L'INOX EST-IL VRAIMENT INOXYDABLE?

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RÉSUMÉ

L'achat initial et les frais de remplacement des instruments chirurgicaux constituent de nos jours un élément important des budgets de salles d'opération. Le personnel de salles d'opération et le personnel de retraitement des dispositifs médicaux travaillent ensemble pour assurer une gestion efficace de cette marchandise de valeur. Le but de cet article est d'examiner la composition des instruments chirurgicaux en acier inoxydable afin d'identifier des processus pour minimiser les dommages aux instruments causés par l'altération de l'aspect, la corrosion et la corrosion par piqûres. Il vise aussi à ce que l'on se serve de cette information pour décrire des mesures efficaces afin de manier adéquatement les instruments à la fois en salles d'opération et dans les zones de retraitement.

Les normes de l'AIISOC relatives à cet article figurent dans la publication Normes, lignes directrices et énoncés de positions pour la pratique de soins infirmiers périopératoires autorisés (9e édition) de l'Association des infirmiers et infirmières de salle d'opération du Canada (AISSOC) de juin 2009, section 2, p. 133-147, Normes 8.1 – 8.7.13.

IS STAINLESS STEEL REALLY "STAINLESS"?

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ABSTRACT

Initial purchase and replacement costs for surgical instrumentation are significant components in today's operating room budgets. OR staff and medical device reprocessing personnel work together as a team to ensure effective management of this valuable commodity. The purpose of this article is to discuss the composition of stainless steel surgical instruments, to identify processes to minimize damage to instruments caused by staining, corrosion, and pitting, and to utilize that information to describe effective measures to manage instrumentation in both the OR and reprocessing areas.

A significant portion of OR budgets is dedicated to purchasing surgical instruments. In order to get value for these health care dollars, we make efforts to prolong the life of these instruments by conscientious intraoperative management and scientific reprocessing techniques. The purpose of this article is to discuss the composition of stainless steel surgical instruments and to identify processes to minimize damage to instruments caused by staining, corrosion and pitting. What are some effective strategies that perioperative nurses and medical device reprocessing personnel can employ to help to prolong the life of surgical instruments?

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Scrub Nurse handing a stainless steel instrument to a Surgeon.

Exploring the Composition of a Surgical Instrument:

What is in stainless steel? Stainless steel is a material composed of iron, carbon, chromium, nickel, manganese, silica and small quantities of other metals. The grade of the stainless steel determines the quantities of each of these components. The higher the chromium content, the more corrosion-resistant the metal will be. The qualities of the instrument are determined by the composition of the steel (carbon-chrome ratio) as well as the heat treatment and finishing process used by the instrument's manufacturer.[1]

There are two basic grades of instruments: floor-grade (sometimes referred to as "ward-grade") and surgical-grade. Floor-grade instruments are made from a less than optimal metal and are not constructed precisely.1,2 They often show pitting and staining after the first few sterilization processes.1,2 Surgical-grade instruments are constructed of high quality stainless steel and other metal alloys that resist bending, pitting, scratching and dulling.[1]

Because stainless steel is subject to corrosion, a manufacturing process called passivation protects instruments from corrosion. Passivation is a manufacturing process that removes manufacturing impurities and coats the surface of the instruments to protect from corrosion.[2] During the passivation process, the instruments are put into a nitric acid solution to remove carbon steel residue, and produce a surface coating of chromium oxide. Chromium oxide is important because it produces a resistance to corrosion. The instrument is polished to remove any pits and prevent corrosion. Some manufacturers may substitute electro-polishing for passivation. This produces a less expensive instrument which does not have a long life.[1]

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A flaw in a surgical vaginal speculum in which debris will accumulate.

