

Sterilization By Formalin In Open Heart Surgery

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Content:

- **Introduction**
- **Formalin as sterilization agent**
- **Advantages and disadvantages of formalin**
- **How to use formalin for sterilization**
- **Alternatives to formalin for sterilization**
- **Formalin using in USA and developing country's**
- **Conclusion**

Introduction:

Formalin is an aqueous solution that contains 37-40% formaldehyde gas dissolved in water, often with 10-15% methanol added to prevent polymerization.

It is a potent chemical agent used in various applications, including tissue preservation, disinfection, and sterilization. Formaldehyde, the active component in formalin, has strong antimicrobial properties, making it effective in killing a wide range of pathogens, including bacteria, viruses, fungi, and spores.

Formalin sterilizes by binding to microbial proteins and nucleic acids, causing them to lose structure and function. preventing microbes from reproducing or surviving.

The combined effect effectively eliminates pathogens, making formalin a strong disinfectant.

Formalin as a sterilization agent:

Formalin is an aqueous solution of formaldehyde gas, typically containing 37-40% formaldehyde by weight, with water and often around 10-15% methanol to prevent polymerization.

Formaldehyde (CH_2O) is a small, reactive molecule with a simple structure consisting of a carbonyl group ($\text{C}=\text{O}$) bonded to a hydrogen and a hydroxyl group in solution.

It is highly soluble in water, allowing it to penetrate cell walls and react with cellular components.

Formaldehyde is a strong disinfectant and preservative due to its ability to form cross-links with proteins and nucleic acids, making it an effective antimicrobial agent.

Advantages and disadvantages and of using formalin

Advantages;

- **High Efficacy:** Formalin is effective against a wide range of microorganisms, including bacteria, viruses, fungi, and spores, making it a strong sterilizing and disinfecting agent.
- **Cost-Effective:** Formalin is relatively inexpensive compared to other sterilization methods, making it accessible and widely used in medical and laboratory settings.
- **Long-Lasting Effect:** Formalin's antimicrobial action can be prolonged, providing lasting sterilization and preservation, which is valuable for instruments and specimens.

Disadvantages

- **Toxicity:** Formalin is highly toxic and can be harmful if inhaled, ingested, or absorbed through the skin. Exposure can lead to respiratory irritation, skin burns, and potential long-term health risks, including cancer.
- **Corrosiveness:** Formalin can damage sensitive instruments and equipment over time, especially when used frequently, leading to increased maintenance or replacement costs.
- **Handling and Disposal Challenges:** Due to its toxicity and potential environmental impact, formalin requires careful handling, special storage, and proper disposal, often under strict regulatory guidelines.
- **Unpleasant Odor:** Formalin has a strong, pungent odor that can be irritating and unpleasant for personnel working with it frequently.

How to use formalin for sterilization:

Formalin, which is a solution of formaldehyde in water (typically 37-40%), is used for sterilization by either fumigation or immersion. Here's how it's applied in these methods:

Using Formalin for Sterilization:

Fumigation:

- a) **Preparation:** Use a 10-15% formalin solution in a sealed, well-ventilated space. Heat the solution to release formaldehyde gas.
- b) **Process:** Allow the gas to circulate for 2-4 hours for effective sterilization.
- c) **Post-Sterilization:** Ventilate the space thoroughly before re-entry. Dispose of formalin according to safety regulations.

Immersion:

- a) **Preparation:** Prepare a 10-15% formalin solution and place items to be sterilized in it.
- b) **Process:** Immerse items for 30 minutes to 1 hour to disinfect.
- c) **Post-Sterilization:** Rinse items with sterile water to remove formalin residues.

Safety Considerations: Wear protective gear and use in well-ventilated areas, as formalin is toxic and carcinogenic.

Alternatives to formalin for sterilization

Comparison formalin with other sterilization methods:

Formalin is effective for disinfecting and preserving biological specimens, but it is toxic and requires careful handling. It is not ideal for routine sterilization due to its hazardous nature.

Autoclaving is generally considered the best for most medical and laboratory applications because it is fast, reliable, non-toxic, and highly effective for sterilizing heat-resistant items.

UV Sterilization is excellent for non-toxic surface and air disinfection, but its effectiveness is limited to direct exposure and is less effective for deep penetration or spores.

Gas Sterilization (Ethylene Oxide) is ideal for heat-sensitive items, but it is toxic, requires long exposure times, and must be carefully managed.

In summary, **autoclaving** is typically the best option for most medical and laboratory sterilization needs, while other methods like **formalin**, **UV**, or **gas sterilization** may be used depending on specific circumstances (e.g., heat sensitivity or need for non-toxic processes).

Formalin using in USA and developing country's

In the United States, formalin is still used primarily for specimen preservation and, in some cases, for sterilization in medical and laboratory settings.

However, due to its toxic and carcinogenic properties, its use is strictly regulated by agencies like OSHA and the EPA.

These regulations ensure proper ventilation, protective equipment, and safe disposal practices to minimize health risks.

In developing countries, formalin is more commonly used due to its low cost and availability, especially in settings with limited access to advanced sterilization methods. It is often used for sterilizing instruments and preserving biological specimens.

Conclusion:

In conclusion, formalin is an effective sterilizing agent but poses health risks due to its toxicity and carcinogenic properties.

While its use is regulated in developed countries, it remains common in developing countries due to its low cost.

However, safer alternatives like autoclaving and gas sterilization are preferred. Proper safety measures and exploring alternatives are crucial to minimize risks.

References

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