Bed Bug Handbook

Georgia Department of Public Health

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INTRODUCTION

Bed bugs were once a common public health pest worldwide, but declined in incidence through the mid 20th century due to the wide scale usage of pesticides such as DDT and Malathion. During the late 1990s however, bed bugs began a dramatic resurgence and worldwide there are reports of increasing numbers of infestations. No one knows for certain what caused the resurgence of bed bugs in the United States.

The Georgia Department of Public Health Environmental Health Program provides primary prevention through a combination of surveillance, education, enforcement, and assessment programs designed to identify, prevent, and abate the environmental conditions that adversely impact human health. One of the many mandates for the Georgia Department of Public Health Environmental Health Program is that of inspecting tourist accommodations in order to "minimize illnesses and injuries associated with unsanitary or hazardous conditions in Georgia's lodging industry." County Environmental Health Specialists working for the local health authority inspect these facilities twice a year and when there is a complaint.

Bed bugs have become a problem within dwellings of all kinds, including homes, apartments, hotels, cruise ships, dormitories and shelters. While we associate bed bugs with unsanitary conditions, the problem may be found in the cleanest of homes, hotels or other buildings. The purpose of this handbook is to provide basic information about the biology and health significance of these pests, to offer guidance on inspection for bed bugs, and to provide information on how to safely and effectively manage an infested residence or hotel.

Contributing factors may include:

- **Worldwide increase in bed bug activity**
- **More frequent introductions during international travel**
- **Changes in pest management practices & resistance to pesticides**
- **Lack of public awareness perpetuating the continued dispersal of bed bugs**

BIOLOGY

Bed bugs are small wingless insects that feed solely upon the blood of warm-blooded animals. They are sometimes mistaken for ticks or cockroaches. A mature bed bug is oval-bodied, brown to red-brown in color, wingless and flattened top to bottom. Unfed bugs are 1/4 to 3/8 inch long and the upper surface of the body has a crinkled appearance. A bed bug that has recently fed is engorged with blood, dull red in color, and the body is elongated and swollen. Eggs are white and are about 1/25 inch long and slightly curved. Newly hatched bed bugs are nearly colorless or straw-colored.

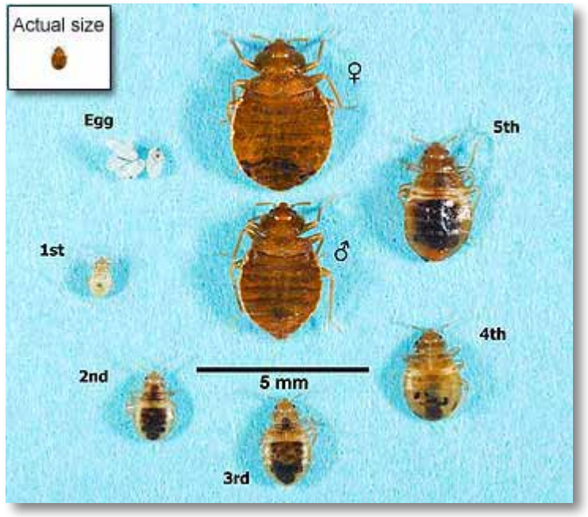


Photo Courtesy of Stephen Doggett, Department of Medical Entomology, Westmead Hospital, Sydney, Australia

Of the 90 or so species in the family Cimicidae, approximately 7 will feed on human blood, but only 2 are commonly found: *Cimex lectularius* (common bed bug) and *Cimex hemipterus* (tropical bed bug). However, some species that are bird or bat ectoparasites will bite humans who come into contact with infested bird nests or live in bat-infested houses.

Cimex lectularius and *Cimex hemipterus* can be distinguished by looking at the prothorax, the first segment of the thorax. The prothorax of the common bed bug is more expanded laterally and the extreme margins are more flattened than that of the tropical bed bug (Ghauri 1973). In other words, common bed bugs have rounded prothorax portions near the eye where the tropical bed bug has squared off and deeper prothorax near the eye. This is difficult to see without proper equipment, and it is not necessary to distinguish common from tropical bed bugs in order to provide proper control.

Life Cycle

Female bed bugs deposit 1 to 5 eggs per day; a total of 200-500 eggs can be produced by one female over her 10-12 month life span. Eggs are usually deposited in clusters and fastened to cracks and crevices or rough surfaces near adult harborages with a sticky cement-type substance.

The eggs hatch in 7-10 days. The newly hatched nymph is nearly colorless or straw-colored before feeding, and then turns red or reddish-brown in color after taking a blood meal. Bed bugs go through 5 nymphal stages before reaching maturity. Under favorable conditions (70-90°F), development from egg hatch to adult takes approximately 1 ½ -2 months; cool temperatures or limited access to a blood meal may extend the developmental period. Nymphs look like small adults with the exception that adults have minute wing pads. Female bed bugs are larger than males. Bed bugs differ from many other blood feeding pests such as mosquitoes and fleas in that adult males and females, as well as all of the immature stages, feed on blood.

Habits and Habitat

Bed bugs lead a very cryptic lifestyle. As a result, bed bugs are often present for weeks or even months before a single bug is ever seen by the occupants of an infested structure. They are active mainly at night; they reach peak activity before dawn. During the daytime, they prefer to hide close to where people sleep. Their flattened bodies enable them to fit into tiny crevices - especially those associated with mattresses, box springs, bed frames, and headboards. Bed bugs do not have nests like ants or bees, but do tend to congregate in habitual hiding places. Bed bugs do not fly, but can move quickly over floors, walls, ceilings and other surfaces.

Bed bugs respond to warmth and carbon dioxide when searching for a blood meal. All nymphal stages and adults of both sexes require blood for nutrition and development. Bed bugs ordinarily feed within 24 hours of hatching, once between each molt and once before egg deposition; an average period of 8 days is required between molts. Adult females will continue to take blood meals every 5-10 days depending on ambient temperature and humidity. Adult bed bugs take up to 10 minutes to complete a blood meal, and will consume 2-5 times their own body weight in blood during that time. Individual bed bugs usually do not feed every night but at intervals of a few days to a week. Once a bed bug is finished feeding, it quickly retreats back to its hiding place. They do not remain on the host between feedings. Bed bugs may also feed on small animals, such as pets. Bed bugs can be quite resilient; they are capable of surviving several months to a year without feeding, depending on environmental conditions.

It is important to note that an irritation or bite experienced in bed may not necessarily be due to a bed bug infestation. A bed bug infestation can only be diagnosed by the identification of live or dead bed bugs, cast skins and hatched or un-hatched eggs collected from the infected residence. The presence of bed bugs in a dwelling should be suspected if there are fecal spots on the bed clothes and on potential harborage areas and the distinctive sweet, musty, sickly smell emitted by bed bugs is present. Blood-spotting on mattresses and nearby furnishings is also often a tell-tale sign of an infestation.

