Understanding the Key Features and Benefits of Mechanical Cleaning Tools

Ultrasonic Baths, Water Guns, and Washer-Disinfectors

BY WILLIAM LEIVA

Mechanical cleaning is a critical step in the decontamination process of reusable medical devices.[1,2] Standards, guidelines, and standard operating procedures require proper cleaning to ensure the removal of visible debris and to prepare instruments for effective disinfection and sterilization.[3-5] Mechanical cleaning tools are designed to make this process safer, faster, and more consistent. Understanding the features, benefits, and correct use of each tool is essential for maintaining safety and compliance in healthcare and laboratory settings.

Learning Objectives

1. **Identify key types of mechanical cleaning tools and describe their main features and functions.**
2. **Explain the benefits and limitations of each mechanical cleaning method.**
3. **Demonstrate the safe and effective use of mechanical cleaning tools.**

LEARNING OBJECTIVE #1:
Identify key types of mechanical cleaning tools and describe their main features and functions.

Mechanical cleaning tools are designed to remove contaminants efficiently and consistently and to reduce the strain that sterile processing professionals face during the decontamination process. These tools aim to reduce reliance on manual cleaning processes, which can be time-consuming and inconsistent. The three main types of mechanical cleaning tools are ultrasonic baths, water guns, and washer-disinfectors, also known as mechanical washers. Each serves a unique function and has specific features suited to different cleaning needs.

Water Guns

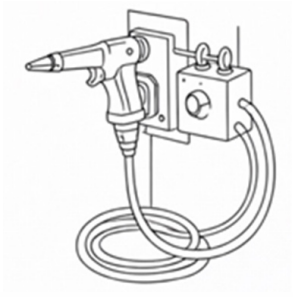
Water guns, sometimes called high-pressure spray systems, use pressurized water to remove visible debris and soil (**Figure 1A**). They are often used for pre-cleaning before a more thorough mechanical or chemical cleaning step.[5,6] Key features include:

- Adjustable water pressure to avoid damaging delicate instruments.

Table 1. Overview of mechanical cleaning tools with main features and usage.

Tool	Main Features	When to Use It
Water Guns	Different tip adaptors and spray nozzles	Before ultrasonic or washer-disinfector cleaning
	Portable and easy to use	When devices remain contaminated after further steps
Ultrasonic Baths	Uses bubbles (cavitation)	When instruments require ultrasonic cleaning
	Common frequencies: 35-40 KHz	
	Timers and set cycles	On short cycles for general instruments
	Uses cleaning detergents	
	Some models include irrigation ports	
	Effective for hard-to-reach areas	
Washer-Disinfectors	Fully automated cycles	Instruments either required washer-disinfector
	Specific cycles based on load	In sterile processing departments required to deliver large throughput
	Require specific load carriers	

A)



B)

Figure 1: A. Rendering of a water gun used in sterile processing and B. water gun tip adaptors and spray nozzles for targeting specific areas. This figure was created using ChatGPT. All content was reviewed by the author for accuracy and appropriateness.

- Spray nozzles (**Figure 1B**) designed for targeting specific areas, such as tapered and luer-slip adapters.
- Portable units suitable for small setups or sink-side cleaning stations.
- Some water guns use steam to flush debris out.

Water guns are primarily used to flush debris from surgical instruments before placing them into ultrasonic baths or washer-disinfectors. They provide rapid, hands-on cleaning with moderate efficiency.

Ultrasonic Baths

Ultrasonic baths use high-frequency sound waves to create tiny bubbles in a liquid solution, a process called cavitation (**Figure 2A**). These bubbles collapse when they contact instrument surfaces, helping to dislodge debris from hard-to-reach areas. Ultrasonic bath systems are especially useful for cleaning complex instruments with lumens, hinges, or other design features that are difficult to clean manually.[5,7] Key features of this technology include:

- **Bath size:** Ranges from small tabletop units used in dental settings, to large baths with multi-level load carriers for a higher throughput.
- **Frequency and power settings:** The frequency is measured in kHz, with most models using frequencies between 35 and 40 kHz. 1 kHz is equivalent to 1000 sound waves per second. Units with 35 kHz provide slightly larger bubbles than units using 40 kHz, yet both are effective in dislodging soil.
- **Pre-programmed cycles:** Customized for different instrument types.
- **Timers:** Allow standardized cleaning cycles, with some specifically designed for devices such as robotic arms or laparoscopic devices.
- **Chemical agents:** Different cleaning chemistries are used on ultrasonic baths including enzymatic, neutral, and mild-alkaline detergents.
- **Irrigation system:** Some units include multiple ports with special adaptors for instruments that require irrigated ultrasonic cycles; in this case, the adaptors must be fully inserted into the instrument flushing port (**Figure 2B**).

