-24.
26. Ryckman RE, Bently DG. Host reactions to bug bites: a literature review and annotated bibliography, part II. *California Vector Views*. 1979;26:25-49.
27. Masetti M, Bruschi F. Bedbug infestations recorded in Central Italy. *Parasitol Int*. 2007;56(1):81-83.
28. Liebold K, Schliemann-Willers S, Wollina U. Disseminated bullous eruption with systemic reaction caused by *Cimex lectularius*. *J Eur Acad Dermatol Venereol*. 2003;17(4):461-463.
29. Alexander JO. *Arthropods and Human Skin*. New York, NY: Springer-Verlag; 1984.
30. Abdel-Naser MB, Lotfy RA, Al-Sherbiny MM, Sayed Ali NM. Patients with papular urticaria have IgG antibodies to bedbug (*Cimex lectularius*) antigens. *Parasitol Res*. 2006;98(6):550-556.
31. Crissey JT. Bedbugs: an old problem with a new dimension. *Int J Dermatol*. 1981;20(6):411-414.
32. McKiel JA, West AS. Nature and causation of insect bite reactions. *Pediatr Clin North Am*. 1961;8:795-814.
33. Sansom JE, Reynolds NJ, Peachey RD. Delayed reaction to bed bug bites. *Arch Dermatol*. 1992;128(2):272-273.
34. Bircher AJ. Systemic immediate allergic reactions to arthropod stings and bites. *Dermatology*. 2005;210(2):119-127.
35. Jimenez-Diaz C, Cuenca BS. Asthma produced by susceptibility to unusual allergens. *J Allergy*. 1935;6:397-403.
36. Pritchard MJ, Hwang SW. Cases: severe anemia from bedbugs. *CMAJ*. 2009;181(5):287-288.
37. Doggett SL, Russell R. Bedbugs—what the GP needs to know. *Aust Fam Physician*. 2009;38(11):881-884.
38. Thompson J. Bed bug. *Agfacts*. New South Wales Department of Agriculture information leaflet, 1983.
39. Criado PR, Belda Junior W, Criado RF, Vasconcelos e Silva R, Vasconcelos C. Bedbugs (Cimicidae infestation): the worldwide renaissance of an old partner of human kind. *Braz J Infect Dis*. 2011;15(1):74-80.
40. Steen CJ, Carbonaro PA, Schwartz RA. Arthropods in dermatology. *J Am Acad Dermatol*. 2004;50(6):819-842.
41. Pfiester M, Koehler PG, Pereira RM. Ability of bed bug-detecting canines to locate live bed bugs and viable bed bug eggs. *J Econ Entomol*. 2008;101(4):1389-1396.
42. Armed Forces Pest Management Board. Bed bugs—importance, biology, and control strategies. Technical guide no. 44. Washington, DC: Armed Forces Pest Management Board; April 2010. <http://afpmb.org/sites/default/files/pubs/techguides/tg44.pdf>. Accessed December 2, 2011.
43. Manuel J. Invasion of the bedbugs. *Environ Health Perspect*. 2010;118(10):A429.
44. Quarles W. Bed bugs bounce back. *IPM Practitioner*. 2007;29(3/4):1-8.
45. Heymann WR. Bed bugs: a new morning for the nighttime pests. *J Am Acad Dermatol*. 2009;60(3):482-483.