

European Code of Practice

Version 2

Bedbug Management



www.bedbugfoundation.org



Preface and Acknowledgements

The European Code of Practice (ECoP) is based on the 3rd edition of the Australian 'Code of Practice for the Control of Bedbug Infestations in Australia' (www.bedbug.org.au). The trustees of the Bedbug Foundation would like to express their sincere thanks and appreciation to Stephen Doggett and the Australian Environmental Pest Management Association for their vision and thoughtfulness in allowing their document to be shared. Bedbugs are a global problem and we need to ensure that global standards are created, based upon shared and similar points of view towards eradication and best practice.

The trustees would also like to thank all those who took the time to read and submit comments on the consultation document that was released in late 2012. The Bed Bug Foundation was overwhelmed by the public feedback and feel that the ECOP has benefitted dramatically as a result.

The ECOP is now in its second edition and will continue be reviewed periodically to ensure it incorporates the most recent advances in research and management technology in the control of bedbugs. All versions encompassing major changes are made available for consultation. Minor changes are undertaken at the discretion of the Senate Working Party (www.bedbugfoundation.org/senate).

Unlike the previous edition, the ECOPv2 is now targeted solely at Pest Control Technicians (PCTs), with the aim of providing the most up to date advice for the treatment of bedbug infestations. The ECOPv2 also outlines key aspects bedbug biology and behaviour; an understanding of which is crucial for informing control strategies. Documents written specifically for private residents and accommodation providers will be made available in due course through the Bedbug Foundation (BBF) website (www.bedbugfoundation.org).

This version of the ECOP has been specifically tailored to PCTs operating in the UK. The ECOP is also being made available in most other European languages complete with country-specific information on relevant rules and regulations.

Any suggestions for the improvement of the ECOPv2 should be submitted to www.bedbugfoundation.org/feedback or sent by email to info@bedbugfoundation.org.

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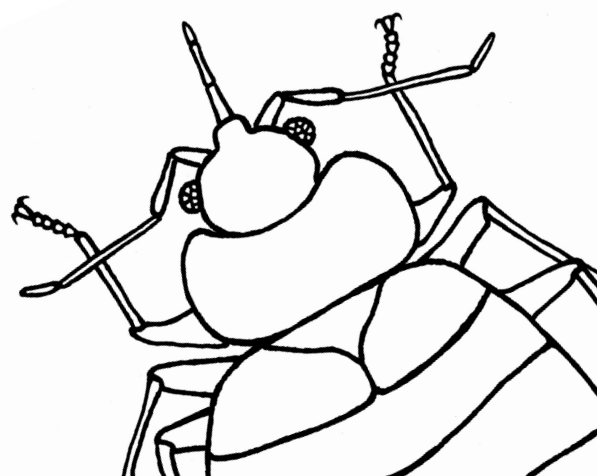


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1 Introduction

The remains of bedbugs have been found in the tombs of Egyptian mummies, proving an association between bedbugs and humans has existed for more than four thousand years. However, it is likely that bedbugs evolved from bat bugs, and made the transition from bats to humans at a time when humans still lived in caves, subsequently following them out into civilisation.

Following World War II, synthetic insecticides (e.g. DDT), combined with better standards of living, removal of slums and construction of affordable housing, contributed to dramatic declines in bedbug populations across Europe and the rest of the developed world.

Bedbug populations remained at very low levels for approximately 50 years, however since the turn of the century many reports have shown a dramatic increase in the number of new bedbug infestations in Europe, Australia, Asia and North America.

The resurgence of bedbugs early in the 21st Century is likely to be the culmination of multiple factors facilitating their survival, reproduction and spread. Treatment failures due to inappropriate pest management practices have certainly contributed to this problem. The aim of the ECoP is to arm Pest Control Technicians (PCTs) with the best information currently available on the treatment of bedbug infestations.

2 Bedbug Management

Successful bedbug management is a 6 step process:

- | | |
|-----------------------------------------------------|-----------|
| 1. Identification of the insect | (see 3) |
| 2. Evaluation of spreading (may include monitoring) | (see 7/6) |
| 3. Non chemical elimination | (see 9.2) |
| 4. Chemical elimination | (see 9.3) |
| 5. Evaluation of elimination | (see 9.5) |
| 6. Prevention (and monitoring) | (see 5/6) |

It is essential that none of the steps are overlooked. Although it may not necessarily be the PCT that carries out each step, it is the PCT's responsibility to make sure that all steps are carried out properly and that all relevant parties are aware of their role in the process. A culture of over-reliance on **step 4** has led to the widespread insecticide resistance we see today and this problem will continue to get worse if it is not addressed. In many cases even **step 1** is overlooked or not done with sufficient competence, resulting in inappropriate or unnecessary treatments.

2.1 Bespoke Bedbug Management Strategy

A Bespoke Bedbug Management Strategy (BBMS) is an operational understanding between the customer (usually a hotel) and the company providing pest management. It is very unlikely that a BBMS would be required in a private residential setting.

The BBMS sets out in writing the specifics of how the 6 steps of bedbug management will be achieved. It contains sets of instructions, policies, reports and responsibilities. If an infestation is identified, the aim of the BBMS is to achieve complete eradication of the infestation, as quickly and cost-effectively as possible. The BBMS can also contribute to reducing potential litigation risks associated with bedbug infestation by demonstrating best practice. The BBMS should be drawn up by the PCT and/or hotel management following an initial site assessment, and ideally before an infestation occurs.

The BBMS should include:

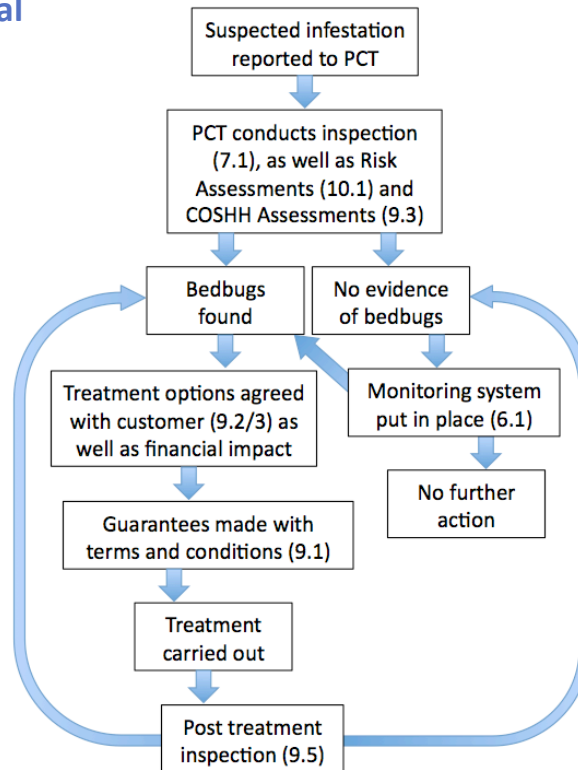
- Guidance on the handling of dirty laundry (avoid piling it up in the corridors)
 - On-site responsibilities for proactive and reactive monitoring
 - Details of staff training
 - Records of inspections and outcomes
 - Escalation framework & Treatment options (see 9.2/9.3)
 - Risk assessments (see 10.1) and COSHH assessments (see 9.3.1)
 - Guarantees (limitations and restrictions, and conditions of validity) (see 9.1)
 - Financial impact
 - A review date for the BBMS
- } see 5.1

The documents need to be treated as a live and evolving set of directions. While conditions on-site may not frequently alter, technology and equipment within the pest industry is rapidly being developed and enhanced for bedbug management. As such, it is advisable to set review dates to ensure that the strategy remains effective, both financially and operationally. Pest control organisations that are already standards-certified (ISO 9000 or 14000) should consider including a BBMS within their operational processes. The BBMS should be made available to all persons included within the document. As such, it may be appropriate to keep any financial detail within a separate service agreement, ensuring that financially sensitive data is not available to everyone.

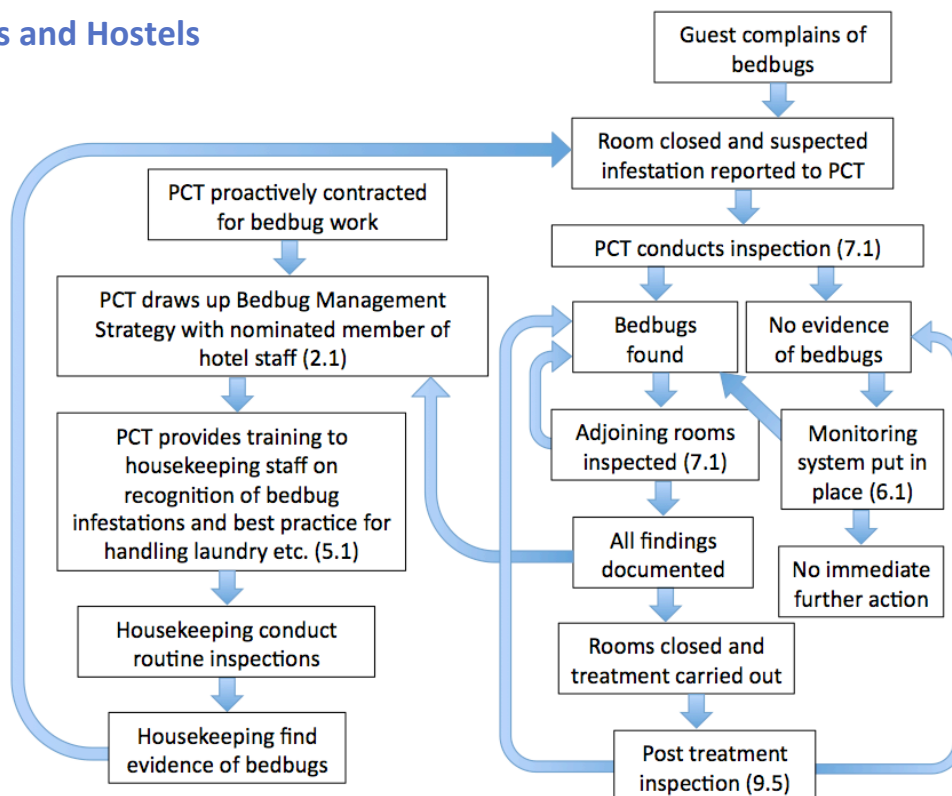
2.2 Typical Treatment Process

The treatment process is likely to vary depending on the particular circumstances of the infestation (e.g. the type of housing). The following flow charts give typical examples of treatment processes in a private residence and hotel, with reference to where detailed information on particular aspects of the process can be found within the ECoP.

