ALMEDIC MANUAL ON THE PROPER CARE AND MAINTENANCE OF GENERAL SURGICAL INSTRUMENTS

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SURGICAL • MEDICAL • VETERINARY • DENTAL • LABORATORY INSTRUMENTS
INSTRUMENTS DE CHIRURGIE • MÉDICAL • VÉTÉRINAIRE • DENTAIRE • LABORATOIRE

INTRODUCTION

The problems confronting the sterilization of surgical instruments was recently studied by a panel of leading experts from the following manufacturers of:

Surgical instruments
Disinfecting and cleaning agents
Disinfecting and cleaning apparatus
Sterilizing systems

The information that resulted from their research was published in a German periodical entitled "WORKERS CIRCLE OF SURGICAL PREPARATION". The contents of this periodical and other leading journals on this subject provide the basis for the Almedic Manual on the Proper Care and Maintenance of Surgical Instruments. With this knowledge, unnecessary claims and disputes pertaining to the standard problems associated with rusty or stained surgical instruments can be avoided.

When surgical instruments corrode the blame is likely to fall on the instrument manufacturer when there is no other apparent cause. Very often the problem is staining and not rusting. By paying special attention to the following points one can considerably reduce or eliminate many of the more common problems that occur with surgical instruments.

1. Use instruments made from high quality surgical steel.
2. Make sure that the instruments have been manufactured in according with high quality standards.
3. Eliminate the exposure to chloride ions.
4. Follow the proper cleaning procedures prior to sterilization.
5. Always rinse the instruments after cleaning.
6. Use the proper sterilization techniques.
7. Properly maintain the instruments.

STAINLESS STEEL

It is a misconception that "stainless" steel will not stain or corrode. Although it is strong, durable, esthetically appealing and ranks high among corrosion resistant metals, stainless steel can and will corrode under certain conditions.

Any instrument will fail if abused and not properly care for. With the proper understanding of the material and it characteristics, it is evident that very special care of these delicate instruments is needed to ensure maximum usage.

SURGICAL INSTRUMENT STEEL

Surgical instruments are almost exclusively produced from a special refined steel. The choice of steels that is available to manufacture surgical instruments is limited because of the specific properties needed. For example, the steel must be heat treatable, since it will be subject to repeated sterilizations. The surface of the instruments must also be plain and homogeneous, since they have to be corrosion resistant. The instruments must meet exacting specifications and formidable physical demands. They must perform precisely as they were designed to, and continue to do so for a long period of time without losing their qualities. The instruments must also be able to withstand repeated cleaning and sterilizing, as well as exposure to prepping solutions, blood saline, and various chemicals.

The preferred material today for the manufacture of quality surgical instruments is known as stainless steel. Stainless steel is an alloy of steel with other elements, notably chrome. Nickel, molybdenum, sulphur, phosphorus and titanium are added in various amounts depending on the type of alloy needed. The alloy is formulated according to the "type" of instrument to be manufactured. Different surgical instruments require specific functional characteristics of the steel.

It is chromium which imparts the stainless quality; the more chromium present in the alloy, the more resistant it is to corrosion.

Carbon reduces the corrosion resistant effect of chromium, and is necessary to produce hardness. Hardness is a prime consideration in instruments which require extremely sharp edges for accurate jaw alignment. It is unfortunate that there are only a few stainless steel alloys which may be hardened sufficiently to be used in the manufacture of delicate surgical instruments. These alloys are low in chromium content and high in carbon content. They belong to the broad class known as stainless steel but are the least corrosion resistant of the group.

These are two major kinds of stainless steel, marthensitic steel and austenitic steel.

Martensitic steel can be hardened and is magnetic. This type of steel is the most common in the surgical instrument industry. Cutting instruments such as scissors, rongeurs, needle holders, and sponge forceps are made from this steel.

Austenitic steel has a greater resistance to corrosion and pitting than martensitic steel. This steel is sometimes referred to as 18 and 8 because the high chromium content (18%) and nickel content (8%), which is a much higher percentage of nickel and chrome than is found in martensitic steel.

It is the carbon content in stainless steel which can cause corrosion or rusting. In order to minimize corrosion of these hardenable stainless steel alloys, special handling is required by the manufacturer. A properly made instrument will have passed through two processing steps which increase its resistance to corrosion.

