

Evidence Brief: Humidifier use in health care



Key messages

- Improperly maintained cool mist humidifiers can release aerosols containing dissolved minerals and opportunistic pathogens into the air. Therefore, many public health and health care institutions restrict their use.
- The decision on use of bedside humidifiers for patients should consider the type of humidifier, and cleaning and maintenance of the humidifier. Recommendations by other jurisdictions may also be useful in decision-making.

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Issue and Research Question

Portable bedside humidifiers are used to increase moisture levels in the air. The use of humidifiers has benefits and drawbacks.

Humidifiers are used to relieve respiratory symptoms such as shortness of breath associated with bronchitis.¹ The moisture supplied by the humidifier is also used to alleviate dry skin² and help cold sufferers feel better by reducing dryness and irritation to the nose and throat.³ Using humidifiers to keep the relative humidity in the comfort range of 40%–60% has been shown to decrease survival of influenza viruses.⁴ A humidity level above 60% should be avoided because it can promote the growth of microorganisms, including mould.

Humidifiers that atomize water to generate micro-sized droplets in the air (referred to as an aerosol) can potentially distribute any microbial contaminants present in that water or in biofilms that develop on humidifier tanks, reservoirs, and spouts.^{1,5} Contaminated room humidifiers can generate high exposures⁵ and have been linked to both health care-acquired and community-acquired infections.^{6–9} Given the reported benefits versus the potential for respiratory disorders, the appropriateness of allowing bedside humidifiers for patients and residents in institutions has been a topic of debate. The following evidence brief was prepared to inform decisions on whether to allow bedside humidifiers for patients.

Types of bedside humidifiers

- **Ultrasonic humidifiers:** These produce a micro-sized aerosol when a reservoir of water is vibrated at ultrasonic frequency.
- **Impeller humidifiers:** A motor-driven impeller (spinning disc) draws up water and forces it through a screen, breaking up the water into a micro-sized aerosol.
- **Evaporative:** These use a reservoir of water from which a wick filter draws moisture. A fan blows air over the filter, creating moisture (via evaporation of water) and blows the moisture into the air.
- **Steam humidifiers:** These boil water to emit water vapour (steam) into the air. However, it is generally cooled to prevent scalding due to the high temperature of the steam (>100°C).
- Because ultrasonic, impeller and evaporative humidifiers do not heat the water, they are commonly referred to as “cool mist” humidifiers by the manufacturers.

Methods

A review of the literature was executed using OVID Medline, Academic Search Premier, Environment Complete and Scopus databases, Google, and Google Scholar. Search terms related to humidifiers, cleaning, disinfectant, and biocide were combined in the search queries. Limits on the language of publication

(English) and date of publication (1980–present) were applied to the searches. To complement this review, references of included papers were checked for other relevant papers.

Main Findings

Findings from the literature are summarized below:

- Because several opportunistic pathogens (such as *Legionella*, *Pseudomonas*, nontuberculous mycobacteria and *Acinetobacter*) are found in the natural environment, they can be introduced into a building’s plumbing system via the public water supply.¹⁰ Given the right conditions, these opportunistic pathogens can then colonize components of the building’s water supply and contaminate the potable water.¹⁰ If the building tap water is then used in an aerosol producing humidifier (ultrasonic or impeller unit), the pathogens can potentially be aerosolized into indoor air and pose a health risk. This is particularly true if the humidifier is not routinely cleaned and disinfected and the water in the humidifier’s reservoir is allowed to stagnate.
- Improperly maintained humidifiers have been associated with increased risk of illness such as humidifier fever^{1,3} and Legionnaires’ disease⁸.
- There are a number of different humidifier designs (see callout box above), each with different levels of risk. Steam humidifiers (where water is boiled to create water vapour that is released into the airstream) represent a low level of risk of exposure to pathogens, because steam is unlikely to produce aerosols containing viable microorganism.¹¹ Similarly, evaporative humidifiers do not pose a significant health

risk, as they do not generate aerosols. Alternatively, because ultrasonic and impeller humidifiers can produce aerosols possibly contaminated with pathogenic bacteria, the risk potential for disease transmission is higher, especially in situations where there is a vulnerable person in close proximity^{11,12} The size of the particles generated by ultrasonic and impeller humidifiers is small enough to be inhaled into the lungs. Highsmith et al. noted that fine particles (< 2.5-µm in diameter) constitute >90% but only 60-75% of the particles generated by ultrasonic and impeller humidifiers respectively¹³

- A review of the literature indicates that most disease transmission associated with portable humidifiers is due to aerosol producing humidifiers, i.e., ultrasonic and impeller units that were not properly maintained, cleaned or disinfected.^{6,7,14-19}
- Once they become contaminated, bedside humidifiers are very difficult to clean. They can still be a source of exposure even if cleaning is attempted and they are refilled with sterile water.²⁰ This is especially true if mineral deposits or biofilm are present in the humidifier. Mineral deposits and biofilm not only protect the microbes from disinfection, but provide a source of nutrients for them to proliferate.²¹
- When it comes to the use and care of home-use humidifiers, guidelines from government agencies responsible for protecting the general public suggest following the manufacturer's instructions.²²⁻²⁴ However, different manufacturers have different requirements, and there has been at least one case where following the manufacturer's instructions (which allowed

the use of tap water for an ultrasonic humidifier) resulted in an outbreak of Legionnaires' disease in a hospital nursery.¹⁵