2.2.1 Private Residential



2.2.2 Hotels and Hostels

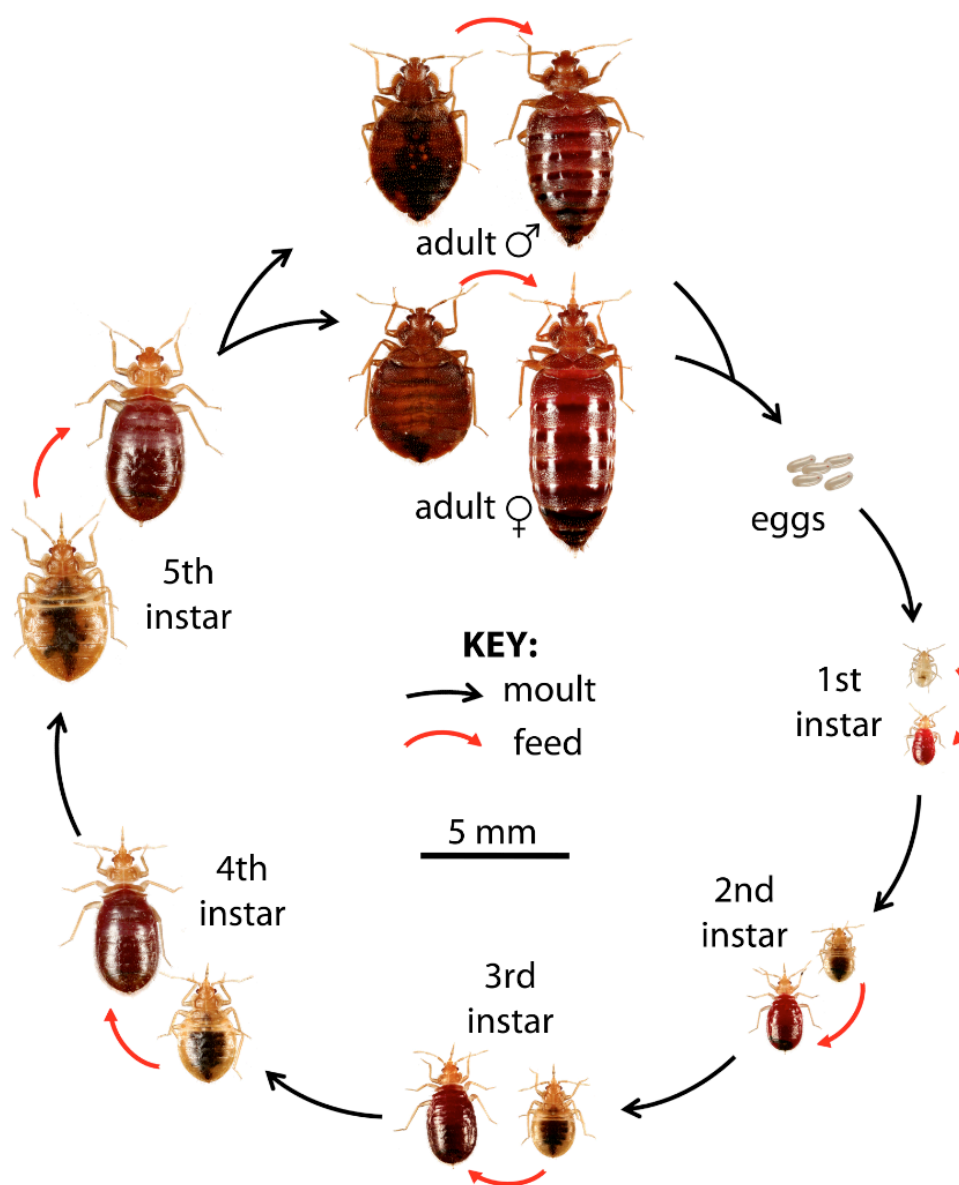


3 Bedbug Biology

To be effective at controlling bedbug infestations it is important to understand various aspects of the bedbug's biology and behaviour. A good understanding of the target pest is essential for its correct identification, location of the harbourages and for devising effective control strategies.

3.1 Lifecycle

Bedbugs are true bugs (Order: Hemiptera), belonging to the family Cimicidae. Like all other members of this family they feed solely on blood, requiring a meal from one of a range of vertebrate hosts in order to develop between instars (life stages) and to reproduce.

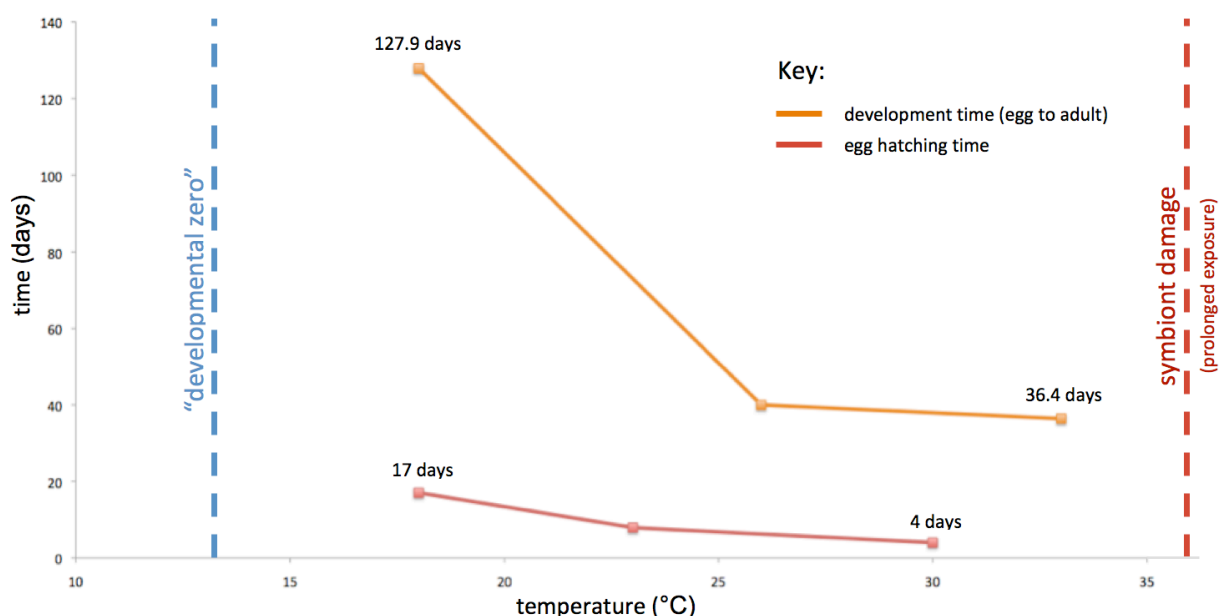


Lifecycle of the bedbug.

Image – ©Richard Naylor

3.1.1 Development Time

Development time is highly influenced by temperature. Below 13°C all development ceases, females stop laying and any eggs that have been laid do not hatch. Above 36°C, damage to the bacterial symbionts, which help with the synthesis of micronutrients, results in reduced fecundity and survival. Between these two extremes development time decreases with increasing temperature (see below).



Effect of temperature on egg hatching time and total development time. At temperatures below 13°C all development ceases. At temperatures above 36°C (prolonged exposure) mortality occurs due to symbiont damage.

3.1.2 Reproductive Rate

Female bedbugs need to mate at least once every 5-6 weeks to maintain full fertility, although natural mating rates are believed to be very much higher.

The number of eggs a female lays per week is highly influenced by temperature and individual variation. In a warm room, a single female might be expected to lay 15-25 eggs per week, and up to 500 throughout her life, as long as she has continuous access to food and is regularly mated.

3.2 Identification

Misidentification and consequently inappropriate treatments have been widely reported. It is essential that Pest Control Technicians (PCTs) can recognise all bedbug life stages and signs. They must also be familiar with other common household insects (see Appendix 1) and be confident in their ability to train others (e.g. hotel staff) in what to look for.