In one of these steps, called passivation, the instrument is treated with nitric acid. This dissolves away any particles of carbon steel which may have been ground in during processing. The nitric acid bath also forms a surface coating, which produce the resistance to corrosion in stainless steel. After the nitric acid bath, the instrument has a rough looking finish which requires polishing to smoothen the surface.

Polishing is the second processing step which reduces corrosion. Polishing produces an extremely smooth surface upon which a continuous layer of chromium oxide forms. Surfaces which cannot be polished are usually the first to show corrosion. Handles with grooves may rust which the remainder of the instrument is unaffected. Even satin finished instruments are more prone to surface corrosion than highly polished instruments. Surface corrosion will not penetrate deeply, and usually can be removed by scrubbing with a brush and an abrasive soap.

PREPARATION FOR THE CLEANING PROCESS

Surgical instruments must be "visibly" examined before cleaning, to ensure that they are completely free of dirt and any traces of albumin. Cleaning dirty instruments can lead to spotting.

Surgical instruments with spots, rust, cracks, or surface corrosion should be withdrawn from circulation, and should not come in contact with other instruments, otherwise they can cause corrosion during the cleaning or sterilization process.

Surgical instruments with joints (e.g. scissors, hemostats) have to be cleaned in an open position. All instruments must be layed down on the sterilizing trays or drainage basket, so that there is access to all parts of the instrument during the cleaning and rinsing process.

Perhaps the single most important consideration in the care of surgical instruments is cleanliness.

INSTRUMENT CLEANING BEFORE STERILIZATION

It is important to remember that *sterilizing is not cleaning.* Subjecting an unclean contamination instrument to high sterilization temperatures can result in foreign material baked on it, or corrosion that will ruin the instrument's appearance and performance. These residues may appear as stains or rust. Instruments should therefore be cleaned and washed with a non-corrosive neutral detergent, and rinsed with demineralized water before sterilization. Stubborn materials should be removed with a clean soft brush – never use steel wool or metal brushes that are abrasive.

If a long surgical procedure is anticipated, cleaning can be facilitated by placing the instruments in a holding solution until they are cleaned. The solution is a combination of detergent and/or disinfectant, and distilled water, which soaks the instruments and keeps organic matter from encrusting on the instruments. Do not allow the instruments to soak in the holding solution for extended periods of time. Most solutions are only slightly corrosive, but prolonged exposure can begin to degrade instruments. The use of a holding solution will make cleaning easier, but is not substitute for cleaning.

Before handling the instruments, heavy rubber gloves should be worn to protect the hands. All hinged instruments such as forceps and pliers should be opened to expose ratchets and hinge areas. Instruments should be rinsed under a hard stream of water to remove large debris. A detergent with a neutral Ph should be used during the cleaning process, as a detergent with a high low Ph may cause staining when the instrument is sterilized. A high alkaline soap, for example, may form a hard film which protects bacteria.

There are three common methods of cleaning instruments: Manual, Mechanical, and Ultrasonic.

MANUAL CLEANING

Manual cleaning is achieved by soaking and washing in an enzymatic detergent for a minimum of 5 minutes. The cleaning solution used during manual cleaning should not exceed room temperature. It is important to carefully follow the manufacturers' instructions regarding the length of time the instruments are exposed to the cleaning solution, the temperature of the solution, and the concentration of the solution. Disinfectant compounds should not be re-used as they may cause corrosion.

When instruments are cleaned manually, the residue of the cleaning solution must be removed by thoroughly rinsing the instruments with purified water, and the complete drying them to avoid water spots, otherwise spotting and/or discoloration can occur. The addition of suitable neutral compounds to the solution can improve the results after rinsing.

Lint free soft textile cloth, paper cloth, plastic brushes (e.g. soft toothbrushes), or water spray guns are recommended for manual cleaning. Drying with a pneumatic gun is the most preferable method since it is gentle and effective.

Manual cleaning is time consuming and somewhat imperfect. It is virtually impossible to manually clean all the crevices and ratchets of the instrument. Mechanical cleaning is therefore recommended when available.