Other "Bugs"

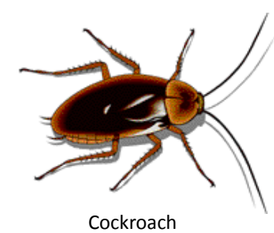
When bed bug-like insects are found, it is important to consider whether bats, swallows, chimney swifts, pigeons, or other wild hosts are involved. Although similar in appearance, bed bug species that normally feed on bats and birds can be differentiated from those that prefer humans by using a hand lens to examine the shape of the bug's head. Other species of bed bugs have appearances similar to the common bed bug. The bat bug is virtually identical but feeds upon bats and has longer hairs on its body than the bed bug. The barn swallow bug is similar in size and coloration but is clothed with long silky hairs. The poultry bug or Mexican chicken bug is more active than the common bed bug, has longer legs, and a longer beak. The poultry bug is found near birds and is a common pest of chicken and duck houses. These bugs hide near where the birds roost and will emerge at night to feed. If humans remain in close proximity with poultry, these bugs can feed on humans, although their preferred food source is poultry and fowl.

In addition, there are other insects and arthropods that can invade buildings and that might be confused with bed bugs. These include roaches, other hemipterans (stink bugs, wheel bugs, etc), fleas, ants, beetles, and earwigs. The masked hunter, an assassin bug, is known to feed upon bed bugs. The presence of this insect in the home may be indicative of bed bug infestations, although this is not always the case (http://www.ento.psu.edu/extension/factsheets/maskedHunter.htm).

From left to right, swallow bug (Oeciacus vicarius), bed bug (Cimex lectularius) and bat bug (Afrocimex constrictus)

Dermestid beetle larva and adult

Information on common pests of man and animals can be found at https://www.ces.ncsu.edu/depts/ent/notes/Urban/biting.htm. A pictorial key of insects that bite humans can be found at http://www.cdc.gov/nceh/ehs/Docs/Pictorial_Keys/Bugs.pdf



Cockroach

Earwig

Flea

Movement

Bed bugs are very successful hitchhikers, moving from an infested site to furniture, bedding, baggage, boxes, and clothing. Some of the most common ways new bed bug infestations may be introduced include:

- Spending a night (or longer) in an environment that is already infested by bed bugs (hotels, homes, international flights, etc)
- Having someone visit from such an infested environment (bed bugs can be transported in luggage)
- Renting furniture or buying used furniture or bedding
- Picking up discarded bedding or furniture from a curbside, trash collection point, or dumpster

Medical Importance

Reaction to Bed Bug Bites

Bed Bug Feeding and Defecating

The bite of a bed bug is painless. The amount of blood loss due to bed bug feeding typically does not adversely affect the host. Unlike flea bites, which occur mainly around the ankles, bed bugs feed on any bare skin exposed while sleeping (face, neck, shoulders, arms, hands, etc). Skin reactions are associated with the saliva injected during feeding by the bed bug. However, some individuals do not react to bed bug bites, while others note a great deal of discomfort often with loss of sleep from the persistent biting. Humans who are frequently bitten by bed bugs may develop a sensitivity "syndrome" that can include nervousness, almost constant agitation ("jumpiness"), and sleeplessness.

"Immediate" immune reactions may appear from one to 24 hours after a given bite and can last 1-2 days. "Delayed" immune reactions usually first appear one to three (up to 14) days after a bite and can last 2-5 days. Reactions can include the development of large welts, often >1cm, which are accompanied by itching and inflammation. The welts usually subside to red spots but can last for several days. Severe itching can last for several hours to days. Blister-like eruptions have been reported in association with multiple bed bug bites and anaphylaxis may occur in patients with severe allergies. Iron deficiency in infants has been associated with severe infestations. It has been suggested that allergens from bed bugs may be associated with asthmatic reactions. Scratching may cause the welts to become infected. The number of welts does not always correlate with the number of bugs that bit the individual. Thus, just a few bugs can be responsible for many welts in a single evening. It is also important to realize that bed bugs cannot be diagnosed by the bite alone.

Bed bugs have been found to harbor at least 28 human pathogens and have been considered in the transmission of a wide variety of infectious agents. <u>However, bed bugs have never been proven to biologically transmit any human pathogen</u>, including HIV and hepatitis B. Although bed bugs are considered more of a nuisance than a health concern, public health officials maintain a level of interest due to the possibility of secondary infections. However, the Centers for Disease Control and Prevention (CDC) & the Environmental Protection Agency (EPA) issued a joint statement saying that "Although bed bugs are not known to transmit disease, they are a pest of significant public health importance." This is because:

- Frequent feeding can disrupt people's sleep and make them irritable.
- Seeing bites may cause emotional distress in some people.
- Heavy rates of feeding can result in significant blood loss and eventually lead to anemia, especially in malnourished children.

Currently, there are no insect repellents registered for use against bed bugs. Insect repellents are intended for the specific pests listed on the product label, and have not been shown to repel bed bugs.

Bed Bug Nymph

INSPECTING FOR BED BUGS

Bed bugs leave fecal stains in the areas they inhabit. These stains are actually partially digested blood. As the blood is digested it turns black and therefore the bed bug droppings usually consist of several black spots in one area. The fecal spots will not flake off if rubbed and will smear if wiped with a wet rag.

Because bed bugs can hide in virtually any crack and crevice, efforts should be concentrated on dark, isolated, and protected areas. Bed bugs prefer wood, paper and fabric surfaces and so these materials should receive special attention during the inspection process.

When bed bugs are suspected, a thorough inspection should be undertaken in areas where people sleep or rest.

Female and Male Bed Bugs

General Information

It is important to have a plan of action for dealing with bed bugs. **The first and most important step of any bed bug management plan is to remain calm.** Dealing with bed bugs is a tedious process, and having a systematic and logical plan of action is really the best way to deal with this pest.

A thorough inspection is important to determine how widespread the infestation is and the best way to manage bed bugs. When conducting an inspection, move slowly and avoid disturbing hiding bugs, so they don't scatter. Keep in mind that in a low infestation, the bed bugs will likely be concentrated close to sleeping areas. Items away from the sleeping area will be at a lower risk of infestation. Prioritize the risk of infestation from high to low to concentrate inspection and treatment time to the most infested areas.

The mattress should be the first site inspected and the seams, beading, under buttons, labels, and corner protectors (if not previously removed) should be examined closely.