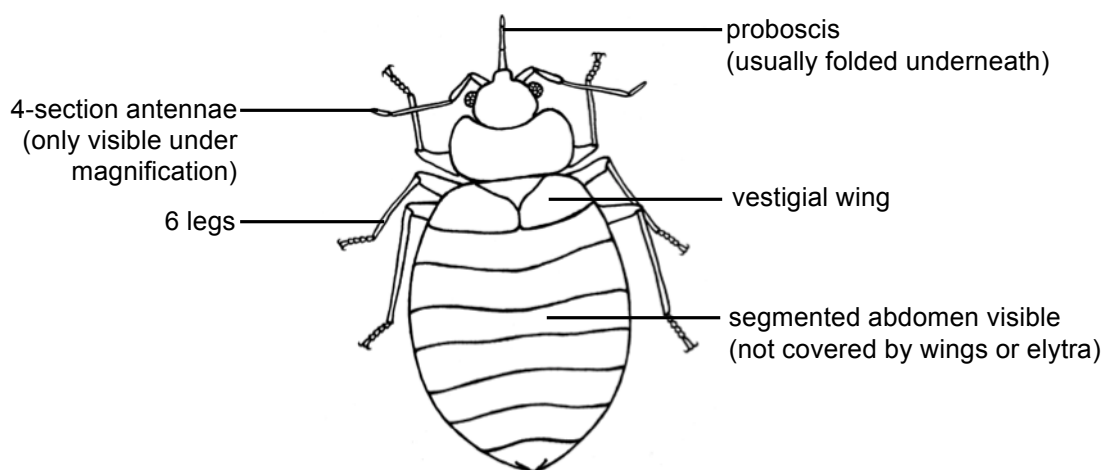
The Bedbug Foundation provides a free identification service for suspected bedbug specimens. Details of where to send photographs or specimens can be found on the Bedbug Foundation website (www.bedbugfoundation.org).

3.2.1 Indicators of an Infestation

The following signs may be an indication of a bedbug infestation.

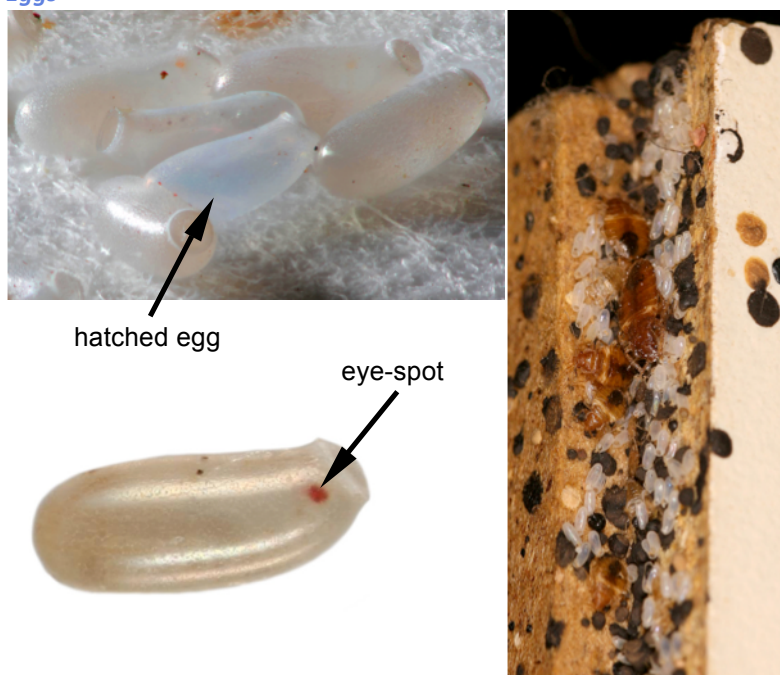
Live stages

The presence of live bedbugs is the only absolute proof of an active bedbug infestation. It is therefore the only justification for treatment. Some of the key features are shown on the diagram below.



As bedbugs do not have a larval stage, these features are visible at all stages of the lifecycle (except the egg).

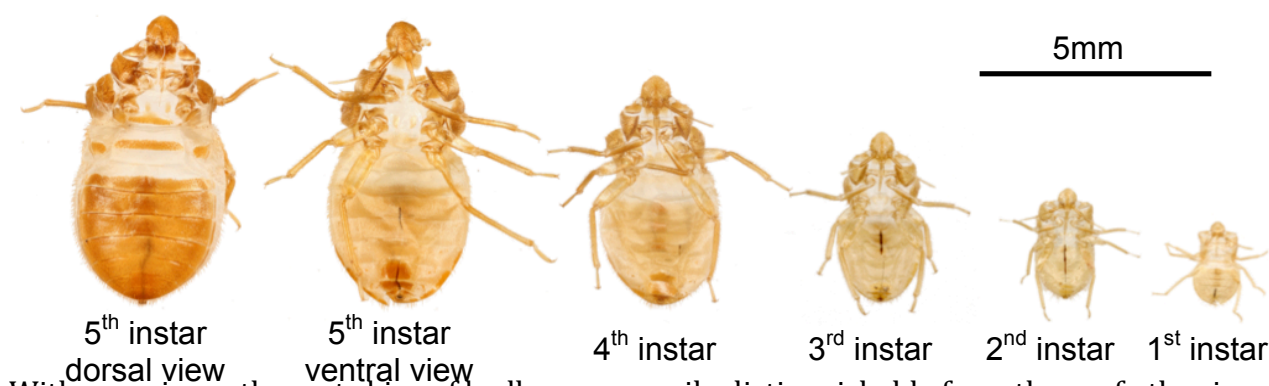
Eggs



The eggs of bedbugs are small (ca. 1.2 mm long), but easily distinguishable (with experience) from those of other household insects.

Under magnification hatched and viable eggs can easily be distinguished. Viable eggs are pearl coloured and, during the later stages of development, the eye-spot of the developing embryo is visible through the shell of the egg. Hatched eggs are recognisable by the absence of an end-cap and their translucent appearance.

Cast skins



With experience the cast skins of bedbugs are easily distinguishable from those of other insects. However, they can last for a long time and cannot therefore be used to distinguish active and past infestations.

Faecal spots



Bedbugs start producing dark, aqueous faecal material as soon as they have fed. These faecal spots are often one of the first indicators of an infestation. Black, ink-like spots on the sheets, mattress or bed frame are one of the most recognisable tell-tale signs of bedbugs. However, very similar spots can be produced by spiders, flies and German cockroaches, so location can be an important factor in distinguishing the two. Spots found high on the walls, on the ceiling, or on light fittings are much more likely to be produced by flies. Blood identification kits have shown promise at being able to distinguish the faecal material of blood-feeding insects, such as bedbugs, from that of other household invertebrates.

Faecal spots can vary in colour from black through to tan depending upon the relative proportions of digested blood and uric acid. The appearance of the faecal spots is also influenced by the absorbency of the substrate they are deposited on. Faecal spots deposited on absorbent surfaces such as bed sheets are wicked into the fibres, resembling ink from a fountain pen. Faecal spots deposited on non-absorbent surfaces such as varnished wood, often dry as a dark, raised lump.



Faecal spots of bedbugs and flies on wall paper.

Bites

Bedbugs feed on exposed skin and often prefer not to climb onto the host as they feed. This can cause bites to occur in rows as they move along the edge of the exposed skin searching for a suitable feeding site.

Bites should never be considered a conclusive sign of a bedbug infestation, as they can be caused by a range of other insects including midges, mosquitoes, fleas and lice. Similar reactions can also be caused by scabies mites and a wide variety of allergens.

Reactions to bedbug bites are highly variable between people. Some have no reaction at all, while others have strong, blistering reactions. More serious (anaphylactic-like) systemic reactions are rare but have been reported.



The skin reaction to a bedbug bite may be delayed for up to two weeks, particularly if it is the first time that the sufferer has been bitten. Consequently, if the person has recently been traveling, it can be difficult to establish exactly where and when the bites occurred. This can lead to the false belief that they have brought bedbugs home with them or alternatively lead to delays in the detection of an infestation.

Bedbugs usually feed at night, however, they are highly adaptable and will adjust their feeding cycle depending on the daily movements of the host. Chairs and sofas often become infested in situations where the occupant spends the majority of the day sitting in one place. In such situations bedbugs will be forced to feed during the day, while the host is present.

DNA swabbing

Companies are now offering bedbug detection services through molecular techniques. This involves swabbing of the mattress and bed frame with a cotton swab, which is then sent off for analysis. In situations where a resident exhibits bites but the cause cannot be determined, DNA swabbing may help provide confirmation. However, it is important to be aware of the following:

- DNA is highly persistent in the environment, so this technology will only determine if there is OR has previously been an infestation. Consequently, this can not be used as sole justification for applying a chemical treatment.
- A negative result is not conclusive of a bedbug free environment as the technology requires that adequate quantities of bedbug DNA are collected on the swab.
- If the swabbing is conducted by a PCT who has recently been in contact with active bedbug infestations, there is a significant risk of accidental bedbug DNA contamination of the swab from the PCT's skin or clothes.

Scent detection dogs

The use of scent detection dogs for detecting bedbug infestations is rapidly becoming more common. However, dogs must never be used as sole justification for treatment and should only be an aid to establishing visual confirmation, as the accuracy of scent detection dogs is controversially discussed in the academic community (recent research publications from the

USA*)

The ECoP recognises the potential value of scent detection dogs, particularly in situations where large numbers of rooms need to be screened in a short period of time.

The BBF endorses the use of dogs for bedbug detection and has proposed best practice for the training and validation of bedbug scent detection dogs. A specific code of practice exclusively on this particular topic was published in December 2016 and is available for download on the BBF website.

