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Sterilization & infection prevention

Water: A critical ingredient for instrument cleaning and disinfection

Using the right type of water for instrument reprocessing can prolong the life of medical instrumentation, contribute to effective function, and—most importantly—minimize the risk of adverse patient outcomes from contamination.

The water quality requirement for various stages of instrument reprocessing depends on the type of instrument and the disinfection or sterilization process used. For example, water quality criteria for reprocessing stainless steel general surgical instruments that will be steam sterilized are different from those for eye instrumentation or for reprocessing flexible endoscopes, which require high-level disinfection or low-temperature sterilization.

The importance of water quality for proper cleaning cannot be overstated. If a detergent is inactivated by poor water quality, cleaning will be inadequate and residual debris may impede mechanical movement of the instrument. Salt or other water deposits left on an instrument may cause corrosion, and the instrument may break during surgery when force is applied to it. Salts or organic deposits can also inactivate the disinfectant or sterilant, leaving behind some microorganisms. As a result, a device that's thought to be sterile could transmit an infection.

Toxic effects and tissue irritation are another concern. Water with high microbial levels may contain high levels of residual endotoxins or other pyrogenic agents. If ethylene oxide (EO) is used to sterilize an instrument, residual salts from the water used for the final rinse could be converted by the EO to toxic residues.

Water types and treatment

There are two types of water: utility and critical water.

Utility water, often referred to as tap water, is used mainly for flushing, washing, and rinsing. Not all tap water is acceptable for sterile processing. It should be analyzed by an accredited facility with expertise in water quality to determine whether the water requires treatment and, if so, what type of treatment.

Critical water is extensively treated, usually by a multistep treatment process that may include softening, deionization, reverse osmosis, and distillation.

Listed below are the different types of water treatment:

- Hard water contains calcium or magnesium, which can form relatively hard deposits that can be left on instrumentation and prevent microorganism and organic material from being removed. Water softeners can be used to remove these minerals and replace them by sodium ion exchange. Water softeners will also remove iron and manganese, although they are somewhat limited in this regard.
- Deionization (DI) uses specially manufactured ion-exchange resin to remove ionized salts from the water. DI does not usually remove organics, viruses, or bacteria, except through "accidental" trapping in the resin. DI water can be of very high quality with respect to ionized contaminants, but non-ionized substances such as bacteria and bacterial endotoxins are not removed, so DI should always be followed by filtration.
- Water treatment using reverse osmosis (RO) consists of a membrane separation pro-

cess for purifying water that is based on molecular sieving and ionic rejection. This process removes ions and dissolved organic contaminants with molecular weights above 100. RO removes most ionic species as well as microorganisms, endotoxins, organic compounds, and colloids.
- Distilled water is produced by the vaporization and condensation of water to remove dissolved and suspended substances such as microorganisms, endotoxins, organic compounds, and colloids. Water distillation is a very slow process that requires a storage tank.

Problems associated with poor water quality

Bacterial endotoxins, total organic carbon (TOC), pH, water hardness, and ionic contaminants are among the characteristics that contribute to unacceptable levels of organic and inorganic components in water.

Individually or in combination, these characteristics can cause changes in the appearance or color of water. If the water used in reprocessing does not look clear and colorless, it should not be used for instrument processing until the problem is corrected.

These contaminants can cause adverse reactions such as toxic anterior segment syndrome, an inflammatory reaction in the eye that can lead to permanent loss of vision after cataract surgery. Therefore, most manufacturers of ophthalmic surgical instruments recommend thoroughly rinsing these instruments with critical water.

Other risks from poor water quality include:
- If disinfection or sterilization processes do not remove bacterial endotoxins, these residues will remain on reprocessed devices and can cause a pyrogenic (fever-like) reaction and other adverse effects.
- Water with TOC contains material from organic pollutants such as microorganisms, plants, animals, or pesticides. Water with a high TOC level can discolor the instrument and interfere with the effectiveness of detergents, disinfectants, or sterilants.
- The alkalinity or acidity level (pH) of water can cause pitting or corrosion of instrumentation. The pH can also have an effect on the cleaning solution if the water pH is not compatible with the detergents.
- Tap water is classified as “hard” if it has a calcium carbonate content higher than 150 ppm. Hard-water deposits left on instruments during reprocessing can affect the cleaning efficacy of detergents and automated cleaning equipment.
- Ionic contaminants in water can corrode instrumentation.

Water should not increase the bioburden on the instrument. However, water can have high microbial levels, and those levels can vary throughout the year. The level of microorganisms in water depends on the effectiveness of the municipal treatment process and on the condition of the water distribution system.

Water is chlorinated to prevent microbial replication, but chlorinated water often contains other inorganic components that can damage instrumentation. DI will remove these impurities, but it also removes chlorine, thus allowing microorganisms to reproduce.

Other water treatment processes, such as RO, will remove microorganisms as well as inorganic components, thereby reducing the microbial load in the water. However, the RO treatment system might become contaminated with microorganisms and subsequently develop biofilm on the inner surfaces of the piping, leaving the water with unacceptable microbial levels.

Matching water type to cleaning phase

In the precleaning phase, tap water may be used to remove gross debris immediately

after surgery. To prevent coagulation of blood and other proteins, the temperature of the water used for this purpose should not exceed 45°C (113°F).

Tap water may also be used in the cleaning phase, but its physical characteristics must be checked to ensure that the water does not have excessive dissolved minerals or other undesirable characteristics that make it incompatible for use with detergents. The detergent manufacturer can verify this.

Tap water may be used for rinsing and removing soil loosened by the cleaning process and for rinsing and removing detergent residue, but it must meet the requirements for utility water.

Critical water is recommended for instruments that will contact the bloodstream or other sterile areas of the body. The final stage in rinsing must be done with water that does not have excessive levels of organics such as endotoxins or other microbial constituents.

Monitoring water quality

Water used to clean instrumentation should be routinely monitored and tested by facility engineers for pH level, hardness, purity, and temperature. Abnormalities should be communicated to the sterile processing department (SPD).

Likewise, the SPD should alert the engineers if there is a problem with the water. The SPD may also use commercial products to test for pH, alkalinity, and hardness, and some detergent manufacturers will test the water to determine how it interacts with their products.

Tap water that meets the requirements for utility water and that is compatible with detergents may be used for instrument cleaning, but it must be monitored and treated if it contains an excessive amount of dissolved minerals or other undesirable substances.

For additional information, consult the Association for the Advancement of Medical Instrumentation's (AAMI) 2014 Technical Information Report, which provides comprehensive guidance on water quality (http://www.techstreet.com/products/1884812). ❖

Susan Klacik, BS, CRCST, CIS, ACE, FCS, is president, Klacik Consulting, in Canfield, Ohio, as well as a CSS consultant and CSS manager at St. Elizabeth Health Center and the IAHCSMM (International Association of Healthcare Central Service Materiel Management) representative to AAMI (Association for the Advancement of Medical Instrumentation).