Three types of finishes are used on metal instruments. A bright, mirror finish is resistant to surface corrosion, but can create a glare from surgical lights. A satin finished instrument, while non-glaring, is more susceptible to corrosion and stains from the effects of detergents and contact with water containing high levels of minerals/solutes. Ebonized instruments have a dull black finish and are used for laser surgery.[2,3]

The majority of surgical instruments are manufactured outside Canada. Rothrock (2007) reports that unlike some other countries, the United States does not have an agency that reviews or sets standards for manufactured surgical instruments. The quality is set by the individual manufacturer. Stainless steel qualities are designated by grading the steel into series by the American Iron and Steel Institute. Handheld ringed surgical instruments manufactured in the US should be made with their 400 series graded stainless steel.[4]

Tighe (2007) states that a well-made, properly cared for instrument can be expected to last 10 years.[1]

Types of Damage to Surgical Instruments:

Stains are discoloration of metal caused by material being added to the surface of the metal.

Brown/orange coloured stains are often mistaken for rust. The stain is usually, in fact, a phosphate deposit on the instrument, and will lead to pitting if not removed. Phosphates can come from traces of minerals in the autoclave water source, a dirty autoclave, high alkaline or

acidic detergents, chemicals in laundered surgical wrappings, or dried blood or tissue. Rubbing an instrument with a pencil eraser is a good test as it will remove mineral deposits but not rust. True rust on an instrument is very rare.[5]

A brown/orange or blue/black stain can be caused by plating during the autoclaving process. Through electrolysis, when dissimilar metals touch while being autoclaved, ultrasonically cleaned, or even stored together, plated stains actually bond the stain to the metal.

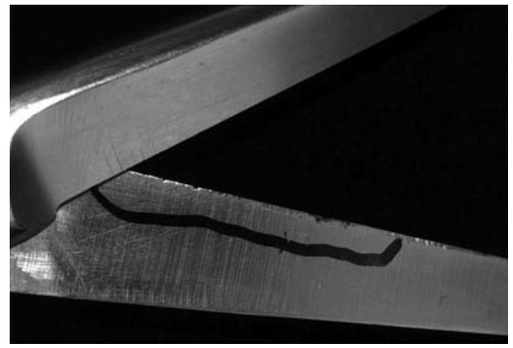
Black stains are usually due to an acid reaction. Always use neutral pH detergents and de-ionized or soft water for cleaning, and completely rinse instruments before steam sterilization.

Multicoloured, or rainbow-coloured, stains are a result of having excessive heat applied to the instrument. Their presence indicates that the instrument may have lost some of its original hardness.[5]

Boilers, used to generate the steam for sterilizers, if not cleaned or maintained properly, will produce contaminated steam which can deposit minerals onto instruments during the sterilization process. Steam lines should be flushed after major adjustments to boilers.

Pitting can occur when an instrument is exposed to a solution containing chloride or and an acid-based detergent. Hydrochloric acid forms in the solution and the acid removes the protective chromium oxide layer from the stainless steel. It then attacks the unprotected steel and creates pits. Organic matter and other debris can become lodged in the pits, creating a challenge for reprocessing.

Use of pH neutral cleaning concentrates has been shown to optimize the efficacy of the passive oxide layer on the instrument.[5] Many cleaning concentrates utilize an alkaline detergent with an acid neutralizer. Many instrument manufacturers recommend against



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Staining and metal break-down on a pair of surgical scissors.

using these detergents and recommend using a neutral pH detergent.

Pitting also develops when dissimilar metals come into contact with each other in an ultrasonic cleaner or autoclave. The steam in the sterilizer acts as a conductive solution that facilitates electrolysis. During this process metal molecules are transferred from one metal to another, leaving pits in one instrument.[5]

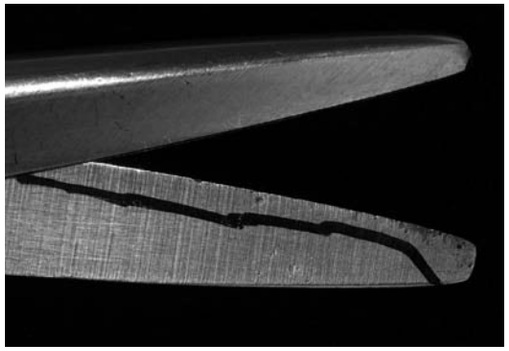
Corrosion may be inhibited by enhancing the passive oxide layer of the surgical instrument. Corrosion starts in the pores of the metal and is often related to improper cleaning. Cleanliness is the single most important factor in preventing corrosion.