* Wang C-L. & Cooper R. (2011) Detection Tools and Techniques. PCT Online – Bedbug Supplement. 72-122

4 Medical Significance

NB: For more detailed information on the medical significance of bedbugs, see the recent review by Doggett, S. L., Dwyer, D. E., Peñas, P. F. and Russell, R. C, (2012) Bedbugs: Clinical Relevance and Control Options. *Clin. Microbiol. Rev.* 25:164-192.

4.1 Disease and Secondary Infection

Many studies have looked at the potential for bedbugs to transmit disease and while bedbugs have been found infected with a variety of human pathogens, at present there is no evidence that they can transmit these pathogens to a new human host. However, this does not mean that bedbugs should be dismissed from a medical standpoint. Reactions to bites are extremely variable and can be severe. Marks on the skin can last for weeks and in some cases result in permanent scarring. Urticaria and anaphylactic reactions have also been reported.

Bedbugs have been implicated in the spread of Methicillin-resistant *Staphylococcus aureus* (MRSA). There is currently little evidence that they actually transmit the bacterium from one host to another. However, MRSA is relatively common in the environment and on the skin of many people. Any skin lesions therefore have the potential to allow environmental or cutaneous MRSA (or other pathogens) to enter the bloodstream and develop into a systemic infection.

Anaemia (iron deficiency in the blood) has been reported in cases where hosts have sustained large numbers of bites over a prolonged period. The frequency of occurrences of bedbug induced anaemia is unknown but presumed rare.

4.2 Psychological and Sociological Consequences

The psychological impact of a bedbug infestation is potentially severe, although it is presently poorly understood. Sleep deprivation, and its associated symptoms, are commonly reported by bedbug infestation sufferers. Bedbug related anxiety can be extreme, even triggering symptoms of ‘delusional parasitosis’, where the sufferer believes that they and/or their surroundings are crawling with parasites (or often specifically bedbugs). These symptoms can persist for long after the real infestation has been eliminated. In some cases sufferers may require counseling to overcome these delusions.

5 Prevention/Mitigation

It is rarely feasible to completely prevent bedbugs from entering a property but steps can be taken to ensure that when an infestation does occur it is identified swiftly and eradicated successfully with minimal impact in terms of time and expense.

For the hospitality industry, the value of being proactive and having a Bedbug Management Strategy (Section 9) in place before an infestation arises has never been more crucial. Negative media attention and lawsuits as a result of bedbug infestations both represent major threats to hotels. Widespread internet access through smart phones makes it possible for upset guests to report infested hotels on consumer forums even before they leave the room. The only defense that the hospitality industry has is being able to demonstrate due diligence. They must be able to reassure a bitten guest that they take the problem very seriously and already have systems in place for dealing with infestations as they arise.

5.1 Routine Inspections

In a private residence routine inspections are unlikely to be worthwhile, unless the particular circumstances of the property put it at significant risk of infestation. However, in hotels/hostels routine inspections form an important part of the Bedbug Management Strategy, not least as a way of demonstrating due diligence.

It is not normally necessary for the PCT to carry out routine bedbug inspections as this can be done by the housekeeping staff. The role of the PCT is to make sure that the housekeeping staff are familiar with the tell-tale signs of a bedbug infestation and to draw up a Bespoke Bedbug Management Strategy (BBMS) detailing the frequency of inspections, how they should be logged and what to do if an infestation is identified (2.1).

The frequency of the routine inspections can be tailored to the requirements of the hotel. A hotel with a history of problems with bedbugs is likely to warrant more frequent/thorough inspections than a hotel that has never had an infestation.

Guidelines for routine inspections within a typical Bedbug Management Strategy may be as follows:

- Housekeeping staff given training on recognition of signs of bedbug infestations (certificates issued and kept on file for demonstration of due diligence).
- Housekeeping staff give cursory inspection of bedding and bed area during each room change between guest, looking specifically for faecal traces on the bedding (this is not expected to extend the processing time of each room).
- If suspected signs of bedbugs are found, the bedding should be left in place and the room closed until a PCT has inspected the room thoroughly.
- On a regular basis (e.g. quarterly) each room is given a more thorough inspection by the housekeeping staff, mattresses are turned over and records of findings are recorded and filed (this is important for demonstration of due diligence).

NB. Many hotels have a policy of turning/rotating mattresses on a biannual or quarterly basis, which provides an ideal opportunity for a detailed survey.

5.2 A Bedbug Unfriendly Environment

Bedbugs thrive in situations where they have abundant harbourages in close proximity to the host. Furthermore, cluttered environments are much more complicated to treat if an infestation

arises, as many items are likely to need to be disinfested. This section outlines some of the ways in which a room can be set up to minimise the impact of a bedbug infestation.

5.2.1 Reducing Clutter

Bedbugs preferentially use cracks and crevices in close proximity to the host. Small infestations are almost always in the structure of the bed, or very close to it. Only in larger infestations, or where bedbugs have been dispersed by chemicals or physical disturbance, do bedbugs occupy harbourages away from the bed. Simplifying the environment in the immediate vicinity of the bed can therefore minimise the number of items that will need to be disinfested should an infestation arise. A zone around the bed of 1-2 meters should be sufficient to keep items free from bedbugs as long as infestations are detected early, although this may not be possible in every situation.

Storing items in sealed plastic boxes can greatly reduce the number of potential hiding places, making it possible to utilise space under the bed for storage, while maintaining a bedbug unfriendly environment.

5.2.2 Bed Isolation Devices

A range of products are available to prevent bedbugs from being able to climb up the legs of the bed. The simplest products are sticky tapes that wrap around the bed legs of the bed and trap bedbugs that are attempting to cross. However, not all tapes are equally effective and anecdotal evidence suggests that bedbugs also have some ability to avoid sticky surfaces.

Several products based on a pitfall trap design are also available. These tend to be installed either under or around the bed legs. As long as the bed and bedding are kept away from the wall, bed isolation devices can provide some protection from bedbugs.

Pitfall trap designs rely on the poor ability of bedbugs to climb shiny surfaces. Some use a dusting of talcum powder to make the surface more slippery. Both the pitfall traps and the sticky tapes tend to be rendered ineffective by a buildup of dust and therefore need regular maintenance or replacement.

5.2.3 Sealants

Silicon or caulk sealants can be used to eliminate cracks and crevices, limiting the number of places a bedbug can hide. This can simplify potential future treatments as long as care is taken to seal crevices thoroughly. Direction on the sealing product must be followed carefully to ensure a good bond. Application to a dusty or greasy surface could peel away allowing access to the void behind. If a void is still accessible to bedbugs after the sealant has been applied, there is a danger that the sealant may provide the bedbugs with extra protection from crack and crevice insecticide treatments in the future.

5.2.4 Encasements

Encasements are designed to eliminate potential hiding places in the bed by encasing the mattress and/or bed base (separately) in a well-fitting bag, usually with a zip closure. These products can be used preventatively or as a control option, sealing in the bedbugs permanently.

Most advertising of these products focuses on encasements for mattresses and pillows. Mattress encasements ONLY prevent bedbugs from infesting the mattress. While this may save a small amount of time and effort, it is of limited use in the context of a complete control strategy, since bedbugs harbouring on mattresses can normally be removed by vacuuming, steam or other treatment options.

By contrast, bed base encasements can be of considerably greater value for bedbug control, as bedbugs harbouring inside divan (or box-frame) beds are notoriously difficult to treat. Bed

base encasements can provide savings (in time and money) compared to replacing the entire bed. These encasements can be left in place permanently, but if the intention is to remove it, after the bedbugs have been eradicated, it is important to be aware that bedbugs have been known to survive for up to a year without feeding.

NB. Chemically impregnated mattress covers are not the same as encasements and are not endorsed by ECoP. Chemically impregnated covers are usually treated with pyrethroids, which most populations of bedbugs are already resistant to. The concentration of insecticide on the covers is very unlikely to control an infestation but may serve to select out the least resistant individuals from the population, resulting in increased resistance in subsequent generations.

5.2.5 Suitcase Stands

It is considered good practice for hotels/hostels to provide suitcase stands and encourage guests to use them. Suitcase stands keep suitcases off the floor and away from the bed. By doing so, they reduce the risk of bedbugs spreading from infested baggage to the bed and vice versa.

6 Monitors

Over the past few years numerous bedbug monitors have become commercially available. Some of these can be a valuable asset to bedbug management. However with so many options and so little independent research it has become extremely difficult to know which devices to select.

There are several different scenarios in which bedbug monitoring may be of value:

- **Continuous, early detection monitoring** – for rapid identification of new infestations
- **Reactive monitoring** – for confirmation of infestation in response to bites or signs
- **Post-treatment monitoring** – for confirmation of treatment success

Note that not all bedbug monitors are suitable for all situations. Some monitors are extremely expensive and are therefore not intended to be placed in every room of a hotel for example. Some monitors are only designed to run for a limited period and would therefore not be recommended as part of a continuous monitoring program.

Monitors can be broadly divided into active and passive designs. Active monitors use an attractant to lure bedbugs in, while passive monitors rely on their location and the attractiveness of the host to catch bedbugs. Active monitors can be subdivided into those that employ bedbug aggregation pheromones, appealing to the bedbug's harbourage-seeking behaviour, and those that employ host cues, such as heat and carbon dioxide, designed to attract foraging individuals.

When selecting a monitor it is important to consider the following questions:

- Is the cost justified?
- Can it be easily and quickly checked for bedbugs?
- Does it have running costs (electricity, consumables etc.)?
- Does it need regular maintenance?
- Is it sufficiently discrete for the situation in which it will be used?
- Will it be rendered ineffective by dust/debris? If so, how quickly?
- Is there any data available to support its efficacy claims?