Functionally, ultrasonic baths provide a consistent, thorough cleaning that reduces manual labor and increases safety by minimizing direct contact with contaminated instruments.

Washer-Disinfectors

Washer-disinfectors, also known as mechanical washers or auto washers, are automated units that combine pre-cleaning, washing, and rinsing, and may include thermal disinfection or lubrication features (**Figure 3**).[8-10] They are designed for larger instrument loads, including multiple-level and specific load carriers for anesthesia, ophthalmology, and lumened or channeled devices.

Lesson:

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1. C, 2. E, 3. A, 4. B, 5. D, 6. B, 7. C, 8. C, 9. C, 10. C

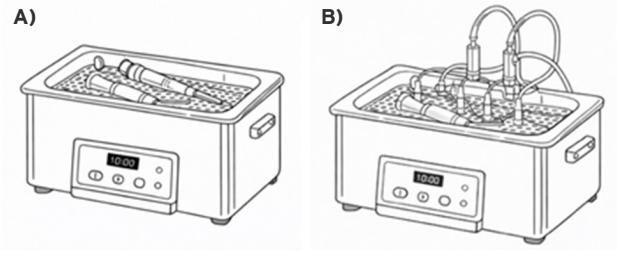


Figure 2: Rendering of A. a tabletop conventional ultrasonic bath and B. irrigated ultrasonic bath. This figure was created using ChatGPT. All content was reviewed by the author for accuracy and appropriateness.

Washer-disinfectors facilitate standardized cycles that manual methods cannot achieve. Key features include:

- Built-in rinsing, washing, and drying stages.
- Monitoring systems for temperature, time, and detergent concentration.
- Reduced water, energy, and chemical consumption, especially in newer models.

These units assist with cleaning and disinfection, reduce human error, and minimize staff exposure to contaminated instruments. Instruments emerge clean, disinfected, and ready for inspection, packaging, and sterilization, improving workflow and safety.

LEARNING OBJECTIVE 2:

Explain the benefits and limitations of each mechanical cleaning method.

Mechanical cleaning methods play an essential role in the safe and effective reprocessing of reusable medical instruments. While all mechanical cleaning tools aim to remove debris and reduce contamination, each method offers unique benefits and presents specific limitations. Understanding these strengths and weaknesses helps healthcare and laboratory staff select the most appropriate tool for each stage of the cleaning process and apply it safely and effectively.

Water Guns

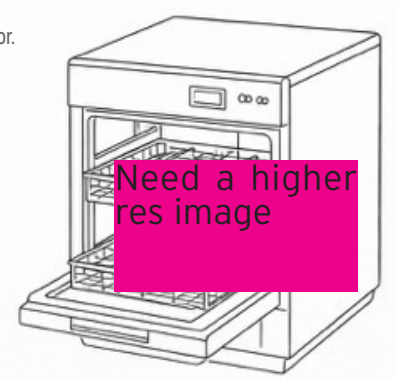
Water guns are commonly used as a first step in mechanical cleaning. Their primary benefit is the rapid removal of gross, visible debris such as blood, tissue, or other soil from instruments. By using pressurized water, water guns can quickly flush contaminants from surfaces and internal channels, making them especially useful immediately after instrument use. They are flexible, easy to operate, and can be used in sink-side cleaning areas with minimal setup. Compared to more complex systems, water guns are also cost-effective, making them accessible for facilities of many sizes.

Despite these advantages, water guns have clear limitations. They are designed only for pre-cleaning and cannot replace thorough cleaning steps. While they remove visible debris, they do not reliably clean microscopic contaminants or microorganisms. Additionally, improper use may create splashing, which increases the risk of staff exposure to contaminated fluids if personal protective equipment (PPE) or splash-control systems are not used.[3] Water pressure must also be carefully adjusted, as excessive force can damage delicate instruments or force debris deeper into lumens. For these reasons, water guns should be viewed as a supportive tool rather than a complete cleaning solution.

Ultrasonic Baths

Ultrasonic baths offer a more advanced level of cleaning by using high-frequency sound waves to create cavitation bubbles in a liquid solution. When these bubbles collapse, they release energy that loosens debris from instrument surfaces, including areas that manual scrubbing cannot reach. This makes ultrasonic baths particularly effective for instruments with hinges, joints, lumens, or intricate designs. Another major benefit is uniform cleaning, as the cavitation process reaches surfaces consistently. By reducing the need for manual scrubbing, ultrasonic baths also reduce staff handling and decrease exposure to contaminated instruments.