For an ensemble, the base is more likely to harbor the bugs than the top mattress. The edge of the material underneath the ensemble base is a favorite spot for bugs, as well as any hollow plastic caster legs. It will be necessary to remove the material covering the base of the bed.

Generally, bed bugs are more likely to be present in the darker areas near the wall. For metal framed beds, if wooden slats are present these contain many cracks for bed bugs to hide in and lay their eggs. If the wooden slats are bolted to the bed frame, the bolts should be undone and the drilled holes inspected. Bed bugs can also hide in coils of bed springs and inside hollow bed posts. The areas around the bed should be investigated next, including the bedside furniture. The drawers in tables and cupboards should be removed and examined. Other furniture in the room should be inspected, especially locations where luggage is placed or stored. Close attention should be paid to seams and buttons (if upholstered) and any wooden joints (especially if constructed of chipboard).

Bed Bugs along a mattress seam

Possible Source of Infestation

Other inspection sites include appliances such as telephones and stereo equipment, books, near electrical outlets and behind cover plates, underneath carpet thresholds, base boards, joints in floor boards and under floor boards, loose wallpaper and paint, old nail and screw holes, ornaments, window casings and wall voids. In moderate to severe infestations, bed bugs may be found higher on the wall in wall hangings, picture frames, wall mirrors, Venetian and vertical blinds, curtains and curtain rods, books, behind electrical conduit, cracks and joints in the ceiling, under wallpaper, under ceiling moldings, smoke detectors and light fittings. In any infestation, the adjoining rooms, both sides, and above and below, should be inspected. With a heavy infestation, rooms across the hallway should also be inspected as bed bugs are quite able to crawl under doors and across hallways. A room site plan should be drawn showing the location of any activity. The room inspection should be as methodical as possible, and all sites of bed bug activity should be noted on the site plan.

Protecting Yourself

If bed bugs are obvious upon entering a room, leave. No further inspection is needed. When doing an inspection, take in only items required to do the inspection. Leave all other items in your vehicle. Do not wear loose-fitting clothing that may drag along a surface and collect bed bugs. Assume all items are infested and do not lean, sit, or lie down on any surface. You may want to change your shoes and put the shoes you wear for inspection in a tightly-closed plastic bag. While wearing a coverall is not necessary, it may be decided that this is desirable.

Specifics for Hotels

In hotels, if headboards are attached to the wall, they should be removed after consulting maintenance staff. **Removing headboards from the wall is important, as this may be the first place bed bugs will be found when the infestation is light.** Common rooms, such as a lounge, should not be overlooked. It is also important that the housekeeping staff be interviewed. Such staff is more likely to have detailed knowledge about an infestation than the management. **Be sure that all inspections are done in the presence of hotel management or their representative and that permission has been obtained before disassembling furniture.**

Specifics for Multi-family Units

An infestation of bed bugs can begin from any number of sources. In multifamily housing, common sources may include: used furniture, friends and family who are visiting or hosting residents and visiting professionals such as cleaning contractors and home health aides. Conversations with the residents during inspection may help identify where the bed bugs came from and is an opportunity for educating the residents about preventing further introduction. Clutter in homes is a significant impediment to finding all bed bug harborages.

Inspecting the infested residence is a must, but inspection should go beyond the infested unit. While early instar nymphs often cluster, increasing the likelihood of detection, adult bed bugs can travel over 16 feet in five minutes, and adult female bed bugs tend to disperse from clusters.

Specifics for Shelters

Clients of homeless shelters and other emergency housing may bring along bed bugs from their previous living arrangements. It is important that intake counselors understand the nature of bed bug issues and express to clients that help is available. **It is in the best interest of a shelter or group home to know whether a client has been exposed to bed bugs.** Helping a client with bed bugs immediately as a preventative approach can reduce risks to other clients and reduce costs associated with eradication if bed bugs become established.

If a potential client indicates that they believe they have been exposed to bed bugs or they know they have bed bugs, immediate help is necessary to avoid spreading them within the shelter or home. Help may be in the form of medical attention, laundering clothes, and isolating their belongings while a control strategy is formed. If a client refuses to follow procedures for bed bugs, such as inspecting belongings, laundering, or medical attention, a social worker may need to build this into their case plan.

Specifics for Hospitals

If the patient has a history of infestation or if bed bugs are detected, the following should occur unless medically contraindicated:

- Confirmation of the presence of bed bugs. Confirmation requires finding and identifying the bugs themselves.
- Implement Contact Precautions
- Remove the patient's clothing immediately and double bag. Send home with family or friends and instruct to home launder with hot water and detergent and heat dry. Items should be kept in a sealed plastic bag until it is clear there are no more bed bugs.
- Provide a shower prior to inpatient admission. This allows for inspection of the body for additional identification of additional bugs as well as inspection of the skin integrity due to bites.
- Notify Environmental Services and/or Infection Prevention.

Environmental Services and Housecleaning staff should be trained to recognize bed bugs. Ongoing inspection procedures of patient rooms including inspection of seams, joints, and cracks on mattresses, bed frames, baseboards, upholstered furniture, and window sills; cracks and crevices in the room, including the floors; and walls behind picture frames.

Specifics for Schools

The best bed bug prevention for schools is early detection; all employees need to know what live bed bugs look like (all life stages) so they can recognize a bed bug when they see one. Remember, bed bug infestations in schools are uncommon and a single introduction does not mean the building is infested. More commonly, a few bed bugs will hitchhike to school from an infested home by hiding in a student's clothing or backpack. Bed bugs that hitch a ride into the school in one student's backpack could be carried home by another student, making the school a potential hub for bed bug spread.

With more people living with bed bugs, the possibility of people transporting bed bugs to other locations increases. Children living with bed bugs at home will bring bed bugs to school, and it is likely that bed bugs have the potential to be transported to school every day that school is in session. Thus, there is a great probability any particular school will experience multiple bed bug introductions every year.

TREATMENT AND CONTROL

Bed bugs may in fact be the most challenging pest problem currently facing the pest control industry. There are many pests that homeowners and building managers may decide to try and control on their own, but bed bugs should not be one of them. Even the most experienced pest management firms will have their work cut out for them and it may be difficult to guarantee the total elimination of bed bugs from some infested environments. Reduction of bed bug populations is not difficult in most cases, however it can be extremely difficult, if not impossible to eliminate every last bug in some situations. If even one adult female survives, the environment may become re-infested. The longer bed bugs exist without being detected, the greater their opportunity to disperse within the environment, making it harder to find and eliminate 100% of the population. Bed bug control takes hard work, follow-up efforts and it can be expensive.