MECHANICAL CLEANING

A – Ultrasonic Cleaning

Mechanical cleaning will remove most of the particular from instruments, especially from the cracks and crevices which are difficult to get to with manual cleaning. During the mechanical cleaning process, the following should be noted:

During the ultrasonic cleaning process, the following should be noted:

1. Instruments must be fully opened and laid down on the sterilizing trays or drainage baskets, to allow full access to all parts of the instruments.
2. Water by itself will not clean instruments properly. Detergent should be added to the water for a proper cleaning.
3. The manufacturer's instructions concerning the concentration and temperature of the solution, as well as the frequency of the ultrasonic cleaner, should be carefully followed.
4. The temperature of the cleaning solution must be between 43°C and 45°C. Temperatures lower than 40°C cannot guarantee a proper cleaning, whereas temperatures exceeding 45°C can result in coagulation of albumin.
5. The cleaning solution should be changed according to the manufacturer's instructions. If there is too much dirt in the ultrasonic bath, the cleaning may not be complete.
6. Frequency of at least 35 Khz for a period of 3 minutes is sufficient for proper cleaning.
7. After ultrasonic cleaning, all instruments must be rinsed mechanically or manually with purified water to avoid water spots.
8. Ultrasonic cleaners remove all lubrication from instruments, therefore the instruments should be bathed in instrument milk or a similar product after ultrasonic cleaning.
9. The surgical instruments must be immediately dried after the cleaning and rinsing process.

B – Thermal Disinfection

After manual cleaning disinfection can be achieved by mechanical washing by means of any mechanical washer.

1. If the surgical instruments are very dirty or coated with coagulated blood, mechanical cleaning may not be sufficient. Manual cleaning may be needed before putting the instruments in the cleaning machine.

2. The instruments must be placed on a tray in such a manner that they do not damage one another.

3. The instruments must be in an open position so that access is available to all of the joints and hinges.

4. During the cleaning process, in order to avoid coagulation, the water should not exceed 45°C.

5. Instruments should be washed with an enzyme detergent.

6. Carefully follow the manufacturer's instructions for cleansers and disinfectants to insure proper cleaning; an insufficient amount can result in corrosion of the instrument.

7. During the rinsing phase of the cleaning with purified water, a temperature of 82°C (180°F) is suggested. If corrosion occurs, the temperature should be lowered to between 70°C – 75°C with purified water.

8. Using de-mineralized water eliminates water spots.

One advantage of the mechanical cleaning process is that it reduces the possibility of injury as compared to the manual cleaning process.

INSTRUMENT STERILIZATION

The following recommendations should be taken depending on the type of sterilization procedure used.

When sterilizing instruments, the accessories used such as the packaging material, etc., must be in harmony with both the surgical instruments and the sterilization procedure.

Surgical wrappings can be a source of staining. It is very important that the wrappings be thoroughly rinsed and cleaned during laundering, so that detergents which may contain phosphates are not present. Wrappings which are not cleaned thoroughly may contain detergents which can cause a reaction during autoclaving. A typical sign of this is a brown stain on the towel where contact has been made with the instrument. This type of stain is very difficult to remove and very often the instrument has to be refinished by the manufacturer. This problem can be eliminated by using disposable paper wrapping materials or individual peel pouches.

Sterilization causes tension in the material due to the process of heating up and cooling down. In order to avoid such tensions and to avoid stress cracking in the joints or deterioration of their elasticity, ***instruments with ratchets should be closed in the first ratchet position only for the purpose of sterilization.***

Prior to sterilization, hinged instruments and those with multiple moving parts should be lubricated.

If instruments of different metal alloys are sterilized together, there may occur under certain conditions, a galvanic effect between the two types of steel. The water functions as a conductor, and a deposit of iron oxide appears on the instrument. This "rust" on the instruments can be removed by rubbing with a cloth.

Instruments can be sterilized by Steam, Dry Heat or Chemicals.

STEAM STERILIZATION

Sterilization with the use of steam under pressure is on the most effective means of destroying pathogenic or vegetative forms of organisms. Steam sterilization also has the advantage of being the least time consuming procedure. Sterilization can be achieved at a temperature of 270°F (27 lbs pressure) and exposure for 4 minutes minimum.

Surgical instruments can be damaged by foreign ions that are present in regular drinking water. Furthermore, stainless steel can become discolored (brown, blue, rainbow colors) when treated in aqueous solutions. Such discoloration may be caused by a high content of iron, copper, and manganese which appears in normal drinking water. Generally this discoloration does not constitute corrosion, and can for the most part, be removed by rubbing them with acidic product.

