Instrument Surface and Functionality Changes, Part I

LEARNING OBJECTIVES
1. Review how the manufacturing process affects the functionality of surgical instruments
2. Discuss instrument-specific and sterile processing-related reasons for surface and functionality changes
3. Explain how operating room practices impact instrument functionality
4. Review two additional functionality concerns: stress fractures and corrosion

Instrument Continuing Education (ICE) lessons provide members with ongoing education in the complex and ever-changing area of surgical instrument care and handling. These lessons are designed for CIS technicians, but can be of value to any CR CST technician who works with surgical instrumentation.

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IT IS A CHALLENGE FOR CERTIFIED INSTRUMENT SPECIALIST (CIS) technicians to consistently deliver reprocessed medical and surgical devices to patient areas in pristine and functional condition. Do older instruments represent a lesser standard of care than new instruments? Are instruments that have undergone color changes, dents or friction marks, or with hinge actions stiffer or smoother than others, acceptable for use?

This lesson, the first in a two-part series, examines instrument surface and functionality changes, and addresses these and related questions.

MANUFACTURING PROCESS AND INSTRUMENT FUNCTIONALITY
Passivation is a manufacturing process that uses nitric acid to remove the iron from the outside surface of a surgical steel instrument. This process allows a translucent passivation layer (coating) to form and, with repeated uses, becomes stronger and harder and makes some well-maintained and cared for instruments more resistant to corrosion than new ones. An example of a beneficial instrument color change is the uniform, glossy, dark grey to near black color changes seen in some high carbon instruments.

Most surgical instruments are made from 300 series (austenitic) or 400 series (martensitic) stainless steel. Austenitic steel cannot be heat hardened and is highly resistant to corrosion. Compared to its 400 series counterpart, 300 series has a relatively high chrome and low carbon content; its surfaces are shinier, non-magnetic and not prone to darkening over time. Austenitic stainless steel is used to manufacture instrument pans, mayo trays, some implants, and implantable wires.

Martensitic 400-series stainless steel has higher carbon content than austenitic steel, and it can be heat hardened. Although treated to increase corrosion resistance as the passivation layer develops, it is not as resistant to corrosion as austenitic steel. Martensitic stainless steel is less expensive to produce and is harder and stronger than austenitic steel. It is commonly used for clamps, scissors and forceps that must undergo frequent and sometimes rough treatment. Also, since it holds a magnetic charge very well, martensitic instruments, such as Castroviejo needle holders and Gerald forceps used for delicate work, require periodic demagnetizing (degassing).

Instruments manufactured using inferior materials with cheap alloys added to expensive chrome, carbon, and nickel materials will break, degrade, corrode, and rust relatively quickly. This is frequently the case when instruments manufactured as single-use disposables are reprocessed. Prevention involves educating end-users about the purchase of high quality instruments, and the appropriate recognition and disposal of single-use items at the point of use.
INSTRUMENT SURFACE AND FUNCTIONALITY CHANGES

Over time and with repeated uses, most instruments undergo surface and possible functionality changes. CIS technicians must know when a surface change represents a patient safety threat or problem warning, and when it is a normal aesthetic change that occurs with repeated appropriate use and reprocessing.

SURFACE COLOR CHANGES: Instruments can change color based on normal aging, misuse, improper mixing of metals in ultrasonic cleaners, as well as exposure to caustic-, acidic-, or chloride-containing substances. Common substances that stain instruments, including those made of stainless steel, are blood, saline, chlorhexidine, potassium chloride, high acid or alkaline detergents, and other common chemicals and elements found in operating rooms or decontamination areas.

The “eraser test” is a simple first step in the diagnosis of surface color changes. A discoloration that can be removed with an eraser is a stain; if there is pitting beneath the stain, it is corrosion and usually indicates prior improper handling in the use and/or reprocessing cycle.

NORMAL INSTRUMENT CHANGES: Uniform darkening (not streaking or uneven changes) of a stainless steel instrument that increases with repeated uses and reprocessing is likely an oxidative reaction in instruments with high carbon content. This type of color change is not affected by the eraser test or by treatment with an acid-based stain remover. Repeated overuse of acid-based stain removers for a darkened passivation layers may actually predispose the instrument to future rust, corrosion, and loss of functionality. Glossy, uniform gray to black discoloration with no surface damage likely represents a high carbon passivation layer or reverse plating in ultrasonic. These changes are esthetic only and hold no specific risk to patient safety.6

DENTS, DINGS AND CREASES: Some instruments look different after just one or two uses. For example, malleable retractors and probes are bent during use and are pressed flat again in the Central Service (CS) department. However, they will likely never be as straight and smooth as before their first use. Orthopedic mallets will always bear the marks of their use, but the marks do not affect the functionality or the safety of the instruments, as long as there is no accompanying rust or corrosion along with the normal wear.

STERILE PROCESSING-RELATED CHANGES

Several CS processing errors can create changes in the surfaces of medical instruments. These include:

MIXED ULTRASONIC LOADS: Mixing metal instruments, especially those containing titanium, aluminum, copper, and stainless steel, in ultrasonic cleaners can cause reverse plating of surface metals and result in instrument surface discoloration. These color changes are cosmetic and do not affect functionality. However, they may affect the inspection process and create the appearance of a poor quality or poorly maintained instrument. Note: discoloration can hamper the usability of an instrument if colored metals are used to identify instrument components.2

CIS technicians should always process dissimilar metals separately in ultrasonic cleaners.