If bed bugs are found during inspection, the hotel management or homeowner should be encouraged to consult a **licensed pest control professional**. A written integrated pest management (IPM) plan should be requested from the pest control operator. This plan should detail the methods and insecticides to be used by the pest control operator and describe the efforts expected by the building manager or home owner. A licensed, professional pest control company should use several means to control the infestation, including vacuuming, steam or heat treatments and insecticides. Generally, pesticides will need to be applied in conjunction with any non-chemical means of control; non-chemical options should be considered as management tools only. Good housekeeping practices and a reduction in possible harborages such as clutter, cracks, and crevices will discourage repeat infestations. As bed bugs are good at concealing their location, complete control is often difficult to achieve with the first treatment. This is especially so with heavy infestations and thus a post control treatment evaluation is always advisable.

Once it has been determined that the rooms are infested, and prior to the arrival of a pest control professional to apply control, infested rooms should be stripped of all bedclothes, cushions, and removable cloth items. All furniture should be moved away from walls, and all items should be removed from furniture drawers. To prevent bedbug contamination of other areas of the building, launderable items should be sealed in plastic bags for transport to the laundry. If possible, these items should be washed in warm or hot water and dried with hot air (minimum air temperature 120°F for at least 20 minutes). If washing is not possible, drying in hot air alone will kill any bedbugs that are present.

Carpets and all furniture should be thoroughly vacuumed, paying special attention to cracks, crevices, drawers, and voids. Mattresses and box springs should be removed from bed frames and vacuumed along all seams, folds and uneven surfaces. Filled vacuum cleaner bags should not be left in the vacuum cleaner to be used in uncontaminated rooms. They should be tightly sealed in a plastic bag before discarding.

Bedbugs are able to travel between rooms through wall cracks or along electrical, ventilation or pipe conduits. Therefore it is recommended that all rooms adjacent to (beside, above and below) the infested room be thoroughly inspected for the presence of bedbugs. Where there are heavy infestations, rooms across hallways should also be inspected. An infested room should never be assumed to be the only infested room in a building, and spot treatments should never be done to rid a building of bed bugs. This is likely to contribute to the spread of the bed bugs rather than to eliminate them.

Below are some of the more common methods for dealing with bed bug infestations.

Physical Removal

Where infestations are heavy, treatment and removal of infested furniture and mattresses may be necessary. If bed bug numbers are small, they can be physically removed from mattresses and harborage sites by vacuuming. Because bed bugs can be distributed to other sites by equipment used to remove them, the vacuum should be bagged and used only for the purpose of removing bed bugs. The vacuum bag should be removed, sealed in a plastic bag, and properly disposed of in an outside dumpster. Be sure to check brushes and filters for live bugs or eggs. Vacuum every day or two until the bed bugs are gone.

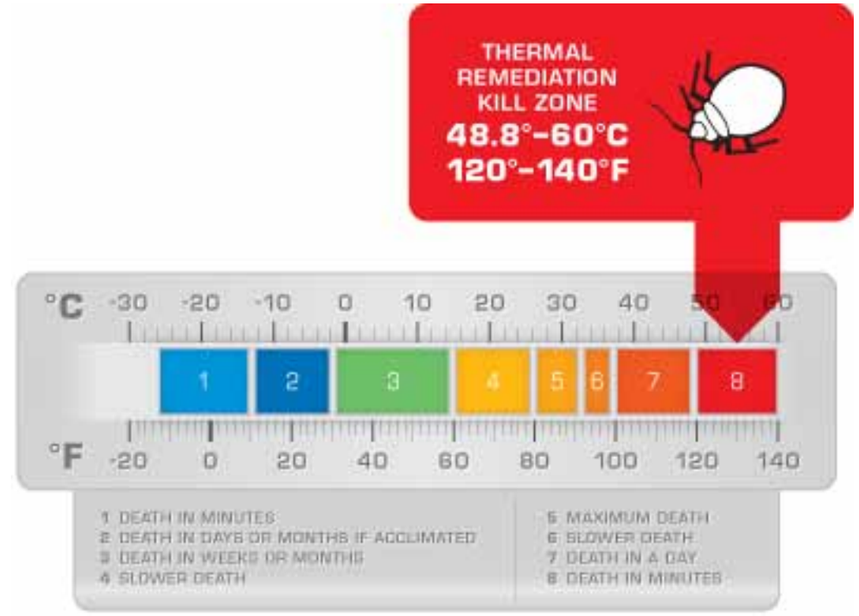
Remember, vacuuming alone will not eliminate every bed bug. Bed bugs will be located in inaccessible sites, and bed bugs can hold tight to rough surfaces and resist vacuuming.

After the mattress is vacuumed or scrubbed and dried, it can be enclosed in a zippered mattress cover such as that used for house dust mites. Any bed bugs remaining on the mattress will be trapped inside the cover. Leave the cover in place for at least a year or so since bed bugs can live for a long time without a blood meal. After bed bugs are removed, cracks in plaster need to be repaired and loosened wallpaper glued down to eliminate bed bug harborage sites.

Temperature Extremes

Bed bugs are very sensitive to heat. Their thermal death point is reported to be 118-122°F. A combination of steam cleaning and insecticide use has been found to be more effective for long-term control than insecticides alone (Meek, 2003). However, the effectiveness of steam cleaning of mattresses and other furniture has been questioned, because the furniture can quickly absorb the heat and the bed bugs may not be harmed. Therefore, it is important to monitor the effectiveness of this or any treatment being used to control bed bugs. Steam treatments should start with the mattress and be applied to the seams, under labels and handles, and both inside and outside of the bed frame or base. Cushions of chairs and sofas should be treated next. Carpet edges can also be treated. It is important to be aware that steam cleaning can leave excess moisture, which can lead to problems with mold, mildew, house dust mites, etc.

Steam Temperature/ Exposure Time Required to Kill All Bed Bug Stages	
Temperature	**Exposure Time**
113° F (45° C)	7 hours
118° F (48° C)	90 minutes
122° F (50° C)	< 1 minute



Bed linens, towels, drapery, and other like items can be washed in hot soapy water and dried in a clothes dryer set to the highest setting that will not damage the items. Just washing will generally not kill bed bugs.

It is often recommended that items be placed into black plastic bags and put in the sun so that the heat will kill any bed bugs on or in the item. This is not likely to be effective with anything but very small items.

Commercial dry heat services are available to treat entire rooms in homes for bed bug infestations. The current label use for commercial heating services is 140°F for two hours or 130°F for three hours, which will kill most bed bugs and eggs. For whole room heat treatment, the preventive use of insecticide in walls and under carpet edges, prior to treatment, may complement treatment by killing bugs attempting to move away from the heat.