When using the steam sterilizer, it is also important to prevent rust or other impurities from being present in the steam supply. Steam containing dirt or rust can cause spotting or staining which is mistaken for rust or corrosion. In most hospitals the cleanliness of the water depends upon the efficiency of the municipal water treatment system. Other random events can also affect the quality of the water.

Steam is by definition sterile, in that it can have no viable micro-organisms. However typical steam is far from "pure". It contains particles of rust, pipe scale, and other particulate matter. ***It is the action of these impurities on instruments that causes staining.*** The impurities in the steam can vary from season to season and even from hour to hour within a water supply system. For example, some hospitals report that they have more staining during the summer when boilers are operating at low capacity.

The steam used for both high pressure steam or ethylene oxide sterilization is usually produced in-house or at a central boiler plant. Very often chemicals are added to the steam in the form of boiler treatments. Such treatments are intended to prohibit the build up of dissolved oxygen or carbon dioxide, which may cause corrosion in the piping system. Concentrations of these chemicals beyond acceptable limits, have an adverse reaction to surgical instruments. Left uncorrected, corrosion occurs because of the incomplete removal of organic material.

In summary, stains are not caused by an imperfection of the instrument or malfunction of the sterilizer, but by the impurity of the steam itself. It is important to prevent rust or other impurities from being present in the steam supply, since they can leave deposits and stains on the instruments which are mistaken for rust or corrosion. This problem can be eliminated by controlling the quality of the steam. Water quality is clearly a critical factor, and therefore it is recommended to use distilled water in steam sterilization, although de-mineralized water may be utilized and yield the same results at a lower cost. The installation of water filters can help guarantee the use of good clean water, and softened water should never be used because of its salt content.

The proper maintenance of surgical instruments after sterilization will prolong the life of surgical instruments substantially. The maintenance of surgical instruments involves the lubrication of the movable joints and the cutting blades of scissors. The lubricants must be water soluble in order to prevent a build-up effect, which would result in joints becoming sticky. Moveable parts in scissor joints should be sprinkled with detergents so that the metal does not wear out.

Steam Sterilization Method

Cycle	Temperature (°F)	Time
Pre-Vacuum	270°	4 minutes – wrapped
Steam-Flush Pressure Pulse	270°	4 minutes – wrapped
Flash	270°	Minimum 3 minutes - unwrapped

Additionally instruments can be processed in ethylene oxide or gas plasma (hydrogen peroxide).

MAINTENACE OF INSTRUMENTS

The proper maintenance of surgical instruments after sterilization will prolong the life of the surgical instruments substantially. The maintenance of surgical instruments involves the lubrication of the moveable joints and the cutting blades of scissors. The lubricants must be water soluble in order to prevent a build-up effect, which would result in the joints becoming sticky. Moveable parts in scissor joints should be sprinkled with detergents so that the metal does not wear out.

SURFACE CHANGES

OXIDATION TINTS AND WATER SPOTS are discolorations of the surface with "flowing" edges. These discolorations occur when heavy metal ions are in the rinsing water or the sterilization steam.

WATER SPOTS are caused by the condensation of water droplets on the surface of the instruments. Mineral bodies (e.g. lime) or organic substances, which can be found in the sterilization steam or rinsing water, are deposited on the surface of the instrument as the water droplets slowly evaporate. They have no effect on the instrument however their appearance is a source of annoyance since they make the instruments appear "unclean or defective". Spots can be easily removed with a buffing cloth, refined steel cleaner (which does not scratch the instrument), or by rinsing the instrument in distilled water.

DISCOLORED RESIDUE ON THE SURFACE OF THE INSTRUMENT The yellow brown spots on sterilizing instruments is very often confused with rust. These spots are usually caused by the following:

1. Residues which are not completely removed from the instrument during the cleaning process. Such residues are usually found on those areas of the instrument which are hard to reach during the cleaning process.

2. If the instruments are cleaned with a solution that has previously been used, the residues of the solution settle on the instruments and appear as spots.

During sterilization, such residues are "baked in", showing dark discoloration. If such residues are not removed from the instrument surface, they will in time lead to pitting.

