A modern pest crisis: Bed bugs and health care

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Meet the bed bug
A little history... bed bugs in WWII
Sulfur
Mercury chloride
Rotenone
Phenol
Cresol
Napthalene
Kerosene
pyrethrum
Hydrogen cyanide
DDT
Malathion

Opening a can of Zyklon discoids (HCN) in an army barracks infested with bed bugs during WWII (1943)
Recognizing bed bugs

- 4-5 mm-long (size of apple seed),
- mahogany-colored, wingless, flattened
- Found crawling or hiding in crevices near beds and sleeping areas
Bed bug life cycle

- Incomplete metamorphosis
- Prefer human hosts
- 50-100+ eggs/female typical
- 2 month life cycle with adults living 4.5 months
- May live 4-5 months without a blood meal
Hosts of the human bed bug

- Humans
- Bats
- Poultry
- Mice
- Rats
- Rabbits
- Horses
- Cattle
Bed bug feeding habits

- Prefer feeding during darkness
- Bites painless
- 50% of people with bed bug infestations may not know they are being bitten
The feeding process
Bed bug bites

Decade of the bedbug

- Infestations increasing globally (est. 100-500% annually)
- Top 8 cities (Orkin 2016)
  - Baltimore
  - Washington, DC
  - Chicago
  - New York
  - Columbus, OH
  - Los Angeles
  - Detroit
  - Cincinnati, OH
  - ...#15 Dallas

NYC Bed bug complaints – Department of Housing and Preservation Development

Bed bug frequency of occurrence by housing type (NYC)
Why the problem?

• Resurgence likely due to multiple factors
  – Increased international travel (1.1 billion international travelers in 2014)
  – Loss of organophosphate and carbamate insecticides
    • (AChε inhibitors)
  – Resistance to pyrethroid insecticides
    • (axonic Na-channel blockers)
Just give me a little of that DDT
Pyrethroids and DDT

- Bed bugs highly controlled with DDT (1940s), but resistance documented within 8 years
- Today, resistance well-documented and widespread to DDT, pyrethroids (both act at same nerve target site)
- Pyrethroids remain primary control tool for bed bugs in industry
Is the bed bug a public health pest?

• “Bed bugs cause a variety of negative physical health, mental health and economic consequences”
  – Mild to severe allergic reactions to bites
  – Bites can lead to secondary infections
  – Mental health impacts
  • Insomnia
  • Anxiety
  • Systemic reactions

http://www.cdc.gov/nceh/ehs/Publications/Bed_Bugs_CDC-EPA_Statement.htm

Joint Statement on Bed Bug Control in the United States from the U.S. Centers for Disease Control and Prevention (CDC) and the U.S. Environmental Protection Agency (EPA)

Introduction and Purpose

The Centers for Disease Control and Prevention (CDC) and the U.S. Environmental Protection Agency (EPA) developed this document to highlight emerging public health issues associated with bed bugs (Cimex lectularius) in communities throughout the United States.

Bed bugs (Photo 1) have been common in U.S. history. Although bed bug populations dropped dramatically during the mid-20th century (1), the United States is one of many countries now experiencing an alarming resurgence in the population of bed bugs. Though the exact cause is not known, experts suspect the resurgence is associated with increased resistance of bed bugs to available pesticides, greater international and domestic travel, loss of knowledge regarding pest management, and bugs due to their prolonged survival in the environment.

Photo 2: Bed Bug

Photo courtesy Harold Hanan

Forces Pest Control
Is the bed bug a public health pest?

- EPA’s primary concern regards “registration of pesticides to ensure that when used to control pests, they do not harm people or the environment.”
Pesticide misapplication
Is the bed bug a public health pest?

- “CDC recognizes that very limited research has been conducted on bed bugs during the past several decades and encourages increased bed bug research to determine the causes of the resurgence, the most effective methods of control and the potential for bed bugs to transmit disease.”
Bed bugs and infection

- BBs found carrying ~45 human diseases—no scientific evidence that field transmission has ever occurred (Goddard & deShazo 2009, Lai et al. 2016)
Bed bugs and infection

- HIV can be detected in BBs up to 8 days
  - No viral replication
  - No virus detected in BB feces
- One candidate for human disease transmission is hepatitis B virus (HBV)
  - BB collected in So. Africa, Senegal, Egypt, Ivory Coast and China were HBV surface antigen +
  - Unable to transmit HBV to chimpanzees
  - Successful 2 year BB eradication program in Gambia had no effect on rates of HBV infection

Goddard & deShazo (2009)
Bed bugs and Chagas disease

- showed efficient and bidirectional transmission of T. cruzi between mice and bed bugs in laboratory.
Bed bugs and *Bartonella quintana* (trench fever)

- Bed bugs can acquire and maintain *B. quintana* for > 2 weeks and release viable organisms into feces
Conclusion

• “To date, no published study has demonstrated a causal relationship between bed bugs and infectious disease transmission in humans””
• “Despite the fact that ...[no] definitive evidence exists...studies [which show that] B. quintana and T. cruzi may survive in laboratory conditions are worrisome.”
Other health effects

- **Cutaneous reactions**
  - Most common reaction: barely visible puncture with slight reddening
  - Most common noticeable reaction: 2- to 5-mm pruritic maculopapular, erythematous lesions
  - Complex reactions include papular urticaria, bullous rash
  - Timing can vary