Bed bugs are also sensitive to extreme cold, so placing small items in bags and freezing them (below 0º F (-19º C) for a minimum of 4 days may also provide control in items that can not easily be treated in any other way.

Chemical Control

Insecticides alone are likely insufficient to control bed bug infestations. Their use must be combined with a program of removing and cleaning infested beds, bedding, and other harborage sites then following up with a regular detection program to ensure treatment was effective. With any pesticide, always read the label and follow directions and safety precautions.

The most effective bed bug pesticides are available to commercial pesticide applicators only. Professionals also have the equipment and expertise that allow a more effective application of insecticides than residents could do themselves. In addition, professionals have the training to detect and isolate infestations, which often allows for more effective control. In Georgia, commercial pesticide applicators are licensed by the Georgia Department of Agriculture. Information on finding a licensed pesticide contractor can be found at http://agr.georgia.gov/pesticide-contractors.aspx.

Insecticides may be applied as liquid insecticide sprays, dusts, or aerosols. Insecticide sprays (including insect growth regulators) are used to spot treat bed bug harborages in cracks and crevices, behind baseboards, along ceiling-wall and floor-wall junctions, in closets, behind crown molding, and along window and door frames. Dusts have the advantage over liquid insecticides in that bed bugs walking on dusted surfaces will become covered in the dust resulting in superior kill. *Insecticidal dusts are* used to treat wall voids and electrical outlets. Insecticidal dusts cannot be used out in the open where they might be picked up on air currents. *Desiccant dusts* kill bed bugs by absorbing the protective wax layer on the outside of their body. *Aerosol formulations* are used in cracks and crevices, the under sides of drawers, drawer slides, nail holes, chipped paint, carpet tack strips, and in the wood framing of the box springs. Some aerosol products (not all) can be used on upholstered furniture. Many aerosol products have the advantage of being able to kill bed bug eggs. Most insecticide sprays and dusts will not.

Liquid insecticide formulations include:

- Products containing the botanical insecticide pyrethrin, which gives quick knockdown but little long-term control
- Various synthetic pyrethroid products (cyhalothrin, bifenthrin, deltamethrin, and permethrin)
- Newer types of products including the pyrrole insecticide chlorfenapyr (Phantom) and the insect growth regulator hydroprene (Gentrol), which cause sterility in adults

There is growing interest in the last two products, because some bed bug populations have developed resistance to pyrethroid insecticides and no longer can be effectively controlled by them. However, both newer products take up to several days to be effective.

Insecticides applied as dusts cling to the pest's cuticle, wearing away the insect's protective wax covering or poisoning the insect when it grooms itself. Several dust products used in bed bug management include boric acid, diatomaceous earth, fumed silica, and formulations of pyrethroids. These materials can provide long-term control as part of an integrated program if they are placed in out of-the-way places—such as under baseboards or in wall voids—that don't get wet.

The first application may not give complete or immediate control, and additional treatments may be necessary. In most cases, bed bugs infestations can be resolved in three to four visits. In most situations, the bed bug populations should be dramatically reduced following the initial visit. The appearance of new evidence of bed bugs after a series of service visits does not necessarily indicate a service failure; the new bed bugs might be reintroductions from other infested locations.

Regardless of how severe the infestation or how complex the environment, there is one way that bed bug infestations can be eliminated with absolute certainty. Structural fumigations, while an extreme and costly method, will effectively eliminate bed bugs from an infested environment. These types of applications are common in the southern United States and on the west coast for the control of drywood termites.

Structural fumigations are an extremely expensive approach and may not be practical or even possible in many situations. In many parts of the country, it may be difficult to locate a pest management firm that is licensed in fumigation services. Thus while this technique will guarantee elimination of the existing infestation, in most cases it is not likely to be economically practical or feasible. Structural fumigations may not be available in all parts of the country and may be restricted by regulatory agencies in some states.

The US Environmental Protection Agency (EPA) has created a new database listing all registered pesticides that can help get rid of bed bugs. EPA has more than 300 different products registered to use against bed bugs. Access the database at http://www.epa.gov/bedbugs/productsearch.

Do-It-Yourself (DIY) Treatments

Although over-the-counter pesticide products that have "bed bug control" written on the label can be found on store shelves, they generally are not recommended. Performance of these products under actual field conditions is not known. If you need to use a pesticide, you are better off hiring a licensed, professional pesticide applicator with experience in treating bed bugs. In particular, "bug bombs" or total release foggers are not effective against well-hidden bed bugs and may cause bed bugs to scatter making eradication more difficult.

Residents do have an important role to play when their homes are infested with bed bugs. Once professional treatment has occurred, you should continue to monitor for bed bugs daily. Also, keep down clutter and vacuum previously infested areas regularly.

Follow-Up

In tourist accommodations the pest control professional should conduct an in-depth physical inspection to determine treatment effectiveness. To avoid spreading the bed bugs to other buildings, the room or rooms must not be used until they have been found to be bug-free. The local Environmental Health Specialist should recheck the room(s) after they have been treated and re-evaluated by the licensed pest control professional to ensure that steps were taken to eliminate and prevent the bed bug infestation. Many times the first application does not seem to give complete or immediate control, and additional treatments may be necessary. Reinspections should occur within a week.

If not already in use as a physical barrier, high quality mattress and box spring encasements should be considered for all mattresses in the facility. These serve two purposes: a properly fitting encasement can be very effective at sealing in any bugs that may have escaped all of the other management efforts as well as protecting the mattress and box spring from becoming re-infested. Bugs trapped inside the encasement will eventually die from starvation and bugs on the outside of the encasement can easily be removed with mechanical methods such as vacuums. It is critical to use high quality encasements that have been specifically designed and tested for use against bed bugs. When purchasing mattress encasements, it is important that the encasements are both bed bug "bite proof" and "escape proof". It is important that encasements are installed correctly so that they are sealed completely, preventing the escape or entry of bugs. If the encasements become ripped or torn they must be replaced. Once installed, the encasements should not be opened or removed in order to insure that any bugs inside do not escape and are eventually starved. Remember, bed bugs can easily survive several months or more without food and in some cases have been observed surviving over a year without a blood meal.

Interception and Monitoring Devices

The ClimbUp® Insect Interceptor is a very simple, inexpensive pitfall style trap that is placed under the legs of bed frames and upholstered furniture. Once installed, they intercept and capture bed bugs as they travel to the sleeping and resting areas. The interception device can also capture bed bugs as they migrate away from beds and furniture, preventing them from infesting other parts of the structure and from getting into personal belongings that are difficult to treat. This type of monitor is considered a passive monitoring device because it does not use any lures such as CO2, heat or other attractants to entice the bed bugs into the device. It is important to pull the bed away from the wall and not to allow linens, comforters, dust ruffles or other items to hang off the bed in contact with the floor, so the bugs have no alternate path onto the bed, forcing them into the interceptors.