Figure 3: Rendering of tabletop washer-disinfector. This figure was created using ChatGPT. All content was reviewed by the author for accuracy and appropriateness.



However, ultrasonic baths also have limitations that must be carefully managed. Instruments usually require pre-cleaning before ultrasonic processing, and some may need soaking to achieve optimal results. Certain instruments can be sensitive to cavitation, particularly at lower frequencies, which may cause surface damage if manufacturer instructions for use (IFUs) are not followed. Additionally, there is no standardized method to measure the strength or quality of cavitation, as current indicators only confirm whether cavitation is occurring, not how effective it is at a specific frequency. This makes adherence to validated cycles and manufacturer guidance especially important.

Washer-Disinfectors

Washer-disinfectors represent the most automated mechanical cleaning option. Their greatest benefit is the ability to deliver standardized, repeatable cleaning cycles that may also include thermal disinfection. These systems can process large volumes of instruments efficiently, reducing variability and human error associated with manual cleaning. Monitoring systems track critical parameters such as time, temperature, and detergent concentration, supporting regulatory compliance and quality assurance. Newer washer-disinfectors often include self-loading carriers, which reduce physical labor and improve workflow efficiency.

The main limitations of washer-disinfectors relate to cost and flexibility. They require a significant initial investment and ongoing maintenance, which may be challenging for smaller facilities. Washer-disinfectors may also be less suitable for very delicate or irregularly shaped instruments unless specialized load carriers or customized cycles are available. Implementing new load carriers or cycles can require additional resources and validation. Furthermore, staff must be properly trained to load instruments correctly, select appropriate cycles, and monitor performance to ensure safe and effective operation.

Water guns, ultrasonic baths, and washer-disinfectors each serve an important role in mechanical cleaning workflows (**Table 1**). By understanding their benefits and limitations, staff can combine these methods effectively to improve cleaning outcomes, protect sterile processing professionals, and maintain compliance with standards and manufacturer IFUs. By weighing benefits against limitations, staff can develop workflows that maximize cleaning efficiency and safety. For instance, a workflow may combine instrument soaking, water guns for pre-cleaning, ultrasonic bath systems, and washer-disinfectors for full sets of instruments.

Despite these three technologies, the decision about which system to use depends on the IFU and its companion documents, such as wall charts. Currently, there is no universal cleaning process appropriate for use across all instruments, including those within the same instrument group (e.g., laparoscopic devices). Following IFUs is critical for sterile processing professionals.

LEARNING OBJECTIVE 3:
Demonstrate the safe and effective use of mechanical cleaning tools.

Demonstrating safe and effective use of mechanical cleaning tools relies on following manufacturer instructions and applying best practices. While general safety protocols are standardized across healthcare facilities and reinforced through accreditation, each sterile processing department must consider the nuances of different technologies to ensure they meet their specific needs.

Water Guns

For water guns, staff should always wear PPE to prevent exposure to splashes and aerosolized droplets. Aerosolization occurs when small liquid droplets are broken into tiny particles that can remain suspended in the air. Droplets smaller than five micrometers can be inhaled, potentially reaching the respiratory tract and carrying contaminants. This can happen during cleaning with water guns or ultrasonic baths, so the use of splash guards, proper ventilation, and PPE is essential to reduce inhalation risk. When flushing or rinsing instruments, the water gun and instruments should be pointed downward to prevent splashes and contamination. Water pressure must be adjusted carefully to avoid damaging instruments, and instruments should be held securely while flushing. Pre-rinsing instruments before transferring them to ultrasonic baths or washer-disinfectors further enhances cleaning effectiveness.[10]

Ultrasonic Baths

For ultrasonic baths, the tank should be filled with the recommended solution at the correct concentration, following both equipment and chemical manufacturer guidelines. Instruments must be fully submerged without overcrowding, which can be challenging in facilities with limited ultrasonic capacity or high instrument throughput. The appropriate cycle time and frequency should be set according to manufacturer instructions. Regularly changing the cleaning solution and maintaining the tank ensures consistent performance and prevents contamination.

Washer-Disinfectors

Washer-disinfectors require proper instrument loading according to manufacturer instructions to ensure full exposure to all cleaning and disinfection stages.[11] The correct cycle should be selected based on instrument type, and load carriers and irrigation ports must be properly positioned. Staff should monitor cycle parameters, including time, temperature, and detergent concentration, to verify effectiveness. Routine maintenance and validation checks are necessary to maintain compliance and operational safety.