When stains do occur they may sometimes be removed by soaking the instrument overnight in a solution of ethyl alcohol and aqueous ammonia, following by scrubbing with a brush and clean water. This should remove the stains if they are not too severe. Do not use abrasive agents, powders, or steel wool to scrub the instruments.

RUST & CORROSION

During the sterilization procedure, remaining residues may be left on the instrument and discolor it. This then leads to corrosion which damages the surface of the instrument.

The most common types of corrosion are the following:

CONTACT CORROSION can occur when materials of different compositions are in the same electrolytic solution. A galvanic process usually takes place between instruments made from different steels. As a result, there is a shift in the ions causing contact corrosion. Particularly strong contact corrosion occurs when stainless instruments come into contact with surgical instruments that have damaged surfaces. In such cases, a dull grey surface discoloration may occur on the instrument which can only then be removed mechanically.

AREA CORROSION occurs very seldom, but when it does it is because the instrument has come in contact with strong acids or rust film (see rust film).

HOLE CORROSION (PITTING) occurs frequently and is caused by halogen ions which affect the surface. For example, salt solutions or chlorides which are present in the cleaning and disinfectant solution can cause hole corrosions. Operating residue such as blood or pus may also have chloride ions. Hole corrosions can occur quickly and destroy the instrument. Therefore when instruments come in contact with any halogen substance they should be immediately cleaned after use.

PRESSURE CRACK CORROSION can occur in the production process of the instrument, but more often is a result of improper care of the instrument. To avoid such damage surgical instruments with ratchets should be cleaned in the open position. These same instruments should be closed in the first ratchet position during the warming and cooling of the sterilization process. A small quantity of chloride ions in the water can also cause pressure crack corrosion. The crack goes right through the rivet bore, across the box lock. In the crack itself, crevice corrosion occurs as a result of rust being washed into the box lock area.

ABBRASIVE CORROSION has a similar appearance to crack corrosion, except that it occurs between reciprocally moveable instrument parts. If the instruments are not properly lubricated, there is an attrition of the passive strata which is damage and it eventually leads to rusting.

CREVICE CORROSION occurs in the clefts between the instrument parts. The natural passive strata of the instrument breaks down, and corrosion occurs. This kind of corrosion can be seen at the fusion-point of two thumb forcep parts. A clear identification is only possible by a laboratory examination.

RUST FILM can develop in cracks, and crevices and contact places. If the rust is not noticed immediately, it will continue to worsen during further cleaning and sterilization. If these rusty instruments are placed in a solution along with clean instruments, the rust particles can be transferred to the clean instruments, causing them to rust as well. This can lead to area corrosion.

EXTRANEOUS RUST can occur from steam which contains rust. This rust is apparent after the sterilization process, as it precipitates onto the instrument and the sterilization package.

GENERAL COMMENTS RELATING TO INSTRUMENT CARE

NEW SURGICAL INSTRUMENTS being used for the first time have to be cleaned, rinsed and sterilized using the same procedure as with any other instruments.

LASER INSTRUMENTS should not be washed and processed with stainless steel instruments and should be processed separately.

MECHANICAL ENGRAVERS that scratch into the instrument surface are not recommended, since they weaken the rust resistant surface of the instrument and cause corrosion. A mechanical engraving device that is used on the box lock (hinge area) can also cause minute fault lines in this critical part of the instrument, resulting in subsequent breakage of the lock. Electro-chemical etching is recommended for personalizing the instrument. If done properly, it will not harm the instrument.

STORAGE OF SURGICAL INSTRUMENTS After being dried thoroughly, instruments should always be stored in a moisture free area, otherwise rust can occur. Similarly, instruments should never be stored in rooms or cupboards with chemicals that develop corrosive vapor.

LUBRICATION Extra care must be devoted to oiling hinges, locks, and all other moving or assembled parts. The use of mineral oil or silicone spray will also prolong the life of an instrument.

PACKING MATERIAL The packing material for surgical instruments should be in accordance with DIN 58 952, and disposable packages must be in accordance with DIN 58 953.

While every effort is made in the manufacturing process to make Almedic instrument corrosion resistant, one can considerably reduce or eliminate many of the more common problems that occur with surgical instruments by paying special attention to the points indicated in this manual.

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