Monitoring devices that employ the use of carbon dioxide have recently been developed for the detection of bed bugs. In addition to using CO2 as the primary attractant, some of these devices also employ other attractants such as heat and chemical lures.

It is important to note that while monitoring tools and methods have certainly improved; no tool or method exists that is completely reliable in detecting bed bugs. For this reason, regardless of what method or device is used, the failure to detect bugs cannot be used as an indicator that no bugs are present. Low level infestations can still escape detection regardless of the detection methods implemented. In addition, detection tools are not to be confused as a solution for bed bug problems; they are strictly monitoring devices.

ClimbUp® Insect interceptor

NightWatch bed bug monitor

Specifics for Hotels

If a room is infested all rooms that have common walls, floors or ceilings with the infested room must be inspected. If the room is heavily infested, rooms across the hallway should also be inspected. If more rooms are found to be infested, the adjacent rooms must, again, be inspected until no infestation is found in a bordering room. If there are multiple complaints in different areas of the hotel it is strongly recommended the entire hotel be inspected, and treated as necessary. It is helpful when using chemical controls to treat a hotel room for bed bugs to treat surrounding uninfested rooms first. When the infested room is treated, any bed bugs that move out of the infested room will come into contact with pesticides and be killed.

Specifics for Multi-family Units

Staff and contractors working in vacant units should inspect for bed bugs on items left by the former resident, around the unit, and behind fixtures such as baseboards. Admission staff should ask new residents about any previous exposure to bed bugs and provides information on how to limit the chance of bringing bed bugs to the property. Housing is not to be denied because of previous bed bug exposure, but the apartment manager should work with the resident to ensure belongings are moved into the new home without bed bugs.

Specifics for Shelters

Furniture and Room Guidelines

Bed bugs thrive under certain conditions which are enhanced by the availability of hiding spots close to their human hosts. Bed bugs have a strong preference for paper and wood over metal and plastic. Porous surfaces provide more humidity and egg-laying locations. Furniture choices can greatly contribute to the control of bed bugs.

Guidelines for furniture include:

- Replace wood frame beds with metal frame beds to discourage bed bug hiding and egg-laying on beds.
- Eliminate head boards completely. Bed bugs hide and thrive in head boards.
- Replace all plush furniture with metal and plastic, or items easily cleaned with soap and water.
- Adding smaller cushions that can be placed in a dryer is one way to make residents more comfortable. Cushions should be dried on a hot setting if bed bugs are an issue.
- Use only white or light colored sheets.
- Use wooden baby cribs, but choose models that are painted white. Paint existing wood-colored cribs white. Fill gaps in the frames with silicone caulk. This will allow for much better inspection and reduce need for treatment. Avoid using pesticides on baby cribs!
- Vinyl-covered or seamless mattresses are recommended for adult beds and cribs.
- If vinyl mattresses have holes, consider repairing them with tape or discarding them.
- Do not discard regular (non-vinyl) mattresses only to replace them with other regular mattresses. Bed bugs will reinfest the new bedding quickly. Use mattress encasements.
- If a box spring is being used, be sure to encase it as well. The box spring is more likely to harbor bed bugs than the mattress.
- Wooden dressers, wardrobes, tables and other furniture can be painted white for easy inspection. Any crevices where a credit card will fit should first be sealed with silicone caulk to eliminate hiding spots.
- Discard any wicker furniture. Wicker provides infinite harborage to bed bugs and is impossible to treat effectively.

Other room guidelines:

- Moldings and joints around the room perimeter (floor, doors, cabinets, and windows) should be caulked with silicone sealant to eliminate hiding spots for both bed bugs and cockroaches.
- Openings around pipes or other structures that come through walls, floors and ceilings must be sealed. This will help with bed bugs, mice and cockroaches.
- People should keep sleeping in the room to avoid spreading bed bugs to other rooms or apartments, when possible.
- Residents should not store belongings under the bed when dealing with a bed bug infestation. This provides plenty of hiding spots that are difficult to clean.

Donations of clothing and household items:

Donations of clothing, shoes, coats, toys and other personal belongings are vital to many programs that help the disadvantaged. But sometimes when people discover bed bugs in their homes, they discard many personal belongings, and it is unclear how much of these discarded personal belongings make it to the donation stream. It is therefore important to be very careful about donated items to avoid the introduction or spread of bed bugs in your facility or home.

Suggested precautions for donations include:

- Wash and especially DRY on HOT all clothing, shoes, coats, linens, blankets, and plush toys before distribution.
- Sort donations on a clean linoleum floor. Prevent the escape of bed bugs into your facility by sorting inside a perimeter of carpet (double-sided) tape placed around the working space. This creates a sticky barrier that bed bugs cannot cross.
- Shake out clothing; inspect books and toys carefully.
- Ban all cardboard boxes for donations from your facility. Instead use clear plastic bags.
- Keep sorted and laundered items away from items that have not been checked or treated.

Specifics for Hospitals

Seal the linens and any other removable cloth (curtains, cushions, pillows, towels and so on) into a plastic bag and take them to the laundry room. Remove any other linens in the laundry room to keep the bedbugs from spreading onto them. Wash the linens from the infested room as soon as possible in hot water with detergent and dry them. Tie the bag closed in between loads and again before disposal. Steam clean the mattresses and any other soft furniture in the infested room. If the room is carpeted, steam clean it as well. Wash down the room, especially crevices and floors, with the alcohol-based cleaner (or use a 50% ethanol/50% water solution). This will destroy any eggs or adults that landed on the floor during linen removal. Clean your laundry room with the solution once all the infested linens have been washed. Continue to check rooms on a routine basis. If the infestation spreads to more than a few rooms or keeps coming back, contact a pest control specialist.

Specifics for Schools

Contact the parents or guardian to inform them of the bed bug presence on their child.

- Suggest clean, freshly laundered (on high heat setting) and sealed change of clothing be sent to school (as long as needed).
- Send only essential items to school with the student and inspect items upon arrival at school. If possible, the school could offer to keep non-essential items overnight to help ensure the items are bed bug free.
- Suggest keeping school items sealed in a plastic bag or tote at home and limit items going back and forth from home to school until infestation is treated.
- If bed bugs are a continuing problem, the school may want to provide sealable plastic containers for students to store items brought from home.