Be aware that the price of a monitor is not necessarily an indicator of its efficacy. Similarly, a photograph on the manufacturer's website of a sticky trap covered with bedbugs is not proof that the trap works. In the absence of independent data, try alternative monitoring devices and report your findings to the Bed Bug Foundation. Reviews from PCTs will be included in the products section of the Bed Bug Foundation website, providing valuable insight to other consumers.

7 Pretreatment Inspection

Following reports of a suspected bedbug infestation, the first task of the PCT must be to conduct a careful inspection. The role of this inspection is to confirm or dismiss the presence of an active bedbug infestation and if an active infestation is apparent, then to establish the scale of it. One of the most common causes of control failure is that inspections often fail to reveal all the hiding places. This is usually due to insufficient time or effort spent looking or a non-competent person carrying out the inspection. A detailed assessment is also necessary to determine the time needed to actually undertake the control programme and the equipment required, which is essential for accurate job costing.

Bedbugs have a very flat body shape and can hide in virtually any crack and crevice, preferring dark protected areas in close proximity to the host. Bedbugs prefer wood, paper and fabric surfaces and so these materials should be given special attention in the inspection process.

Inspection should be carried out as carefully as possible so that harbourages are identified with minimal disturbance to the bedbugs within, minimising the risk of dispersal.

7.1.1 Preparing the Occupants

Before the inspection takes place it is important to inform the occupant and/or relevant personnel (e.g. landlord, site management etc.) what the inspection will involve and what they should and should not do. Ideally this should be done in writing and include the following:

- That it will be necessary to inspect the whole bedroom, including cupboards and drawers
- That it may be necessary to remove bed-heads, lift carpets and dismantle some items
- That it may be necessary to remove the fabric from the underside of divan beds and sofas
- That some items may need to be removed for off-site treatment (if applicable)
- That access to the room will be restricted for a period during and immediately after treatment (the duration will depend upon the treatment applied)
- That further follow-up inspections will be required after the treatment

The occupant should also be advised of their role (if any) during the treatment process, and how to avoid reintroducing bedbugs to the property on their return. The occupant should be made aware that they should not attempt to remove items from the room before the PCT undertakes the inspection, as this can spread bedbugs around and cause them to disperse.

7.1.2 Inspection Equipment

The following may be useful for those carrying out a bed bug inspection:

- A powerful torch
- A 10x magnifying lens (to inspect for live bedbugs and eggs)
- Collection bottles
- Fine-tipped forceps
- Screwdrivers and spanners or a multi-tool (for dismantling items)
- An inspection mirror
- Plastic bags/boxes (large and small - to hold equipment, infested items, etc.)
- Notepad (for recording details of the infestation)
- Digital camera (for recording infested locations - the images can also be reproduced in a report and the Management Strategy)
- Faecal trace identification kit

To reduce the risk of transferring bedbugs, items brought into the room should be kept to a minimum. These items should either be placed well away from infested areas or preferably in large plastic storage boxes. Equipment should never be placed on beds, furniture or next to walls. Likewise, the PCT should avoid prolonged contact with beds, curtains and other potentially infested materials.

7.1.3 Where to look

Bedbugs can be found more or less anywhere, but the most common locations include:

- peeling paint/wallpaper
- between mattress and bed base
- bed frame and slats
- behind posters/pictures
- countersunk screw-holes
- carpet edges
- plug sockets
- shelves
- edge of the mattress
- inside divan base and around drawers
- head boards
- under/in the valance
- curtain pleats/pelmets
- electrical appliances
- top of skirting boards
- moveable items (books, toys, bags etc.)

7.1.4 Establishing the Scale

Identifying the extent of a bedbug infestation is key to any control strategy. Population numbers, hiding places (current and potential) and risks for potential fresh infestations all need to be considered as these will differ between sites.

In a hotel it is standard practice to inspect all adjoining rooms including those above and below. In a multiple occupancy apartment block this is not always possible. It would be considered unprofessional, and a breach of customer confidentiality, for the PCT to contact neighbouring residents without the consent of the customer. The situation becomes more difficult when the adjoining property is the source of the infestation, as re-infestation in the treated premises is likely to occur. All the PCT can do in these cases is to suggest that the occupant instigates communications with the other residents, and inform the site or district management or the property owners. It is important that all residents are made aware that bedbugs have been found in the complex and that anyone who experiences bite-type reactions should have their premises inspected by a competent PCT.

7.1.5 Treating Large Infestations

Controlling large infestations can be very difficult as such properties tend to be very cluttered and bedbugs will be scattered throughout the belongings. Control is impossible unless the clutter is removed and destroyed or taken off site for suitable treatment. For the tenant, this clutter may be their lifelong possessions, so any suggestions of disposal must be undertaken with sensitivity and in conjunction with the manager of the facility, with the possible assistance of social workers.

In heavy infestations, the PCT will require considerable cooperation from a number of parties to achieve control. This may include the owner or manager of the facility (such as public housing), contract cleaners, community health nurses, and social and/or charitable workers to help relocate the tenant and provide assistance in removing and replacing clothing and belongings. Maintenance workers may also be required to assist the PCT in gaining access to areas for treatment and dismantling fixed items in the premises. The tenant will need to be relocated and none of their belongings (possibly including any clothing currently worn) should be permitted into the new premises, until a comprehensive inspection has occurred and items are free of bedbugs.

8 Pretreatment Preparation

Preparation is crucial in facilitating the treatment process. However it should only be conducted after the pretreatment inspection. The amount of preparation will depend on the severity of the infestation and is likely to involve the *careful* removal of bedding, soft furnishings and clothes, for immediate laundering. Books may need to be removed from shelves and drawers may need to be emptied. Divan beds may need to be upturned and the fabric underneath removed to allow access. There is some debate as to who should conduct the preparation work. Some pest control technicians prefer to conduct the preparations themselves in order to minimise the risk of dispersing bedbugs throughout the property. While this is generally regarded as the better approach, it does require more time from the PCT and therefore justifies higher costs. Where the occupants are fit and able-bodied, it may be acceptable for pretreatment preparation work to be conducted by themselves. However, it is the PCT's responsibility to ensure that the occupant is properly informed (preferably in writing) about what preparation is required and how to do it without causing dispersal.

9 Treatment

9.1 Guarantees

A customer accepting a recommended Bedbug Management Strategy typically expects that elimination will be achieved. Accordingly, where possible, the PCT should offer a written service warranty. However, any contractual obligation should contain reference to customer and PCT responsibilities and limitations within the Bedbug Management Strategy. These would include:

- The cooperation of the customer during treatment.
- Circumstances encountered during the implementation of the plan.
- The quality of ongoing housekeeping.
- The nature of the room itself, i.e. whether or not it is 'Bedbug friendly'.
- The level of ongoing maintenance.
- The potential risk of Bedbug reintroduction (especially in apartment complexes if the adjoining units cannot be inspected).

9.2 Non-Chemical

Non-chemical options are an essential, sustainable element within all control programmes. However, best results are achieved by integrating them with chemical control methods.

Leaving an infested room vacant for extended periods is not an option to control the bedbugs, as they can live for many months without a blood meal. Infested rooms must be treated as per this code of practise.

9.2.1 Room Treatment

Vacuuming

Reducing the overall population size of a bedbug infestation should be the first activity for any control programme. While vacuuming will not remove all bedbugs or their eggs, it can have a significant impact on the population, as well as removing dust and debris, which can aid in the penetration of chemical insecticides if required.

The process of vacuuming must be slow and deliberate in order to collect as many bedbugs as possible. A crevice nozzle can be used along carpet edges, bed frames and mattress seams and in divan bases, furniture and other potential hiding places.

Vacuuming can disperse insect allergens, causing symptoms like hay-fever or asthma in some people. Vacuum cleaners with HEPA filters are therefore advisable.

Following any vacuuming, the machine must be isolated and thoroughly cleared of any insects or eggs once outside the property. When not in use the vacuum cleaner itself should be stored in a sealed bag or box.

Steam

Steam has the capacity to kill bedbugs of all life stages, including eggs. However, unless the level of infestation is low, control cannot reliably be achieved with steam alone and it should be used as part of an integrated approach.

There are many different brands and types of steam machines on the market; however, not all are appropriate. The most effective unit must be able to produce steam of a low vapour flow and high temperature. It is best to use commercial units that employ 'dry steam', which allows for quicker drying times. Steam machines that have a continual flow feature can be filled and remain operational without the downtime of some of the cheaper units, which go through a cooling and reheating phase.

Steam flow rates must be kept to a minimum to avoid 'blowing' bedbugs about and to reduce wetting of the surface material. Multiple jet steam heads produce a gentler flow rate, and are thus less likely to blow bedbugs away. They can also treat larger areas over a shorter period of time. Low flow rate machines must be in direct contact with the surface being treated. The temperature drops away rapidly with distance from the nozzle and a separation of only a few centimetres will not be lethal to the bedbugs.

Brush heads and brush fittings on steam machines should be avoided as the stiff bristles can 'flick off' eggs and bedbugs.

Like any tool, steam machines are only as effective as the operator. To achieve control, an intimate knowledge of the pest and its ecology are essential, inspections must be diligent and the treatment process must be meticulous.

Carpet edges can also be treated with steam, along with the upper and lower edge of the skirting board. After the completion of the steam treatment, any dead bedbugs should be removed by vacuuming, which will aid in determining the success of the treatment. Some machines have a combined steam and vacuum process.

