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OCULAR INFECTIONS

Prophylaxis and Management

Includes

- Operation Theatre Design
- Sterilization and Disinfection of OT and Instruments
- Post-Surgical Ocular Infections

Namrata Sharma
Neelima Aron
Atul Kumar

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CHAPTER 4

Water Requirement in Ophthalmic Operation Theatre

Mrittika Sen, Neelima Aron, Namrata Sharma, Atul Kumar

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INTRODUCTION

Water is an indispensable part of the infrastructure of any operation theatre complex. A continuous supply of clean water is essential for the functioning of an operation theatre (OT), maintenance of sterile environment, disinfection, sterilization of instruments, handwashing and presurgical scrubbing by OT personnel. An ideal operating room complex must have provision for adequate and continuous water supply at the rate of 400 L/bed/day. Apart from this, there should be a separate reserve emergency overhead tank. The chapter describes the water requirements for various activities in an operation theatre.

HANDWASHING

Surgical hand antisepsis with medicated soap or disinfectants requires clean water to rinse the hands. Gloves may prevent but do not eliminate the transmission of microorganisms from the hands of a surgeon to the patient. This is because of the presence of microperforations in the gloves that are present in about 18% cases at the end of the surgery. About 35% of all gloves have punctures after two hours of surgery; and 80% of the times, these punctures are not perceived by the surgeons.[1] Thus, prior preparation of hands is essential for preventing surgical-site infections.

Ohmori et al[2] examined the suitability of tap water for surgical handwashing. The volunteers who participated in the handwashing test using tap water showed immediate, persistent and cumulative bacterial activity within the limits set by the Food and Drug Administration (FDA). They concluded that tap water in their institution was safe for surgical handwash. Furukawa et al[3] conducted another study to examine whether sterile water and brushes are necessary for handwashing before surgery. No difference in bacterial counts was found between tap water and sterile water. However, storage of tap water in reservoir tanks lowers the chloride concentration and increases the chance of bacterial contamination. The concentration of chlorine in water is important for maintaining the microbiological quality. It has been reported that 0.2 mg/L of free chlorine can kill 90% of *Escherichia coli* in water within 2 hours. Hence, it is recommended that presurgical scrubbing should ideally be performed with water purified by reverse osmosis (RO). In hospitals where RO water system is not present, purified filter water can suffice.

INSTRUMENTS

Cleaning of Surgical Instruments

The guidelines for cleaning surgical instruments as provided by the American Operating Room Nursing (AORN)[4] Recommended Practices Committee suggest that the instruments should be washed with sterile distilled cold water to remove protein materials followed by brushing the instruments with special brushes. The instruments are then rinsed in clean water and dried. Mechanical cleaning using an ultrasonic cleaner is preferred as it minimizes handling and exposure to infectious material. Similar to handwashing, RO water is preferred, however, distilled water is sufficient to clean the instruments.

Cox and Stevens recommended use of either rain water or distilled water for cleaning surgical instruments.[5] When neither is available, freshly boiled cooled tap water may be used.

Corrosion and Rust

Corrosion and rust are caused by:

- Inadequate cleaning, rinsing and drying
- Using tap water
- A malfunctioning autoclave.

Most surgical instruments are made of stainless steel and do not usually rust but can corrode if they are washed with saline or left to soak in any liquid for long. Chrome- or nickel-plated instruments commonly get rusted. Once the carbon steel is exposed, it is further corroded by autoclaving and washing. Sodium nitrate is an antirusting agent that can be added to water while washing the instruments.

Autoclaving

Autoclaving is a method of wet sterilization using steam under pressure. The water being used for this purpose will determine the lifespan of the autoclave and the types of load that can be sterilized.

Tap water is a practical source of producing steam. However, if the quality of tap water is not adequate, it can damage the autoclave. This is because tap water contains a number of dissolved minerals and salts depending on the geographic location and source of water, i.e. ground well, lake, river, etc. Hard water can drastically lower the efficiency and functionality of an autoclave. On boiling, hard water is converted to steam while leaving behind salt and mineral deposits within the steam generator, pipes and valves. Over time, these get accumulated in layers and can clog the pipes and valves. It is recommended that any water harder than 85 mg/L should be treated.