IMPROPER STERILIZATION METHODS: Processing heat- and moisture-sensitive devices in a steam sterilizer is never appropriate. As well, low temperature sterilization cannot be used for all instruments. For example, although generally safe for most low temperature sterilization devices, plasma based sterilizers may significantly alter the surface of surgical polymeric devices: PUR (polyurethane), PVC (polyvinylchloride), and LDPE (low-density polyethylene). Always
consult the manufacturer’s Instructions for Use (IFU) for the device to ensure compatibility.3,4

STEAM STERILIZER OVERLOADING: Overloading the sterilizer increases the formation of condensate and can create spotting or a milky/grey residue on instrument surfaces. Overloading can also cause wet packs, leading to additional discoloration and failed biological indicator (BI) tests. Most of these types of stains can be wiped off or removed with a mild acid-based remover. Ensure that the IFU for stain removers are strictly followed, as improper dilution can damage the instruments’ passivation layers. Water spotting can indicate that staff may need additional sterilizer loading training.

WATER QUALITY: Hard or excessively softened water may leave silicate deposits on instruments and create uneven streaking and “rainbow” staining. Unpurified water is not appropriate for instrument reprocessing, especially in the final rinse. Many IFU recommend reverse osmosis, distilled, or otherwise purified water for the final rinse.

CHEMISTRIES: Sterile processing detergents and enzymatic solutions may need to be acidic, alkaline or neutral according to the manufacturers’ IFU and the water quality employed. For example, to minimize the effect of a high chloride water supply, alkaline detergents may be temporarily used until better water purification technologies are available. However, an alkaline environment can create discoloration of color-coded aluminum anodized items/ instruments, and alkaline substances may damage some endoscopes.5 Overuse of acidic detergents and stain removers may be associated with the increased susceptibility to rust formation, pitting and corrosion. As with any critical process, the manufacturers’ IFU for instruments and chemicals must be consulted when selecting and developing cleaning processes that deliver a safely cleaned and functional medical or surgical devices.

STEAM QUALITY: Steam with a high level of dissolved solids or which is not at least 97% dry may create condensate/water staining and the formation of surface rust stains. Boiler plant engineering and biomedical engineering staff can help with steam quality issues. However, a steam quality expert may be needed for recurrent wet loads, water staining and rust stains on the surface of quality instruments.

OPERATING ROOM AND INSTRUMENT FUNCTIONALITY
Stainless steel is stainless – not stain-proof. While the post-manufacturing treatment of metal with nitric oxide helps prevent stains and corrosion, many common substances used in the OR can damage or destroy their passive layers. While passive layers are self-healing, repeated inappropriate exposure to caustic substances and physical misuse will eventually make instruments unusable.

The most common substances known to affect the surface quality of surgical stainless steel were noted above and are found in most ORs. Bioburden left to dry on an instrument’s surface is more difficult to remove in the cleaning process and is also damaging to the passivation layer. The Association for the Advancement of Medical Instrumentation (AAMI), the Association of periOperative Registered Nurses (AORN), and the International Association of Healthcare Central Service Materiel Management (IAHCSMM) agree that surgical instruments should be kept free of gross debris during and after a surgical procedure. These associations also recommend pre-treatment with an enzymatic spray or use of a towel soaked in clean water to prevent bioburden from drying on instrument surfaces.

Wiping instruments with a sponge wetted with sterile water during the procedure will have a positive impact on the instrument’s functional life. Extended exposure to moisture also affects the surface of even the highest quality instruments. They should never be left to soak for extended periods in any liquid, but especially not in bloody water or any liquids containing chlorides, such as saline, potassium or chlorhexidine.

TWO OTHER FUNCTIONALITY CONCERNS
Stress fractures and corrosive changes affect instrument life.

STRESS FRACTURES: Inappropriate handling and use, sterilizing with ratchets closed, manufacturing defects, reprocessing of single-use disposable instruments, and poor repair quality can cause these very fine cracks.2

Misuse of instruments (example: using...
CORROSION: Rust, pinholes, or dull uneven, dark grey to black discoloration are examples of varying states of corrosion. Rust may present as light surface staining due to steam quality issues. This surface staining is usually removable with an acid-based stain remover. Rust that breaches the passivation layer, sometimes represented as pinholes after stain removal, are an example of small areas of rust that cannot be repaired. The most common culprits include chloride exposure (saline, chlorhexidine, potassium), improper or lack of instrument lubricant (instrument milk) and permitting blood to dry on the instrument surface. Prolonged immersion in any liquid can promote rust formation, and should be avoided.

CONCLUSION

Providing quality surgical instruments for patient care is the primary purpose of CIS technicians, and this requires the collaboration, cooperation, education, and engagement of all instrument reprocessing shareholders. High quality instruments and devices must be selected. Their appropriate use and care is also required in the OR, and proper reprocessing is necessary in the CS department to ensure the maintenance of instrument surface and functionality.

Part II in this series will continue the discussion of instrument surface and functionality changes, and also address inspection and testing methods and options to manage these changes.

REFERENCES


IAHCSMM acknowledges the assistance of the following two CS professionals who reviewed this lesson plan:

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