Following these instructions ensures instruments are cleaned thoroughly while protecting both staff and equipment from harm. By adhering to best practices, sterile processing personnel can maintain safe, efficient, and reliable cleaning workflows.

Conclusions

Mechanical cleaning, both manual and semi-automated, is a critical step in instrument decontamination, ensuring that instruments are free from debris and ready for further reprocessing steps. Water guns, ultrasonic baths, and washer-disinfectors each offer unique features that make cleaning safer, faster, and more reliable than manual methods. Ultrasonic baths excel at reaching intricate areas, water guns provide rapid gross-debris removal, and washer-disinfectors offer standardized, large-scale cleaning and disinfection. These systems are used in a sequential fashion, with some instruments requiring or recommending all of them, while others only require some of these steps.

Understanding the benefits and limitations of each method is essential. Ultrasonic baths are highly effective but require careful handling and maintenance; water guns are flexible but limited in depth of

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1. **Why is mechanical cleaning important in the decontamination of medical devices?**
   A. It makes instruments look newer
   B. It replaces sterilization
   C. It removes visible debris and prepares instruments for further reprocessing steps
   D. It is optional if instruments look clean
   E. It only improves speed, not safety

2. **Which of the following is NOT a main type of mechanical cleaning tool discussed in the text?**
   A. Water guns
   B. Ultrasonic baths
   C. Washer-disinfector
   D. Mechanical washers
   E. Lint free cloth

3. **What is the main purpose of water guns in mechanical cleaning?**
   A. Flushing visible debris before further cleaning steps
   B. Sterilizing instruments
   C. Drying instruments
   D. Lubricating instruments
   E. Inspecting instruments

4. **Which feature of water guns helps prevent damage to delicate instruments?**
   A. Steam-only operation
   B. Adjustable water pressure
   C. Automatic timers
   D. Chemical detergents
   E. Thermal disinfection

5. **Ultrasonic baths remove debris using which process?**
   A. Heat sterilization
   B. Manual scrubbing
   C. High-pressure water spray
   D. Cavitation created by sound waves
   E. Dry air circulation

6. **What does "1 kHz" mean when discussing ultrasonic bath cleaning systems?**
   A. 1,000 bubbles per second
   B. 1,000 sound waves per second
   C. 1,000 cleaning cycles per minute
   D. 1,000 liters of water per hour
   E. 1,000 instruments per load

7. **Why are ultrasonic baths especially useful for complex instruments?**
   A. They use higher temperatures
   B. They are faster than all other methods
   C. They reach hard-to-clean areas like hinges and lumens
   D. They require no chemicals
   E. They disinfect instruments completely

8. **Which is a limitation of ultrasonic baths?**
   A. They cannot clean visible debris
   B. They replace washer-disinfectors
   C. Some instruments may be damaged by cavitation
   D. They do not use water
   E. They cannot be standardized

9. **What is a key benefit of washer-disinfectors?**
   A. Low purchase cost
   B. Manual control of every step
   C. Standardized cleaning and possible thermal disinfection
   D. Use only for single instruments
   E. No training required

10. **Which action helps ensure safe use of mechanical cleaning tools?**
    A. Skipping manufacturer instructions
    B. Overcrowding instruments during cleaning
    C. Wearing PPE and following proper loading guidelines
    D. Using the highest pressure at all times
    E. Reusing cleaning solutions indefinitely

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cleaning; and washer-disinfectors are efficient yet require a significant capital investment. By knowing when and how to use each tool, sterile processing professionals can optimize workflows, improve patient safety, and comply with regulatory standards.

Equally important is using these tools safely and effectively by following manufacturers' IFUs. Proper training, PPE use, solution concentration, adequate maintenance, and adherence to recommended cycles help prevent damage to instruments and reduce the risk to staff. Combining these mechanical cleaning methods into an appropriate workflow ensures that every instrument is prepared for the next step in decontamination. By mastering the features, benefits, limitations, and proper use of these tools, healthcare and laboratory personnel can confidently maintain high standards of cleanliness, safety, and efficiency in their daily work, ultimately protecting both staff and patients. **HPN**

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William Leiva MBA - MPH is currently a Subject Matter Expert on Medical Devices Sterilization and Reprocessing and is currently the Senior Program Manager for Sterile Reprocessing with Medtronic. He holds undergraduate degrees in physics and engineering and master's degrees in business administration and public health, where he focused his research on infection prevention strategies involving medical device reprocessing. He is currently a candidate for a Ph.D. in Cybernetics and Econometrics, researching around the economic impact of the burden of premature mortality. He has published peer review articles on the application of 3D printing technologies for medical devices and for austere environments.