Steam may damage heat- and water-sensitive materials, thus the PCT should always test the item to be treated in a non-conspicuous area before the main treatment begins. Steam will raise the humidity in the room, which can lead to mould growth unless properly ventilated after treatment.

Dry ice

Dry ice (solid carbon dioxide), freezes bedbugs and their eggs. It is safe, odour-free and unlikely to damage property. However there is limited independent research on the efficacy of the application equipment available.

Like steam, knowledge of the pest and its ecology are essential for treatment success. Dry ice cannot penetrate items, so direct access to the bedbugs is required, which can only be achieved if the operator knows where to look.

Like some steam machines, an overly high flow rate may blow the bedbugs out of harbourages without killing them. It is also important to be aware that both cold and carbon dioxide have an anaesthetic effect on insects. Consequently insects treated with dry ice can appear dead for some time, only to 'wake up' as they warm up and replenish their oxygen levels. Following the treatment, a thorough vacuuming to remove any dead (or apparently dead) bugs should minimise the chances of treatment failure.

Heat Treatments

Temperatures above 48°C are lethal to bedbugs. If the entire room and its contents can be heated to above this temperature, and there is no means of escape to neighbouring rooms, all bedbugs will be killed. The main advantage of a heat treatment is that the entire contents of the room, including the furniture, mattress and even infested linen, can remain in place during the treatment process.

During the pre-treatment inspection it is essential that all potential escape routes are identified and blocked as bedbugs become extremely active during the treatment process and will attempt to escape. Air ducts that can't be blocked should be treated with a residual insecticide to prevent bugs from escaping and returning after the treatment.

Providing heat treatments is a specialist industry, requiring a considerable initial outlay and an in depth knowledge of the heating equipment used. In systems where the heat is generated electrically, considerable power may be required, which may not be available at all premises.

Thick stone walls have high thermal inertia, which will shield bedbugs harbouring within. Mattresses and duvets can provide considerable insulation for bedbugs harbouring beneath and are often turned during the treatment process to aid heat penetration. Heat sensors should be employed to ensure that lethal temperatures are reached in every corner of the room without over-heating and potentially damaging other areas.

Treatment times vary according to the heating equipment used and the environment being treated, but times of 8-12 hours are typical for hotel rooms. To minimise the risk of damage to property, heat sources should not normally exceed 58-60°C.

Bubble treatments, where infested items are treated in a fixed space, are becoming increasingly popular. Items as large as beds can be treated in situ, saving the time and cost of removal and replacement.

9.2.2 Movable Item Disinfestation

Some PCTs insist on the disposal of many of the occupants furniture and other belongings rather than attempting to treat them. This contributes to spiraling costs for the occupant and/or landlord. In some situations the value of the infested items may not justify the time taken to treat them but, more often than not, items can be disinfested in one of the following ways:

Laundry

Bedbugs and their eggs are very sensitive to heat and are quickly killed when exposed to temperatures over 45°C. Laundering is one of the most effective control processes for infested linen, clothes and soft furnishings.

Care must be taken when transporting items between the infested location and the washing facilities and also to ensure that Bedbugs are not spread to the washing facilities.

Infested linen and clothing should be laundered on a hot cycle (60°C) to kill all life stages. A 40°C wash has been shown to be effective against live stages but not eggs (see Naylor, R. A. and

Boase, C. J. (2010) Practical solutions for treating laundry infested with *Cimex lectularius* (Hemiptera: Cimicidae). *Journal of Economic Entomology*, 103:136-139.).

Note: Some washing machines do not heat their own water and hence rely on the hot water supply from the boiler. Many boilers may not heat water to a temperature sufficient to kill 100% of eggs.

Tumble Drying

Tumble drying has been shown to be an effective means of disinfesting dry laundry when run on a hot cycle for at least 30 minutes (based on 2.5kg of laundry). Wet laundry has more thermal inertia, making it slower to heat up. It should therefore be given long enough to dry and an additional 30 minutes from that point. It is important to be aware that overloading a tumble dryer will limit the extent to which warm air can penetrate the laundry, which may result in treatment failure. Some machines may also incorporate a cooling period into their drying cycle, which must be taken into account when setting the time.

Portable Heating Units

Portable heating units are now available in some countries, and can be used to treat small items such as cushions, clothes, books etc. Items are packed into an insulated bag/box with an integrated heater. These systems are thermostatically controlled and have a timer to automate the treatment process. Unfortunately they are not currently available in the UK, although they are becoming widely used in the USA.

Freezing

Freezing has the advantage that heat-sensitive materials will not be damaged. While this method often cannot be directly used by the PCT for logistical reasons, it can be recommended for small items within a property. Large chest freezers can be used for off-site decontamination. Items should be packed into plastic storage boxes, which are sealed before leaving the infestation and remain sealed for the duration of the treatment.

The duration required in the freezer is dependent on the density of the material to be disinfested. Dense items have more thermal inertia and hence take longer to reach the lethal temperature. Only 2 hours at -17°C (the temperature of a typical household freezer) is required to kill all life stages, however a recent study has shown that 10 hours was necessary to sufficiently reduce the temperature of a 2.5kg bag of loosely packed dry laundry. Larger and/or denser items may therefore be expected to take days for the centre to cool sufficiently to kill all bedbugs present (see Naylor, R. A. and Boase, C. J. (2010) Practical solutions for treating laundry infested with *Cimex lectularius* (Hemiptera: Cimicidae). *Journal of Economic Entomology*, 103:136-139.).

Be aware that the freezing process causes some condensation of moisture in the air. It may therefore not be suitable for items that are very sensitive to moisture.

Oxygen removal

A commercially available system is now available for decontaminating items up to the size of a mattress by the removal of oxygen. The system involves sealing the items into a heat-sealable plastic bag with an oxygen scavenger pack that reacts with any available oxygen, causing bedbugs to suffocate. It is important that as much air is removed from the bag as possible prior to sealing, to limit the amount of oxygen that needs to be removed by the chemical oxygen scavenger. This can be achieved with a household vacuum cleaner. It is also important to be aware that suffocation anaesthetises insects, causing them to appear dead long before they actually are.

9.3 Chemical Insecticides

Non-chemical solutions are not currently capable of providing rapid, reliable control of established bedbug infestations. The Bedbug Foundation is therefore committed to promoting safe and effective use of insecticides where they are required.

It is a legal requirement under the Biocidal Products Directive that insecticidal treatment of bedbugs is only carried out with insecticides that are specifically approved for use against bedbugs. The product label must be read before every application to ensure that it is currently approved for its intended use and the label conditions must be adhered to at all times.

9.3.1 COSHH

Control of Substances Hazardous to Health (COSHH) legislation, states that potentially hazardous chemicals should only be used after all other treatment options have been considered and discounted. Where a pesticide is deemed necessary, care should be taken to ensure the safest and most suitable product/formulation is applied.

It is also a requirement of the legislation that a COSHH Assessment be carried out and documented prior to the use of any insecticides. This document will need to take into consideration many factors but should at least include:

- Whether or not an insecticide is required at all
- The property location/environment
- Formulation of the proposed insecticide
- Quantities to be applied (in connection with the inspection/treatment area)
- Control measures to prevent access by staff or residents into the treatment area
- Emergency contact details.

A generic COSHH assessment can be drawn up by the pest control company and copies should be carried by each PCT. A mental COSHH assessment of the specific situation should be carried out by the PCT during the inspection phase but need not necessarily be documented.

COSHH regulations do not support the application of an insecticide to act as a 'just in case' barrier. Unless the risk is sufficiently high, a target pest must be identified in order to justify the application of a pesticide.

9.3.2 Resistance Issues

There is now widespread resistance to two of the most common classes of insecticides (pyrethroids and carbamates). Due to improvements in their formulation and the use of synergists, some pyrethroid and carbamate-based products continue to be effective against resistant populations. However it is becoming increasingly necessary to treat the bedbugs directly with the insecticide, rather than relying solely on their residual properties. Where once a single treatment was all that was required to eliminate an infestation, now multiple treatments are routinely necessary.

To avoid exacerbating resistance issues it is important to avoid overuse of insecticides. When insecticides are used, thoroughness is critical in avoiding sub-lethal doses that only serve to select out the 'weaker' individuals from the population.

In the USA and many parts of Europe the halogenated pyrrole Chlorfenapyr provides an alternative class of insecticide for bedbug control. Because the mode of action of Chlorfenapyr is completely different to that of pyrethroids and carbamates, populations that are already resistance to these insecticide classes remain susceptible to Chlorfenapyr.

By alternating between pyrethroids and carbamates (and Chlorfenapyr where available), and using these in conjunction with insect growth regulators (IGRs) and desiccant dusts (to which resistance has never been reported), it is still possible to gain control of severe infestations and limit further resistance issues.

9.3.3 Formulations

The type of formulation (for example, liquid spray, aerosol or dust) selected for the treatment will be dependent on the location of the bedbug harbourages. Each individual product will have advantages and disadvantages and these need to be understood in order to assess each product *prior* to a treatment. The use of one formulation over another needs to be considered during the assessment process and is predominantly based on the efficacy of each formulation on a given treatment surface and the risks that a product may pose in the location that requires treatment. For example, water-based liquid sprays around an electrical point are not acceptable; however, the application of a dust may deliver effective control with minimal risk (see formulations guide in Appendix 2).