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APPENDICES

1. BED BUG MYTHS
2. INFORMATION FOR THE ENVIRONMENTAL HEALTH SPECIALIST
3. INFORMATION FOR THE HOTEL MANAGER/HOME OWNER
4. ACTION PLAN FOR HOTEL BED BUG TREATMENT – EXAMPLE
5. BED BUGS: WHAT SCHOOLS NEED TO KNOW FLOWCHART
6. SCHOOL LETTER TO PARENT OR GUARDIAN

BED BUG MYTHS

Bed bugs are only a problem in low-income neighborhoods.

False! Anyone can have a bed bug infestation. It is a common misconception that only dirty or low-income homes carry bed bugs. The truth is that bed bugs prefer human blood, and they will feed on anyone, regardless of their cleanliness or socioeconomic status.

Bed bugs carry disease.

False! Bed bugs do not transmit disease; however, secondary infections can occur from scratching bed bug bites.

Any insecticide will kill bed bugs.

False! Pesticides and other treatments are effective against pests, but are not necessarily effective against bed bugs. For example, boric acid kills cockroaches, because they ingest the poison. Bed bugs only feed on blood so boric acid is virtually ineffective. Some pesticides will kill bed bugs that are out in the open and if they are sprayed directly. However, the majority of bed bugs in an infested building are hiding and it is unlikely they will be killed by these contact pesticides.

Household bug bombs that are meant for flying insects will kill bed bugs.

False! Bug bombs will not kill the majority of bed bugs in an infested room. These insecticides typically cause bed bugs to scatter so that they can avoid the irritating effect of the spray. The scattering effect from bug bombs makes the bed bug infestation much worse!

INFORMATION FOR THE ENVIRONMENTAL HEALTH SPECIALIST

Steps to take when inspecting a room for bed bugs:

- **Furniture must be inspected carefully**, even to the point of dismantling the bed for easier inspection and possible treatment. Look especially behind the headboard. Check the mattress and boxspring carefully, particularly the seams and dust cover on the underside of the boxspring.

- **Check under and behind other pieces of furniture**, such as chairs, couches, dressers, etc. It may be necessary to remove the dust covers on the undersides of chairs and couches. Pull drawers out of dressers, inspect them carefully and examine the interior of the dresser. Check under lamps on nightstands.

- **Remove and inspect objects,** such as pictures, mirrors, curtains, etc., that are hung or mounted on walls.

- **Check obvious cracks and crevices** along the baseboards, particularly the back framing pieces.

- **Inspect** torn or loose wallpaper and decorative borders.

- **Check clothing and other items** stored in areas where bed bugs have been found.

- **Check attics, eaves and roof overhangs** for signs of bat or bird activity. Request old nesting material is removed. If there are bats roosting in the attic, have management contact a pest control company or wildlife removal company in the area for assistance.

From: http://www.ces.ncsu.edu/depts/ent/notes/Urban/bedbugs.htm

INFORMATION FOR THE HOTEL MANAGER/HOME OWNER

Steps to take to enhance pest control treatments and to eliminate an infestation more quickly:

- **Examine all items in infested rooms for bed bugs**. Look for black or brown fecal spots to pinpoint hiding places. Kill bed bugs by dropping them in hot, soapy water and flushing. Remember that immature bed bugs are very tiny. Don't forget to check under mattress buttons, between the mattress and box springs, and behind the headboard.

- **Launder bedding and dry** in a hot dryer to kill all stages of bed bugs.

- **Thoroughly vacuum** infested areas. This includes the mattress, box springs furniture, beds, headboards, and sofas. Do not forget the void area underneath box springs--tear away the cambric fabric and look for bed bugs there. After you are finished, bag the vacuum cleaner bag and take it to the outside trash dumpster. Bed bugs are very resistant to being killed and you do not want them crawling out of the vacuum cleaner to re-infest the building. Vacuum every couple days until the infestation is gone.

- **Use a steamer on mattresses** to kill eggs that might have been overlooked. Steaming is effective and safer than spraying mattresses with insecticides. Steam cleaning carpets is also a good idea, but work with the pest control company to make sure you are not interfering with the effectiveness of treatments. Be sure that mattresses dry completely to avoid mold and mildew.

- **Eliminate clutter** in infested areas to reduce bed bug hiding places and make treatments more effective. Stacks of clothing, paper items, and corrugated cardboard are likely hiding places because bed bugs like to hide in small cracks.

- **Repair cracks and crevices. Eliminate harborage areas by filling in cracks, removing torn wallpaper, and sealing joints and cracks.**

Action Plan for Hotel Bed Bug Treatment - EXAMPLE

1. Communicate and partner with hotel management on necessary steps, timing and access.

2. Vacuuming (provides immediate reduction of bed bug population)

   - Remove bed linens & covers and seal in plastic bags
   - Vacuum seams of mattress (both sides). Stand mattress against wall.
   - Vacuum seams along top of box springs. Carefully stand box springs on end.
   - Vacuum along all edges along dust cover under box spring & carefully remove cover
   - Vacuum any bed bugs found inside box springs. Some rooms have platforms instead of box springs.
   - Vacuum any bed bugs found elsewhere in the room (drapes, upholstered furniture, etc.)
   - Vacuum carpeting under and around bed to remove eggs

3. Steaming and/or RapidFreeze
   (to provide thermally induced mortality for bed bugs and their eggs)

   - RapidFreeze and/or Steam all areas of mattress and box spring where bed bug activity was found.
   - RapidFreeze and/or Steam headboard, along baseboards, and all furniture where bed bug activity was found.

4. Dust Treatment (residual to help control bed bugs and for new bed bug introductions.

   - Apply dust liberally to cracks and underneath box springs — reattach dust cover
   - Apply dust into all cracks of furniture, cracks in baseboards, etc.
   - Apply dust under edge of carpet along tack strips.
   - Apply dust into wall voids behind wall outlets and plumbing voids.
   - If a wood frame is present for the bed, apply dust liberally to that area once box springs are replaced

5. Spot Treatments (with Phantom SC)

   - Treat back side and cracks of headboard and the back sides and underneath side of nightstands, drawers & dressers.
   - Treat along baseboards of wall.
   - Treat carpeting around and under bed.
   - Install mattress encasements

6. Other Guidelines

   - Advise hotel to heat bed spreads and draperies (if infested) in dryer at high heat for 30-45 min.
   - Advise hotel to launder sheets and pillow cases ASAP in hot water.

