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The Importance of Chemical Solutions Used for Cleaning Stainless Steel Surgical Instruments in the Central Sterile Supply Department

To the Editor—The sterilization process can only be effective if cleaning and disinfection are adequate. Surgical instrument cleaning is usually performed by manual cleaning followed by mechanical cleaning. After surgery, primary cleaning of an instrument takes place in the user area, and secondary cleaning is conducted in the Central Sterile Supply Department (CSSD) holding room for soiled items. In our 167-bed oncology center in eastern India, we use multienzyme solutions for manual cleaning, rust inhibitor for rust removal, and acidic and alkaline solutions for mechanical cleaning.[1] After instruments are presented to the CSSD for disinfection, they are sorted into wire-mesh baskets and soaked in neutral enzymatic solution for at least 10 minutes to remove gross blood from the instrument's surface and from hollow orifices. This enzymatic cleaning solution dissolves proteins by breaking the amino acid bonds, and the blood or tissue can then be easily removed from the instrument with normal water. According to the manufacturer's recommendation, the solution concentration of this cleaner is 5 mL per liter of water (minimum), and the solution is considered active for not more than 3 hours after it is originally mixed. A good-quality enzymatic solution should have some surfactant when used in hard water. In our experience, manual cleaning solutions should be transparent when mixed with water to reduce the chance of instruments being missed or forgotten.[2]

Pure stainless steel instruments never caught rust, but occasionally, due to poor water quality, various metallic reactions, or insufficient drying, superficial rusting may occur, which can be removed by using rust inhibitor. For this procedure, we use inorganic phosphorus (from phosphoric acid) at a concentration of 10 mL per liter of water (minimum) as a rust removal solution. The contact time with the solution must be properly maintained to protect the passive layer of the stainless steel surface. This solution is used in an ultrasonic bath (Soniclean PS 3000, Australia) with lukewarm water, and brushing is not required.[1]

The mechanical washing process requires different quantities of solution during the prewashing and intermediate washing steps. Every TIVA 700 (Steelco, Italy) washer/disinfector (W/D) has two pumps through which the solution is added according to predetermined concentration levels. In our institution, we use both alkaline and acidic solutions in our mechanical mixing system. Here, an alkaline solution (ie, a phosphate) is used to remove organic substances and an acidic solution (ie, phosphoric acid) is used as a neutralizer, though phosphoric acid can also remove inorganic substances from the water, if they are present. The ratio of alkaline solution to acidic solution is 2:1 (4 mL:2 mL) per liter of water. In this system, low-foam enzymatic solution or alkaline with enzymatic solution can be used as a cleaning agent in the W/D.[1]

However, both systems exert some adverse effects on the instruments. If the ratio of the acidic to the alkaline solution (pH) is not maintained properly because of a faulty mixing pump, then black corrosion can occur on the instrument surface, which is difficult to remove.[4] Likewise, if the enzymatic solution creates foam during mechanical washing, then proper cleaning can be impaired due to bubble formation. Also, if the temperature of the water is >40°C, then the properties of enzyme break down, resulting in insufficient cleaning. Moreover, the quality of enzyme solutions and their preservatives can also hamper cleaning efficacy.

Cleaning performance can be monitored by using proper testing devices such as adenosine triphosphate (ATP) or soil testing. The ATP test (ie, a molecule test) is performed by swabbing the instrument after disinfection. The ATP reacts with the luciferase enzyme and emits light; the light intensity is then captured using a luminometer, and the level of contamination is determined according to a scale provided by the manufacturer. The amount of light produced is directly proportional to the amount of ATP present in the sample and, thus, to the quanta of organic matter contamination.

The soil indicator is composed of protein, fat and carbohydrate. The protein can coagulate when heat treatment starts (ie, a boiled egg). In the W/D there are three steps: pre-wash, intermediate wash, and thermal wash. In pre-wash, the temperature does not rise above 20 °C and so protein never coagulates. In intermediate wash, the temperature rises up to 40 °C and so protein only starts to coagulate. However, in thermal wash, the temperature rises between 40 °C and 90 °C and protein can easily coagulate and tightly adhere to the surface of the instrument. This soil indicator should be passed (by color change) before the final thermal wash step inside the W/D, or the color will never change due to protein coagulation.

Currently, various cleaning solutions have been introduced. Cleaning solutions must be optimized according to the potential contamination on the instruments and compatibility with the steel content. To avoid hazards, quality certificates and material safety data sheets are crucially important for every cleaning solution. Each solution should have proper certification by the original instrument manufacturers for use on the specific instrument being disinfected.

In our hospital, cleaning efficacy is monitored in every cycle using soil tests in the W/D. In our experience, soil tests rarely fail. However, failure may occur due to high total dissolved solids in the water or due to overloading surgical instruments in the mesh baskets.

The total cost of solution as a consumable is Rs. 809,947.12 (US$13,499.11) per year, which represents 4.19% of the total

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TABLE 1. Cleaning Solutions Used in the Central Sterile Supply Department at Tata Medical Center

Cleaning Solution	Area of Use	Concentration mL/L	Monthly Usage, Bottles	Cost of Solution per Bottle, INR	Cost Per Year, INR	Cost Per Year, US$
Enzymatic	Surgical instruments	5	12	1,225	176,400.00	2,940.00
Rust remover	Rust and scale removal	10	4	1,836.45	88,149.60	1,469.16
Alkaline	Mixing pump inside the W/D	4	3	8,475.97	305,134.92	5,085.58
Acidic	Mixing pump in the W/D as a neutralizer	2	1.5	8,639.13	155,504.20	2,591.73
Disinfectant	Surgical instrument disinfection (HLD)	25	2	3,531.60	84,758.40	1,412.64
				Total	809,947.12	13,499.11

NOTE. INR, Indian rupees; W/D, washer/disinfector; HLD, high-level disinfectant.

annual running cost of the CSSD and approximately 22.5% of the total annual consumable cost.[3] These costs are borne by the institution as part of the quality-related expenditures of the CSSD, and they have significant implications for the CSSD and hospital administrators.

In conclusion, when purchasing a cleaning solution concentration, pH value, mixing system, and activation/contact time should be clearly indicated on the brochure or the container, and this information should be easily understood by the end user. The cleaning procedure should carried out efficiently and effectively to prevent unnecessary usage and quality is maintained.

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Debabrata Basu, M.Sc, DHM[1]

Affiliations: Central Sterile Supply Department, Tata Medical Center, Kolkata, India.

Address correspondence to Debabrata Basu, M.Sc, DHM, Associate Scientific Officer, Central Sterile Supply Department, Tata Medical Center, Kolkata, India (debabrata.basu@tmckolkata.com).

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