9.3.4 Insecticide Reapplication

Depending on the insecticide applied and the level of insecticide resistance in the population, it will often be necessary to apply more than one insecticide treatment. Since eggs tend to be more resistant to insecticides than nymphs, the minimum interval between treatments should be guided by the egg hatching time, which in turn is influenced by temperature. A two week interval will usually be sufficient for all eggs to hatch, however longer may be required in particularly cool conditions (see 3.1.1).

9.3.5 Safe Insecticide Use

- Keep residents and pets out of the room until all liquid insecticides have dried (usually 2-3 hours). Aquaria can remain in the room if well covered (air pumps should be turned off, and only turned back on after ventilation of the room)
- Insecticides must not come into contact with food. Avoid food preparation areas, crockery, utensils and anything else that might have contact with food in the future
- Clothing must not be treated with insecticides. It should therefore be removed from drawers and laundered or tumble-dried
- Only treat mattresses with insecticides that are approved for that use and then only if the mattress will subsequently be covered with a sheet
- Avoid over-application of liquid insecticides, which can lead to run-off and contamination of areas where treatment was not intended

9.4 Post Treatment Procedures

Following the treatment, the customer should be advised on the following:

- Not to re-enter the treated area until after the chemical has completely dried. Refer to label instructions for re-entry period
- Not to vacuum floors and upholstered furniture for at least 10–14 days after final treatment
- After 14 days a comprehensive cleaning programme should be undertaken to remove all past signs of the infestation, such as dead bedbugs, exuvia and faecal spotting on the walls and mattresses, to avoid future confusion

9.5 Final Inspection

The final inspection should be as detailed as the initial inspection. All previously identified locations of bedbugs must be re-examined, cracks and crevices receiving specific attention and the surrounding areas checked in case bedbugs have been flushed out by the insecticides. It is

also necessary to inspect previously unoccupied locations as the bedbugs may have relocated. If live bedbugs are found, a further treatment and subsequent inspection should be undertaken. All findings during this final inspection must be thoroughly documented (in writing/photos), compared against the notes from the pretreatment inspection.

10 Legislation

10.1 Risk Assessment

The Management of Health and Safety at Work Regulations 1992 make it a requirement to carry out an assessment of the risks to health and safety to which employees are exposed while at work, as well as risks to others such as residents, that may be affected by the work. For bedbug control, hazards may include electrical safety issues arising from working around electrical items, lifting injuries from moving heavy furniture, injuries to hands from concealed sharp items in bedrooms, or slips on flooring wet with spray. The employer should prepare a generic written risk assessment for bedbug control, that covers most foreseeable issues, but the technician should mentally 'adjust' the assessment to suit each particular job.

This is separate from the COSHH assessment, which is related solely to the substances used (see 10.3).

10.1.1 Manual Handling

It is likely that, in the majority of bedbug jobs, the PCT will need to move beds and other heavy furnishings to gain access to harbourages. For this reason, it is suggested that maintenance or a second person who has bedbug awareness assists in gaining access to hiding places, in preparation for inspection and treatment.

10.1.2 Electricity

If power needs to be disconnected in a room (e.g. plugs removed for inspection and insecticide application), on-site or contract maintenance staff should perform electrical procedures.

Many insecticides are liquid-based and are unsafe around electricity. A review of the available formulations will allow the most suitable control options to be delivered.

10.2 Qualifications

For professional users of non-agricultural pesticides, there are currently no specific statutory qualifications. The Control of Pesticides Regulations 1986 and 1987 (as amended) simply states that professional users of non-agricultural pesticide products should be 'adequately trained and competent'. The need for training is also reinforced by other legislation such as the Health and Safety at Work Act (1974) etc.

In effect, the pest control industry is expected to establish its own training and qualification scheme. In practice, pest control companies are encouraged to become a member of a trade association (e.g. the BPCA or NPTA). Membership comes with various requirements, including that those actually doing pest control should have passed at least the RSPH/BPCA Level 2 examination. In addition, to stay as members, individuals should accrue a certain number of Continuing Professional Development (CPD) Points each year, which they get from attending seminars, training courses etc.

10.3 Insurance

Like any business, the pest control company must have Public/Product Liability insurance. If they have employees, they must also have Employers Liability insurance. It will also be necessary to have insurance for any vehicles and premises.

10.4 Gaining Access

Private pest control companies have no legal powers to gain access to premises that they consider may be causing a problem. Of course, they may be able to persuade the neighbours to allow access, but who would pay for any treatment required? If they are working on behalf of the landlord of the premises, then the landlord will normally have powers of access to individual rented properties under the tenancy agreement. If the access is refused to the PCO working for the landlord, then the landlord could write to the tenant insisting that they provide access. If access was still refused, then the landlord could go to Court to obtain access, but this would be very rare, and costly. In any case, the court may rule that landlord's powers of access are more for emergencies such as floods and gas leaks, not for pests. If access is refused to local authority pest control staff, then the local authority's Environmental Health Officer may be able to obtain access under the Public Health Act 1936. In practice however this would be very unusual.

10.5 Waste Disposal

10.5.1 Waste chemical insecticides

Care should be given to minimising waste by considering the volume likely to be required. It is highly likely that at some point surplus will be produced and this must be disposed of in the correct way. Do **not** pour insecticides down the sink or onto the ground. Do **not** place insecticides in standard waste bins.

Business waste is all 'Controlled waste', which is subdivided into 'Non-hazardous', or 'Hazardous'. Most pesticides are 'Hazardous', but the label or Material Safety Data Sheet (MSDS) will confirm this. If hazardous, then the PCT needs to hold a Waste Carriers Licence to transport the waste anywhere. The waste will need to be transferred to, or collected by, a Licensed Waste Disposal organisation. The PCT will then sign and receive a copy of a Waste Consignment Note, bearing the European Waste Code for the particular products disposed of. They must keep this Consignment Note for 3 years. The Licensed Waste Disposal organisations will arrange final disposal, depending on the material. Disposal of Hazardous Waste is costly, but failure to dispose of it properly can lead to prosecution.

10.5.2 Bedbug Infested Waste

Prior to disposal, items such as mattresses should be rendered unusable, e.g. with a knife, to prevent subsequent unofficial re-use.

If the PCT carries someone else's waste (even if it is not toxic, e.g. an infested mattress) then again they must have a Waste Carrier's Licence. Infested items would be classed as 'Non-Hazardous'.

They would only be classed as Hazardous if they were 'infectious', which they are not, especially if they are sprayed. The infested material could either be collected from the PCT's premises (e.g. in a skip, like any other non-hazardous waste) by a waste disposal company, or they can take it to any waste disposal site that accepts business waste (see the Council website), and will pay a fee.

11 Further Sources of Information

11.1 General Biology

Reinhart K, Siva-Jothy MT. 2007. Biology of the bed bugs (Cimicidae). *Annu Rev Entomol.* 52: 352-74

Usinger R. 1966. Monograph of Cimicidae (Hemiptera-Heteroptera). The Thomas Say Foundation, vol. 7, *Entomological Society of America*, College Park, Maryland, USA.

11.2 Control

A Code of Practice for the Control of Bed Bug Infestations in Australia (4th Edition) – available at: <http://medent.usyd.edu.au/bedbug/>

CIEH Pest Control Procedures Manual - Bedbugs – available at: <http://www.cieh.org/policy/pest-control-procedures-manual-bedbugs.html>

Greater London Pest Liaison Group - Good Practice Guides - available at: <http://www.londonpestgroup.com/publications.html>

Bed Bug Beware Website – available at: <http://www.bedbugbeware.com>

Bed Bug Foundation Website – available at: <http://www.bedbugfoundation.org>

Appendix 1 - Household insects commonly confused with bedbugs

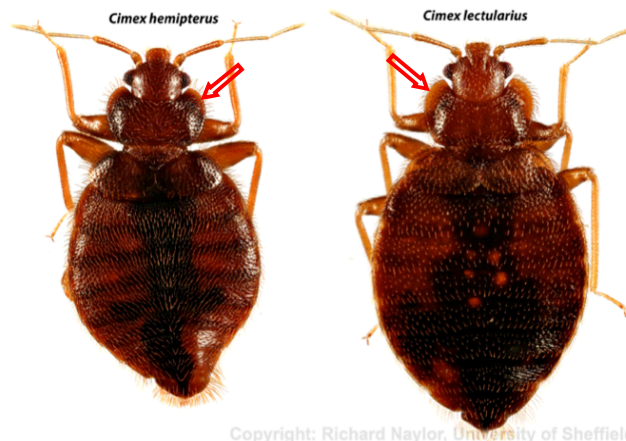
It is important to be familiar with all stages of the bedbug's lifecycle (see diagram on page 7). Some other household insects bear resemblances to bedbugs at various stages of development and consequently reports of incorrect identification leading to unnecessary treatments are relatively common.

Cockroach nymph



Most cockroach species are very much larger than bedbugs, however small cockroach nymphs can sometimes look similar. With good light and/or magnification, the presence of long, slender antennae can help to distinguish them.

Tropical bedbug



Copyright: Richard Naylor, University of Sheffield

Tropical bedbugs (*Cimex hemipterus*) are rarely found infesting premises in the UK, but may be brought home from holidays in the tropics. Being able to recognise this species can therefore help to determine the origin of the infestation, however the treatment process would likely be the same for both species. Tropical and common bedbugs are very similar in their appearance. Tropical bedbugs are slightly more hairy and have a narrower flange around the sides of the thorax.