- Depending on the geological location, tap water can be "hard." Hard water contains a higher concentration of minerals such as sodium, calcium and magnesium.²⁵ These mineral particles can be aerosolized (as a "white dust"), potentially causing adverse reactions in susceptible people.²⁵ To avoid this, manufacturers of ultrasonic and impeller humidifiers and researchers often recommend the use of distilled water (or demineralized water).^{13,25} Some ultrasonic and impeller humidifiers can be equipped with demineralizing filters, but these are expensive and have to be changed frequently. Steam vaporizer and evaporative humidifiers are not expected to aerosolize any minerals particles into the air.
- Fatal lung disease has been reported when ultrasonic humidifiers were run with biocide detergents in the water reservoir rather than it being used to clean the reservoir.²⁶⁻²⁸

Recommendations for bedside humidifiers in health care institutions

Various health care institutions and public health agencies have made different recommendations concerning the use of bedside humidifiers:

- Current American National Standards Institute/American Society of Heating, Refrigerating, and Air-Conditioning Engineers/American Society for Healthcare Engineering (ANSI/ASHRAE/ASHE) ventilation guidelines state that humidifiers should be located within air handling units

or ductwork, and that steam humidification should be used.²⁹

- The United States Department of Veterans Affairs, Veterans Health Administration requires that only steam be used for building humidification purposes, and prohibits the use of ultrasonic (cool mist) humidifiers.³⁰
- Current CDC environmental infection control guidance states that “Reservoir-type humidifiers are not allowed in health care facilities as per AIA (American Institute of Architects) guidelines and many state codes. Cool mist humidifiers (ultrasonic and impeller) should be avoided because they can disseminate aerosols containing allergens and microorganisms. Additionally, the small, personal-use versions of this equipment can be difficult to clean”.^{31,32}
- In its guideline for preventing health-care associated pneumonia, the CDC warns against the use of room-air humidifiers that create aerosols unless they can be sterilized or subjected to high-level disinfection at least daily and filled only with sterile water.³³ They also recommend the use of sterile water for rinsing after chemical disinfection. Note: Distilled water may not be sterile. There have been at least two cases where distilled water used to fill humidifiers has led to infections.^{34,35}
- In instances of nosocomial infections traced to aerosol-generating equipment in patients' rooms, the WHO notes that “substitution of steam humidifiers for equipment that provides humidification by the aerosolization of unsterile water” has been followed by cessation of further cases.³⁶

- The National Institutes of Health recently conducted a study to determine the risk to health of their humidifier policy.³⁷ The policy allows patients to request bedside humidifiers, but states that humidifiers “must be filled with sterile water and that the humidifier must be discarded after three days of use.” In the study, ultrasonic humidifiers were filled with sterile water and the microbial content examined over five days. The study found that contamination appeared after just one day, and increased over time. It concluded that aerosolization of potential pathogens by this type of humidifier may pose a risk, especially to individuals whose immune systems are suppressed. Based on the study’s findings, the authors recommended against the use of bedside in hospitals.³⁷

Discussion and conclusions

Humidifiers are used to help maintain comfortable room humidity. There are four types of humidifiers: evaporative, steam, ultrasonic and impeller. Ultrasonic and impeller humidifiers generally pose a greater risk than evaporative and steam humidifiers because evaporative and steam humidifiers are not expected to aerosolize any mineral products into the air. This is because they can release aerosols containing dissolved minerals and opportunistic pathogens into the air. Many public health and health care institutions restrict their use or allow their use only under strict conditions. Some allow only the use of steam for building humidification.

Implications for practice

Portable bedside humidifiers are used to increase moisture levels in the air. The use of some types of humidifiers may create a risk of

infection. The decision to allow bedside humidifiers should consider:

- The type of bedside humidifier as steam and evaporative-type represent a low level of exposure to pathogens and dissolved mineral particles whereas ultrasonic and impeller humidifiers can be a source of exposure to the dissolved and suspended components, including pathogens, of the water.
- Proper maintenance, cleaning or disinfection of the humidifier in accordance with manufacturers' specifications.
- Other jurisdictions also provide recommendations that may be considered in decision-making.

Specifications and limitations of Evidence Briefs

The purpose of this Evidence Brief is to investigate a research question to help inform decision making. The Evidence Brief presents key findings based on a systematic search of the best available evidence near the time of publication, as well as systematic screening and extraction of data from that evidence. It does not report the same level of detail as a full systematic review. Every attempt has been made to incorporate the highest level of evidence on the topic. There may be relevant individual studies that are not included; however, it is important to consider at the time of use of this Evidence Brief whether individual studies would alter the conclusions drawn from the document.

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