Corrosion can be inhibited with the application of an instrument lubricating and protective "milk"[2]. This solution helps to maintain a thin protective coating on the instrument making it more resistant to corrosion. Some newer washer/disinfector systems apply an instrument lubricant/protector with every cycle. The milk is not recycled, which eliminates the old problem of bacterial growth in reused solutions.

Contact between dissimilar metals can cause corrosion when ultrasonics are applied. Overloading and low water temperatures will decrease the effectiveness of ultrasonic equipment. Visible debris and blood should be removed from the instrument prior to ultrasonic cleaning.[6]

What Can OR Personnel Do To Minimize Damage to Instruments?

One of the most effective measures that can be used by OR personnel to prevent instrument damage is to wipe instruments, intraoperatively, using a sponge moistened with sterile distilled water (not saline).[7,8] Sterile distilled water is not used as often for patient care in today's OR environment and so staff may find it tempting to "save" opening a bottle of sterile water and just use saline for wiping instruments. The cost of opening one bottle of sterile water for each procedure is, however, much less than the cost of replacing corroded, stained or pitted instruments.



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Staining, pitting and corrosion on a pair of surgical scissors.

As many surgical procedures can take several hours or more the blood and tissue will dry and remain on the instruments for many hours if the instruments are not wiped with sterile distilled water. Reduce long exposures to blood and saline during complex surgical procedures, by wiping or rinsing often during the procedure, in order to prevent corrosion.

Cleaning of surgical instruments should not be performed at a surgical scrub sink, with the substitution of hand antiseptics for detergents, or with no detergent. Hand antiseptics located at scrub sinks may not be pH neutral and not using detergent can result in a failure to remove organic material and microorganisms – this will promote corrosion, staining and pitting, and will render disinfection and sterilization ineffective. Chlorexidine and iodine-based products, often located at scrub sinks, act as an enemy to stainless steel and cause pitting and corrosion.10 Instruments should be sent to medical device reprocessing areas for cleaning and disinfection.

Another strategy to prevent instrument deterioration is to ensure that instruments are transported to medical device reprocessing areas immediately after the surgical procedure has been completed and that these instruments are immediately reprocessed upon arrival in that department.[9]

It is very challenging for reprocessing departments to separate surgical instruments of different grades or different metal composition for reprocessing. The initial additional purchase cost of surgical-grade stainless steel instruments is balanced out by the extended life of the instruments. If an instrument becomes corroded or pitted in a short amount of time, perhaps another manufacturer should be considered. Return new items to the vendor and request a replacement if the set is not holding up under the manufacturer's specifications for reprocessing. Utilize the manufacturer's warranty agreement to its greatest advantage.

Hospital-acquired vibrating engraving devices scratch off the protective surface of the instrument and increase the risk for corrosion. Etching processes are preferred, because they do not harm the instrument. Manufacturers may offer etching or stamping at the time of purchase.[1] It is helpful to have the manufacturer etch or stamp the date of purchase on the instrument, as that allows OR personnel to evaluate the ability of that instrument to maintain quality over time.

Surgical instrumentation is the joint responsibility of the OR and the medical device reprocessing departments. When purchasing any new instrumentation it is essential to consult with the reprocessing department regarding the manufacturer's recommendations for cleaning and re-sterilizing. It is not cost-effective to purchase surgical instruments that cannot be cleaned and reprocessed effectively. It is impossible to sterilize an instrument that has not

been cleaned effectively. Manufacturers' specifications for cleaning and parameters for re-sterilizing can be quite different from standard reprocessing practices.