7. Adjoining Rooms

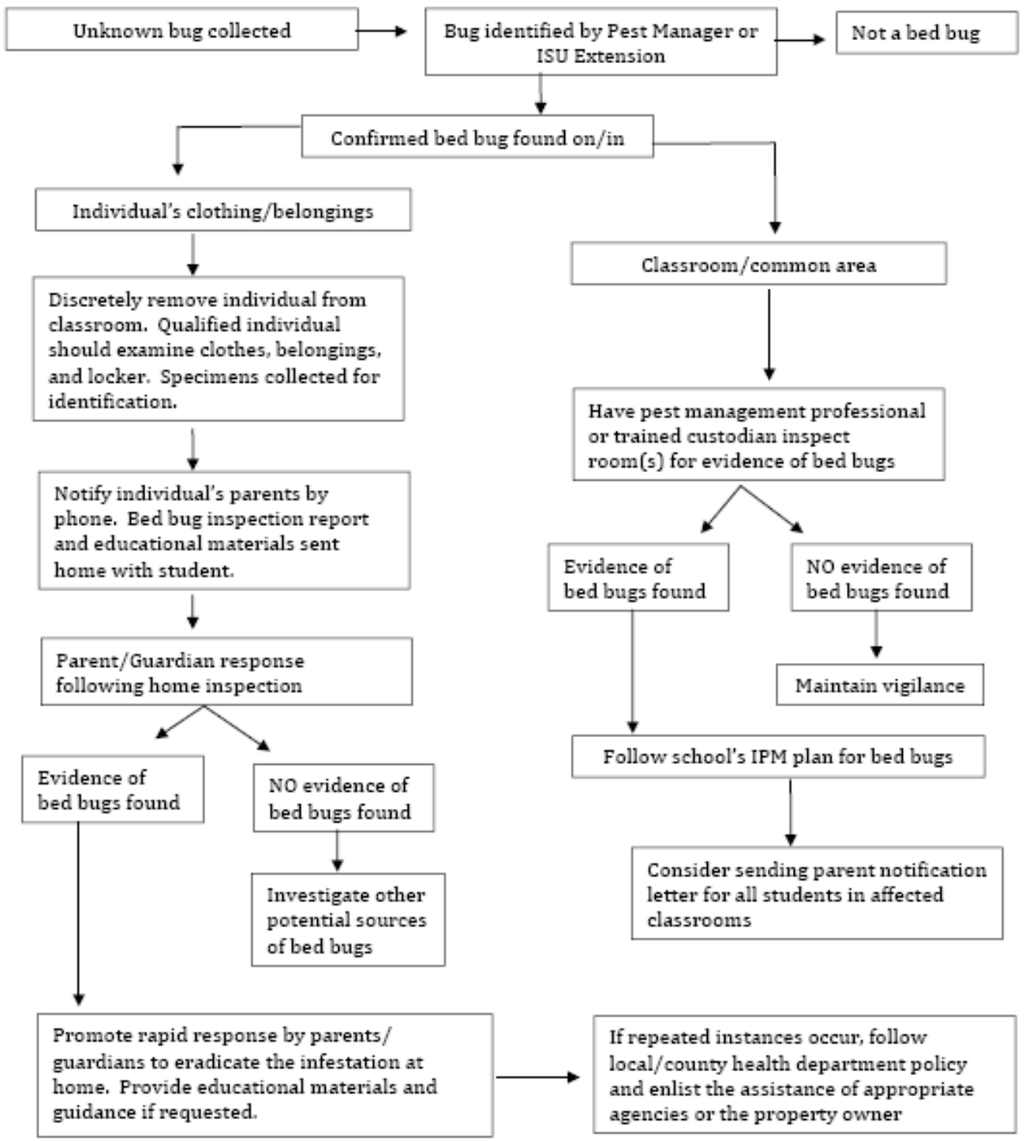
   - Inspect for bed bug activity and perform defensive treatments as described above. Results of inspection and treatment to be entered on a chart for follow up. Any adjoining rooms with evidence of activity will become “primary” rooms and the rooms connected will be inspected and treated as well.

This particular service requires a certain amount of preparation prior to the service professional’s arrival to make sure the property is properly serviced. Simply follow the steps listed below to ensure the best results from the bed bug service.

- All sheets, bedding materials and pillows except the bottom sheet should be removed from the beds and sealed in plastic trash bags until they can be treated as described in the next step. This helps prevent spreading bed bugs to other rooms.
- Sheets, pillows and clothes stored under the bed (or in a dresser harboring bed bugs) can be washed in soap and hot water. Bed spreads, covers, pillows and other items that cannot be washed should be dried in the dryer at high temperatures for 30 minutes. Please read the washing instructions on clothes to ensure the item will not be damaged.
- Headboards, wall hangings and pictures permanently fastened to the walls must be removed from the wall and left in the room for treatment. Electrical fixtures should not be removed.
- Drapes should be bagged before moving from an infested room. Remove them from the bag and dry them at high temperatures for 30 minutes.
- Plastic bags should be available for when the Service Professional inspects items stored in the nightstand. If items are free of infestation, they will be sealed in the bags.
- Treated rooms will be out of inventory for a minimum of 48 hours.
- The treated rooms will be cleared in writing before being placed back in service.

Any furniture that cannot be properly treated for control by the above described means will be contained in plastic and treated by alternative means such as heat or fumigation.

Flowchart courtesy of Michigan Bed Bug Working Group's "Bed Bugs: What Schools Need to Know" document.



HEALTH SERVICES

NOTIFICATION AND INFORMATION

ABOUT BED BUGS

Dear Parent or Guardian:

We recently found a bed bug in your child's classroom. Bed bugs are a nuisance, but their bites are not known to spread disease. Bed bugs are usually active at night and feed on human blood. The bite does not hurt at first, but it may become swollen and itch, much like a mosquito bite. Watch for clusters of bites on exposed areas of the body. If you have concerns for you or your child, please contact your doctor.

The source of bed bugs often cannot be determined, as bed bugs may be found in many places including hotels, planes, and movie theaters. Even though it is unlikely for bed bugs to be spread in schools, _____ (add your school district here) will conduct an inspection and, if needed, will treat the area where the bed bug was found.

_____ (add your school district here) will continue to work to identify bed bugs, provide thorough inspections of schools, and have licensed pest control specialists treat the rooms if a problem is found.

Contact your physician or school nurse for proper care and treatment of bed bug bites.

If you have any questions regarding bed bugs in your school, please contact the principal or school nurse. If you have any questions regarding bed bugs found in your home, refer to the Georgia Department of Public Health's web site at http://health.state.ga.us/epi/zvbd/infest/index.asp.

Sincerely,

School Nurse_____ Principal_____

(If one is available)

Vector-Borne & Zoonotic Diseases Team
Acute Disease Epidemiology Section