[Image of skin reaction with text: 30%+ patients show no reaction]
Systemic reactions

• Few studies
• Reports include
  – Generalized urticaria
  – Asthma
  – Anaphylaxis
Other health effects

- Anemia
- Secondary infections
  - Impetigo
  - Ecthyma
  - Lymphangitis
- Other pathogens?
Lowe & Romney letter

• 3 patients from downtown eastside Vancouver, BC hospitalized with bed bugs
• High rate of drug use and community-acquired MRSA infections
• 5 bed bugs tested positive for drug-resistant organisms
  – MRSA
  – VRE (vancomycin-R Enterococcus faecium)
• A “plausible potential mechanism for passive transmission during a blood meal”
Mental health impact

• Mental effects
  – Anxiety
  – Insomnia
  – Other systemic effects?

• Complications with delusions of parasitosis
Over half of consumers calling for bed bug service do not have bed bugs.

- Pest misidentification
- Illusions of parasitosis
- Delusions of parasitosis
Definition

• **delusions of parasitosis** (DOP) - aka Ekbom’s Syndrome (1938). A type of somatic delusion in which the victim falsely believes that insects (or other arthropods) are crawling on, biting, or burrowing in the skin.
Typical samples from a sufferer of DOP

- Numerous samples from floor, bed, skin, wash water, vacuum bags, etc.
- Often very detailed descriptions
- Much time devoted to sample
Bed bug management issues
Challenges with bed bugs

• Hiding places diverse
  – 50% on or around bed
  – Upholstered chairs, sofas, nightstands, dressers, other furniture
  – Baseboards, under carpet tack strip, any small cracks, behind posters, clocks, etc.

• Replacing mattress more of a problem than a solution
  – Mattress and box spring encasements the answer
Challenges with bed bugs

• Bed bugs are excellent hitchhikers
  – Suitcases
  – Clothing
  – Backpacks

• Highly mobile within buildings

Photo by Ed Yourdon, Flickr
Challenges with bed bugs

- Control is expensive
  - Labor-intensive
  - Expensive ($500 - $1500+/apartment)
  - Requires 2-3+ visits for success
  - Current pesticides not highly effective
IPM tactics for bed bugs

- Pesticides
- Mechanical controls (barriers)
- Physical controls (heat, cold)
- Pest proofing / Sanitation
- Education and Awareness
IPM for bed bugs is a process

**Education**
- Planning
- Training
- Collaboration

**Inspections / Monitoring**
- Building wide (annually)
- Visual inspections and traps in all suspect units

**IPM Actions**
- Non-chemical or minimal insecticide
- More aggressive insecticide protocol
- Heat treatment

Bed bug monitoring options

• Visual inspections
• Pitfall traps
• Dogs
Bed bug feet

Bed bug feet lack pads for smooth surfaces

Cockroach feet adapted for smooth or rough surfaces

Clemente and Federle 2008 Proc Roy Soc B

Photo by Adam Nadel/Polaris and http://content.time.com
How an interceptor trap works

Fabric tape or textured plastic outside cup

Smooth, talcum powdered plastic unclimbable for bbs

Bb drawn to bed climbs rough outside of cup, falls into moat
Climbup Interceptor
Socio-economic issues

• Bed bug treatment expensive
• Apartment associations writing pre-lease agreements and require tenants to pay for treatments
• System rigged to discourage renters from reporting bed bugs
Homeless shelters provide temporary or permanent homes for approximately 58% of homeless
Bed bugs in hospitals

• *Infestations* can occur, but not common
  – Reproducing, self sustaining population of bed bugs
• Hospital *introductions* increasingly common
  – Patients arriving from infested environments bring isolated bed bugs
Protocols for hospitals

• For patient with bed bugs
  – Isolate belongings (plastic totes or clear plastic bags)
  – Bath patient
  – Wash or dry clothing on high temperature
Protocols for hospitals

• For suspected infestation in room
  – Vacuum and encase mattresses
  – Inspect bed, visitor chairs
  – Install bed bug monitors in room
  – Consider CO2 monitor trap
  – Insecticides should be rarely (if ever) needed
    • Silica aerogel dust
    • Alcohol-sprays (Sterifab®)
    • Botanical sprays
      – EcoRaider™
      – Bed bug Patrol™
Protocols for home health workers

• Risks of picking up bed bugs relatively low... BUT if possible
  – Avoid sitting on upholstered furniture
  – Avoid placing purses, backpacks, other containers on or next to upholstered furniture
  – Carry-in supplies in plastic vertical-sided totes or other smooth sided carrier
Roles of public health professionals

• Understand the bed bug crisis
• Understand the role of bed bugs in mental health issues
• Understand socio-economic constraints
  – Better coordination with social service agencies
• Be able to implement common-sense protocols for staff and facilities
Resources

• Insects in the City website http://citybugs.tamu.edu
• Do-it-yourself control options
  – http://citybugs.tamu.edu/factsheets/biting-stinging/others/ent-3012
• EPA bed bug site
  – http://www.epa.gov/pesticides/bedbugs
References on bed bugs and human disease


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Questions?

http://insectsinthecity.blogspot.com