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BEDBUG FUMIGATION: TOXIC RISKS AND NATURAL REMEDIES

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Abstract: Bedbug fumigation is a common method for controlling infestations, utilizing chemical fumigants such as sulfuryl fluoride, phosphine gas, pyrethroids and neonicotinoids. While effective, these chemicals pose significant health risks, ranging from mild symptoms like skin irritation and nausea to severe effects including respiratory distress, neurological damage and fatal poisoning. Several documented fatalities have been linked to improper fumigation practices, highlighting the dangers of toxic gas exposure. Safety measures, including professional handling, proper ventilation and alternative treatments like heat or steam are crucial in minimizing health risks. This paper underscores the need for regulated pesticide use and safer bedbug control methods to prevent further health hazards.

IndexTerms - **Bedbug fumigation, toxic gas, health hazards, safety measures, control methods**

I. INTRODUCTION

Bedbug fumigation is a process where insecticidal gases or chemicals are used to eliminate bedbugs in infested areas. It is often used when traditional methods like sprays, heat treatments and power fails. While effective, it is crucial to understand the methods associated risks and safety precautions to ensure both efficacy and safety. Common fumigation chemicals are phosphine gas, Pyrethroids and Neonicotinoids. These require strict handling protocols as they can cause potential health risks like skin irritation, respiratory issues and death in human if misapplied. The use of certain fumigation chemicals for bedbug extermination has in rare instances led to fatalities due to improper application or exposure to toxic substances. According to CDC report (2003-2010), the centres for Disease Control and Prevention identified 111 cases of illness associated with bedbug-related insecticide use (2). While 90% were of low severity, there was one fatality. The majority of cases involved pyrethroids and pyrethrins. Contributing factors included excessive application, failure to wash or change pesticide-treated bedding and inadequate notification of pesticide application. According to French study (1999-2021), the French Poison Control Centres recorded 1056 cases of exposure to bedbug insecticides, with the first incidence in 2007. (3) Reports increased over the years, highlighting a growing public reliance on chemical insecticides for bedbug management and the associated poising risks. Therefore, only licensed professionals should perform fumigation. Considering the risks associated with chemical fumigation, exploring non-chemical methods can be beneficial. The non-chemical methods include heat treatment, steam treatment and vacuuming. Elevating the room temperatures to lethal levels for bedbugs can effectively eliminate them without chemicals and applying steam directly to infested areas can kill bedbugs and their eggs on contact.

Threshold limit values (TLVs), Recommended exposure limits (RELs) and Permissible exposure limits (PELs) are established to protect workers from adverse health effects of chemical exposures during fumigation processes. (4) These values are set by organizations such as American Conference of Governmental Industrial Hygienists (ACGIH), National Institute for Occupational safety and health (NIOSH) and Occupational Safety and health Administration (OSHA) and are defined as follows:

Fumigant	OSHA PEL	NIOSH REL	ACGIH TLV
Phosphine gas	TWA of 0.3 ppm (0.4 mg/m^3) over an 8-hour work shift	TWA of 0.3 ppm (0.4 mg/m^3) over a 10-hour work shift; STEL of 1 ppm (1 mg/m^3)	TWA of 0.05 ppm; STEL of 0.15 ppm
Pyrethrum (natural Pyrethroid)	TWA of 5 mg/m^3 over an 8-hour work shift	TWA of 5 mg/m^3 over a 10-hour work shift	TWA of 5 mg/m^3 over an 8-hour work shift

*TWA:Time-weighted Average
PPM: parts per million
STEL: short-term Exposure limit

I. METHODOLOGY

1. **Research design:** This study employs a mixed methods approch to examine the effectiveness, challenges and public perception of bedbug fumigation. The research is based on data collection from online sources, including reports and case studies.
2. **Data Collection methods:**
   - Online news articles from reputed sources reporting on bedbug infestations, fumigation processes and outcomes.
   - Scientific studies, government reports and pest control company case studies.
   - Online customer reviews discussing personal experiences with fumigation.
3. **Ethical considerations**: Ensured that all online sourcesused were publically available and cited properly.