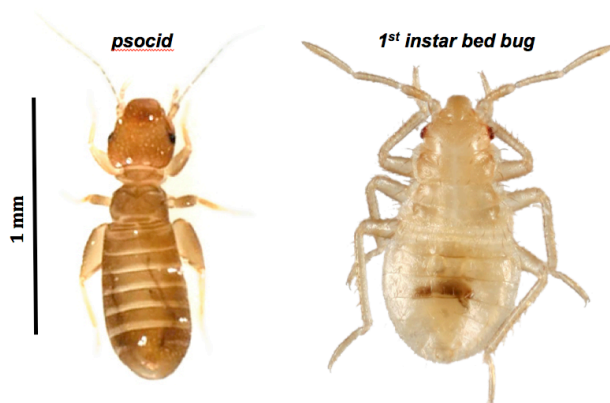
Dust mites

Dust mites are commonly confused with bedbugs, but bear no similarity in morphology, feeding behaviour, or size. Dust mites are microscopic arachnids (related to spiders), which feed on dry organic material such as skin and feathers. They thrive in cool, damp environments, do not bite humans but can trigger asthma and skin allergies.

The “Cable Bug” phenomenon

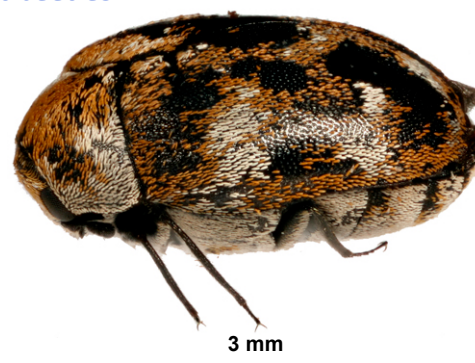
“Cable bug” is the name given to the phenomenon whereby electrostatic charge causes fibers to impale themselves into the skin of humans, sometimes producing a bite-like skin response. Cable bug is most common in offices where short, bristly carpets and large electronic machinery such as photocopiers contribute to the static electricity in the environment. This phenomenon should be considered where people exhibit bite-like reactions but no likely culprit can be identified.

Psocids (book lice)



Psocids are very commonly found around the home, especially on old books and in stored food product such as flour. They are similar in size and colour to first instar Bedbug nymphs and distinguishing the two may require a hand lens. Psocids have long, slender antennae and a very pronounced head.

Carpet beetles



Carpet beetles are a large family of small beetles, some of which are similar in size and shape to bedbugs. They are among the most likely household insects to be found in or around the bed. The exuvia of the carpet beetle larvae can also be confused with those of bedbugs, however the numerous bristly hairs of most carpet beetle larvae (and their exuvia) is an obvious distinguishing feature. Carpet beetles do not bite but can cause bite-like skin reactions in some people.

Spider beetles



Spider beetles are a subfamily of small beetles with long antennae that are similar in size to recently fed first or second instar bedbug nymphs. Some spider beetles even have a glossy red abdomen, which gives them the appearance of being full of blood. Spider beetles are stored product pests but do not bite people.

Minute pirate bug



Minute pirate bugs are predators of aphids and are most commonly found on fruit trees. Although they are rarely encountered indoors, they bear very close resemblance to a bedbug nymph and will also occasionally bite people.

Photo: Tom Murray (with permission)

Fleas



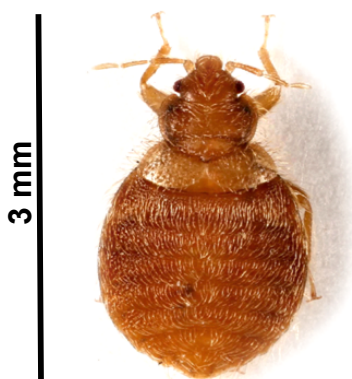
Fleas are very different in appearance to Bedbugs and jump rather than walk. However, like Bedbugs, they will bite people in bed, and the bites themselves are indistinguishable from those of bedbugs. Fleas have a tendency to bite the feet and ankles although they can bite anywhere. Unlike Bedbugs, fleas produce dry, gritty faeces. If these small, black flecks are moistened, they dissolve into a red smear.

Ticks



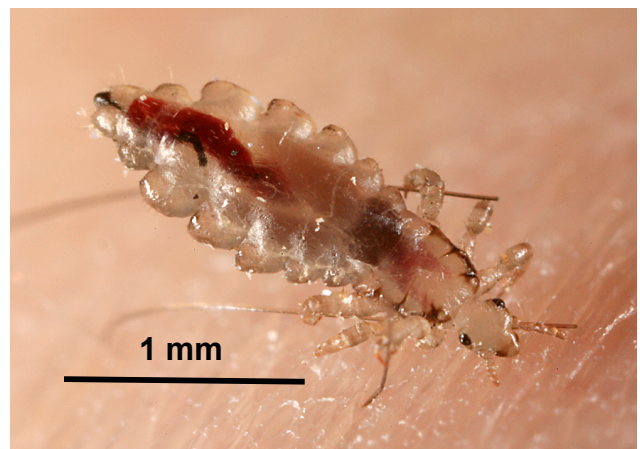
Unlike bedbugs, ticks attach themselves to the host for hours or days while feeding. They are most commonly found attached to the skin of the lower legs after walks in open countryside where deer or sheep graze.

Swallow bug (*Oeciacus hirundinis*)



Swallow bugs have broadly the same features as bedbugs, although adults are around half the length of adult bedbugs and are paler in colour. Nymphs are more difficult to distinguish. Unlike bedbugs, swallow bugs will tuck in their legs and “play dead” if disturbed. They will occasionally find their way into bedrooms and bite people in situations where swallows or house martins are nesting close to the bedroom, particularly if the nests are abandoned.

Head louse (*Pediculus humanus capitis*)



Head lice are blood feeding insects, which can be similar in size to a first instar bedbug nymph. However their bodies are much more elongated and they are comparatively much slower moving. Head lice are rarely found anywhere but on a human head, however they can be dislodged by scratching or combing and so can occasionally be found in the bed.

Appendix 2 – Formulations guide

Class	Formulation Type	Code	Description	E.g.	Active Ingredient	Notes
Residual Sprayable Insecticides	Wettable Powder	WP	A powder suspended in water, generally presented in water-soluble sachets for ease of handling.	Ficam W	Bendiocarb (Carbamate)	Good residual life and not absorbed into porous surfaces, making them ideal for wood, fabric concrete etc. Some may leave a visible residue on shiny surfaces. Absorbed into porous surfaces, reducing efficacy and residual life. Unlikely to leave any visible residue, which may be an advantage on laminate floors, painted wood or other shiny surfaces. The cryptic, often nocturnal, nature of bedbugs makes residual insecticides very useful for their control, since direct application of the insecticide onto the insect may not be possible. Crevice and surface treatment can be achieved with different spray nozzles. Not suitable around sources of electricity. Always make up fresh prior to use. Over-application can lead to accidental contamination of areas by run-off.
	Wettable Granule	WG	Similar to above but granulated for ease of handling. Often supplied in a tub with a sifter.	K-Othrine WG250	Deltamethrin (Pyrethroid)	
	Suspension Concentrate	SC	Milky-white liquid that is mixed with water. Supplied in plastic container for accurate measurement of concentrate. Good for small treatments as small quantities can be made up.	K-Othrine SC	Delamethrin (Pyrethroid)	
	Micro Encapsulated	CS	Similar in appearance to SC. Encapsulated formulation offers excellent residual life.	Demand CS	Lambda-Cyhalothrin (Pyrethroid)	
	Emulsion in Water	EW	Typically a clear or milky liquid that is diluted before spraying.	—	—	
	Emulsifiable Concentrate	EC		Nylar	Pyriproxifen (Insect Growth Regulator - IGR)	
	Suspo Emulsion	SE		Cimetrol	Alpha-Cypermethrin, Tetramethrin & Permethrin (Pyreth. & IGR)	
	Ready to Use	RTU	Presented in a plastic container that is decanted directly into spraying apparatus without diluting.	Insectaban	Permethrin & Piperonyl Butoxide (Pyrethroid & synergist)	
	Insecticidal Dusts	DP	White/grey dust. Supplied in small, hand-held applicator or with larger electrically-powered machine.	Ficam D	Bendiocarb (Carbamate)	Messy and easily removed by vacuuming but good for wall voids and around electrical outlets and under edges of carpets.
	Diatomaceous Earth		Grey/white powder available in a variety of forms including aerosols, puffers and plastic	Oa2Ki Powder	Diatomaceous Earth	
Space Treatments	Smoke Generators (aka Pyrotechnics)	—	Ignited like a firework and releases an insecticidal smoke, which settles on horizontal surfaces.	CoopeX	Permethrin (Pyrethroid)	Space treatments (treating the air volume of a room/office etc) is ideal for flying insects but not recommended for bedbug control. The airborne insecticides do not penetrate sufficiently into cracks and crevices and have little or no residual life. Sub-lethal doses of insecticide may contribute to resistance and cause dispersal.
	Ultra Low Volume (aka Fogging)	ULV	Insecticide is atomised to produce an airborne insecticidal mist.	ULV 500	d-Phenothrin, tetramethrin, and synergist	
	Thermal Fogging	—	Uses high temperatures to evaporate and disperse an insecticide, which condenses as a thick white fog.	—	—	
	Aerosols	—	Ready to use insecticide aerosol spray.	—	—	

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The Foundation harmonizes research fellows, together with the pest management industry, accommodation providers and homeowners, to create, deliver and maintain professional standards.

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Necessity to prevent and monitor potential activity

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