Methods to Remove Impurities from Tap Water to Make of it Suitable for Use in an Autoclave[6]

Reverse Osmosis

Osmosis is a process that occurs naturally while reverse osmosis is an active process requiring energy. High pressure is applied on the side which is more hypertonic. The pressure forces the water across a semipermeable membrane while 95–99% of dissolved salts are left behind in the reject stream. Reverse osmosis is capable of removing up to 99% of the dissolved salts (ions), particles, colloids, organic matter, bacteria and pyrogens from the water.

Deionization

Deionization (DI), and continuous electrodeionization (CEDI) are methods of improving the quality of water by removing cations and anions. DI systems have charged resins that require periodic regeneration with an acid and base.

Distillation

Distillation units purify water by thermal vaporization, mist elimination, and water vapor condensation. The water should be treated for hardness and silica impurities should be removed before feeding it in the distilled water systems as these impurities may corrode the heat transfer surfaces. In spite of general perceptions, even the best distillation process cannot afford absolute removal of contaminating ions and endotoxins.

The level of water purity is defined by American Society for Testing and Materials (ASTM) international standards to have characteristics of resistivity, measured in ohm-cm or conductivity measured in μS/cm. Type I water is further defined by its total organic carbons (TOC) purity, measured in parts/billion (ppb).

- *Type I:* Ultrapure, type I water is defined by the ASTM as having a resistivity of >18 MΩ-cm, a conductivity of <0.056 μS/cm and <50 ppb of TOC. Type I water is ultrapure and used in analytical labs, HPLC, cell and tissue culturing, mass spectrometry.
- *Type II:* ASTM defines type II water as having a resistivity of >1 MΩ-cm, a conductivity of <1 μS/cm and <50 ppb of TOCs. Type II water is cleaner than type III/RO water but not ultrapure like type I. Type II water is used to feed clinical analyzers because there is less calcium build-up. It is also used for electrochemistry, radioimmunoassay and media preparation.
- *Type III:* ASTM defines type III water as having a resistivity of >4 MΩ-cm, a conductivity of <0.25 μS/cm and <200 ppb of TOCs. It is less pure than type I and II water. Type III water removes 90–99% of contaminants. It is produced using a reverse osmosis (RO) system directly from tap water, and is the starting point for many laboratory applications such as glassware rinsing, media preparation, and other non-critical laboratory applications. It is also

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a source of feed water for systems producing type I ultrapure water.

- *Type IV:* ASTM defines type IV water as having a resistivity of 200 KΩ-cm and a conductivity of <5 μS/cm. Type IV water is most generally produced by RO and is used as feed water to a type I or type II deionized (DI) system.

The easiest and the least expensive method of treating tap water for use in an autoclave is to install a type III RO filter in the water line and an 'Automatic generator blowdown' feature in the steam generator. The RO filter retains majority of the contaminants while the blow down feature flushes away any minerals that make it through.

Recommended Quality of Water

Water between 0.1 MΩ-cm and 1.0 MΩ-cm is considered appropriate for majority of the items that need to be sterilized for research work, biohazardous waste, clothing, glassware, media and instruments. This level of purity is achieved with type III RO filter. One must remember that highly pure water which lacks ions or minerals will try to leach impurities from everything it touches like glass, steel and copper. This could result in corrosion. Hence, high purity water should only be used in autoclaves constructed from stainless steel.

Water is the lifeline of an operation theatre and its supply is essential for all activities from the time the doors of the OT are opened in the morning till last of the instruments are put back in their respective containers. Hence, appropriate measures should be taken to ensure a high quality water supply in the operation theatre to prevent ocular infections.

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OCULAR INFECTIONS

Prophylaxis and Management

Salient Features

- An explicit and easy-to-read book
- Provides comprehensive information on operation theatre design, layout and requirements for setting up an operation theatre
- Highlights the methods of sterilization and disinfection of operation theatre and instruments with special reference to ophthalmic operation theatre
- Enlists the prophylactic measures to be taken pre-, intra- and post-operatively for the prevention of post-surgical infections of the eye
- Provides step-by-step management protocols for the timely and proper treatment of post-operative ocular infections
- Includes original good quality photographs wherever appropriate for a simplified understanding of the text
- The chapters are supplemented with flow charts and tables for easy comprehension of the subject
- Useful for the whole ophthalmic team: the surgeons, nursing staff, ophthalmic assistants and postgraduate students.



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