II. RESULTS AND DISCUSSION

Despite the establishment of OSHA, NIOSH and ACGIH threshold values for chemical fumigants, people continue to face fatalities after bedbug fumigation due to several key reasons. Some fatalities due to improper fumigation are listed below:

1. **Sri Lanka Incident (2024):**
   A 24-year-old British woman died after severe vomiting at the Miracle Colombo City Hostel. Investigations revealed that the hostel had recently fumigated rooms with toxic bedbug chemicals, specifically phosphine gas, a highly toxic pesticide. The room was sealed for 72 hours post-fumigation and exposure to residual toxic gases was suspected as the cause of death. (5)
2. **Pompano Beach, Florida, USA case (2023):**
   Following the fumigation of a warehouse, three workers fell ill and two subsequently died due to exposure to highly toxic fumigants. This incident highlighted ongoing health concerns associated with certain fumigation practices. (6)
3. **London Case (2021):**
   Jesmin Akter, 34, unintentionally killed her 11-year-old neighbour, Fatiha Sabrin, by using illegally imported aluminium phosphide to treat a bedbug infestation in her flat. The chemical released phosphine gas that seeped into neighbouring apartments leading to child's death and hospitalization of another. Akter was sentenced to manslaughter and importing a regulated substance. (7)
4. **British couple in Egypt case (2018):**
   John and Susan Cooper died while on vacation at Steigenberger Aqua Magic Hotel in Hurghada, Egypt. An inquest revealed that the room adjacent to theirs had been fumigated for bedbugs using a pesticide containing cyhalothrin. The Coopers subsequently suffered from symptoms consistent with exposure to toxic chemicals. (8)

From above data, it can be found that many fumigation deaths occur because of incorrect usage, where chemicals exceed safe limits due to misapplication of lack of proper ventilation. In residential settings, unlicensed individuals often misuse highly toxic substances, like phosphine gas, leading to fatal poisoning. Some cases involve the use of banned or unregulated pesticides, often smuggled into countries where they are illegal. For example, aluminium phosphide (a highly toxic pesticide) has caused several deaths when used in non-industrial settings without proper controls. (9) After fumigation, if the treated area is not ventilated properly, toxic residues can remain, leading to continued exposure and health complications. Children, elderly individuals and those with pre-existing health conditions are more susceptible to toxic effects, even at lower exposure levels. Fatalities often involve accidental exposure in multi-family homes or hotels, where non-targeted individuals inhale dangerous fumes. Some fumigation chemicals leave behind toxic residues on furniture, bedding and food, leading to chronic exposure and poisoning.

The most effective non-chemical methods are heat treatment (thermal Remediation), which involve the use of heat chambers, steamers or whole-room heat treatments to kill bedbugs at all life stages. Bedbugs die at temperatures above 115 ºF (46 ºC). Another effective non-chemical method involves the use of diatomaceous earth (DE), a natural non-toxic powder that dehydrates and kills bedbugs when they come into contact with it. It is applied in cracks, crevices and along bed frames. Bedbugs can also be effectively killed by steam cleaning. High temperature steam above 200 ºF effectively kills bedbugs on mattresses, furniture and carpets. Special bedbug-proof covers for mattresses and pillows can also prevent bugs from escaping and feeding. It will work as preventive measure rather than sole treatment. Bedbugs can also be killed by cold treatment or freezing by exposing the infested item to 0 ºF for at least 3 days.

III. SUMMARY

While regulatory agencies set safe exposure limits, real-world misapplication, lack of safety measures and illegal pesticide use contribute to ongoing fatalities. Stricter enforcement, better public awareness, and safer alternatives like heat treatment are necessary to prevent further deaths. In summary, while chemical fumigation can be effective against bedbugs, it is essential to approach it with caution due to potential health risks. Non-chemical alternatives offer safer options and can be used in conjunction with chemical methods for comprehensive control.

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