Invite industry representatives or educators from instrument manufacturers to give a talk to OR and medical device reprocessing personnel about the principles of good instrument management. It can be an investment in an extended life for surgical instruments and improved purchasing skills that is well worthwhile.

What Can Medical Device Reprocessing Departments Do to Minimize Damage?

Medical Device Reprocessing departments also are committed to employing strategies to reduce damage to instruments purchased by operating room departments. Instrument reprocessing practices should be based on current Canadian Standards Association (CSA) standards.8 Some key steps in the prevention of pitting, staining and corrosion include:

1. Cleanliness is a critical factor in the prevention of instrument damage. Instrument washers/disinfectors should be serviced and maintained on a regular basis. New guidelines from the Association of OR Nurses (AORN), the Association for the Advancement of medical Instrumentation (AAMI) and the CSA call for testing of automated instrument washer disinfectors before initial use, weekly during service and after major maintenance.[8,9] Test kits are available that utilize a surrogate device to approximate the type of soils on surgical instruments;

2. The decontamination process should begin within 10 minutes following a surgery. This is the best defence against corrosion, pitting and staining.[8,11] Do not allow blood and debris to dry on instruments as this causes corrosion. Clean instruments or apply treatment, to prevent drying and encrustation of blood, body fluids and debris, as quickly as possible after use. If cleaning must be delayed, then place instruments in a covered container with enzyme-detergent or apply an enzyme-detergent foam spray to delay drying;

3. An inexpensive and simple way to detect gross amounts of protein is to completely immerse the instrument in hydrogen peroxide after it has gone through the cleaning process. Bubbling indicates the presence of organic matter, and hydrogen peroxide is not harmful to the instrument;

4. Other test kits are available to measure water quality, temperature, instrument cleaning efficiency, as well as to test residual soil on instruments;

5. Neutral pH surgical instrument cleaning products are recommended universally by surgical instrument manufacturers.[5] Lubrication protects the instruments from staining and rusting during sterilization and storage.[5,8] Instructions for rinsing are also important. Multiple rinses are required for some products;[1]

6. If the washing process is to be delayed, the instruments can be soaked in or sprayed with an enzymatic cleaning solution to prevent drying. The decontamination process should include sorting, soaking, washing, rinsing, drying and lubricating;[1,8,9]

7. The necessity for water treatment will depend on the local water quality. Soft or de-ionized water should be used for the final rinse to reduce water impurity

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Pitting on a pair of plastic surgery scissors.

deposits. If untreated tap water is used for final rinsing then the instruments should be dried immediately to avoid staining;[6]

8. On-line instrument inspection programs are available for purchase. These programs can be a tremendous resource towards education and skill-building for personnel working in reprocessing departments;

9. Re-usable wrappers, towels and drapes can retain soap particles. During the sterilization cycle, steam passes through the fabric, picks up these particles and deposits them on the surface of instruments.[12] Re-usable wrappers should be washed with minimal detergent and rinsed well;

10. Working closely with OR instrument purchasers promotes the use of instruments for which the manufacturers' cleaning recommendations can be met; and

11. Avoid contact between dissimilar metals in ultrasonic cleaners and steam sterilizers. The solution in ultrasonic cleaners must be changed as recommended by the manufacturer or the bioburden on instruments can actually increase.[1]

CONCLUSION

The term "stainless" is indeed misleading. While steel does not tarnish, rust or corrode easily, some staining and spotting will occur with normal use. Efficient management of surgical instruments is an important process in today's fast paced and high cost surgical environment. Operating room and medical device reprocessing personnel can work together as a team to effectively minimize damage, reduce costs and prolong the life of surgical instrumentation, and maintain them in optimum and safe working condition.

ORNAC Standards pertaining to this article can be found in the Operating Room Nurses Association of Canada (ORNAC) (June 2009). Recommended Standards, Guidelines, and Position Statements for Perioperative Registered Nursing Practice (9th edition), Section 2, p. 133-147, Standard (s) 8.1 – 8.7.13.

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