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Eliminating Corrosion on Surgical Instruments

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LEARNING OBJECTIVES

1. Discuss the types of corrosion found on surgical instruments, and their origin
2. List steps for building a collaborative risk assessment and implementation plan to prevent surgical instrument corrosion
3. Identify steps for preventing common types of pitting and corrosion on surgical instruments

Sterile Processing departments (SPDs) frequently find rust, pitting or other corrosion on surgical instruments. Instrument specialists inspect thousands of these instruments daily and when corrosion is found, technicians are forced to remove the instruments from service, even when a replacement may not be available. Alternatively, if the technician does not notice the damage and the instrument stays in circulation and is then used on a patient, that incident can lead to a higher risk of surgical site infection (SSI) or injury. Sterile Processing (SP) managers and surgical leaders spend a large portion of their tight budgets replacing these damaged instruments. It is essential to stop the cycle and build an understanding of what causes surgical instrument corrosion and how it can be prevented.

Objective 1: Discuss the types of corrosion found on surgical instruments, and their origin

Inspecting surgical instruments is one of the most important steps in the SPD. In the assembly area of the department, technicians spend hours each day individually inspecting each instrument to check for cleanliness, damage and functionality. This process ensures each instrument is safe for patient use. Corrosion is a common type of surgical instrument damage that can be identified during the inspection process. Types of corrosion include pitting, wear/friction, stress/cracking, surface, contact, film and crevice. Each of these types of corrosion have their own root cause and solutions to prevent them.

Pitting presents as a small hole in stainless steel, surrounded by reddish-brown corrosion deposits. The main cause of instrument pitting is chlorides; these break through the passive layer of instrument's steel causing pitting.[1] Specifically, pitting is typically caused by high chloride content liquids that adhere to the surface of the surgical instrument (e.g., blood left on instruments for long periods of time or final rinse water with a high chloride content). New instruments have a higher risk of pitting because their passivation layer is still thin. Surgical instrument passivation layers get thicker over time through multiple reprocessing cycles.[1]

Stress corrosion presents as visual cracks and fractures in the stainless steel. This type of instrument damage is typically located in high tensile stress areas like welded, rivet or screw connections.[1] These cracks can be caused by poor instrument repairs or when the instrument is reprocessed in the closed ratcheted position. Instruments become overstressed when they are ratcheted; when this is coupled with a corrosion-promoting environment, it can lead to stress corrosion or cracks.[1]

Surface corrosion is damage in the form of corrosive deposits on the surface and it is typically presented as a uniform grey corrosion over the surface of the instrument.[1] When technicians see discoloration and erosion at the tungsten carbide inserts of needle holders, they are witnessing surface corrosion, which is caused by water or condensate on the stainless-steel instruments.[1] Washers in the SPD may have ineffective drying cycles that can lead to water or moisture retention and subsequent surface corrosion.

Film corrosion presents as individual, irregularly-dispersed rust particles that are brown in color. They are typically localized corrosion deposits or rust. Film corrosion may be caused by iron or rust particles in the steam or water pipes. If there are instruments with corrosion on them in the sterilization cycle, the corrosion can become dislodged and dispersed over other instruments. Reprocessing non-surgical grade or old instruments whose passivation layer is not intact can lead to film corrosion on instruments.[1]

Wear friction corrosion presents as brown stains/discolorations or rust and is found in the joint of an instrument. Atypical cause of wear friction is blood or tissue that remains in joints or sliding rails; the movement with the foreign bodies causes micro-abrasions in the instrument's joint. The surface becomes rough over time and the passivation layer is destroyed. Insufficient lubrication can also cause wear friction corrosion.[1] Some instrument manufacturers require lubrication of new instruments prior to processing to reduce the risk of pitting and wear friction corrosion.

Crevice corrosion presents as a small dot or ring-shaped, brownish-blue discoloration and is located in crevice areas of surgical instruments (such as forceps joints or screw tips of probes).[1] Unlike pitting, crevice corrosion does not have a hole in the center of the corrosion. Crevice corrosion is typically caused by poor drying. Microfractures at the joints leaves the passivation layers cracked and subject to corrosion when insufficiently dried.[1]

Objective 2: List steps for building a collaborative risk assessment and implementation plan to prevent surgical instrument corrosion

Surgical instruments are subjected to changes in their passivation layer over time due to chemical, thermal and/or physical impacts.[1] When corrosion is identified, instrument specialists should identify the origin in order to develop a plan to resolve the issue. The investigation should be conducted by an interdisciplinary team that includes all key stakeholders: SP subject matter experts; Engineering; Infection Prevention; device manufacturer representatives for surgical instruments, processing chemicals, and processing equipment; and clinical leaders. This team should identify the nature, origin and cause of the corrosion[1], and the team should estimate the risks and implement measures to prevent recurrence. Finally, the team should revalidate the instrument reprocessing process.

When attempting to solve a corrosion problem, the team should evaluate the type of corrosion that is present and then look at possible root causes. The team should partner with the washer and sterilization equipment manufacturers, Facilities representative and infection control to evaluate the contents of water used at the sinks, washers and, sterilizers, and for steam for the washers. The team should conduct a document review of the equipment manufacturers' recommended water specifications as well as the Association for the Advancement of Medical Instrumentation requirements for water and steam.[2] Again, chlorides or iron particles in the water can lead to rusting and pitting.[1] Ensure the reverse osmosis (RO) or deionized (DI) water systems are working correctly, and that the final rinse cycles on the washers are RO or DI water.[2] Steam filters or clean steam systems can be installed on sterilizers to improve steam quality.

Next, the team should review existing instrument repair processes. Are instruments being repaired often enough, as required by the instrument manufacture or industry standards? *Author's note: I have seen large organizations receive weekly instrument service. If you do the math, when an organization owns 1,500-plus trays, that translates to 520 trays serviced per year, which is not nearly enough. Some organizations use a time-based approach, meaning every tray is serviced every three or six months. If the department has an instrument tracking system, then, ideally, each tray will be serviced after a certain number of uses. I typically start with every 20 uses and then adjust based on need. I have found that Vascular, Labor and Delivery (L&D), Ortho, and Spine instruments may need repairing every 10 uses (approximation) to prevent corrosion. This process should be included in the risk assessment and evaluated as a potential solution.*

Finally but, perhaps, most importantly, the team should look at instrument point-of-use care.[3] Blood left on instruments for extended periods of time causes rusting and pitting on surgical instruments. Typically, L&D, floor trays and instruments from extended procedures like open heart procedures have more problems with rusting and pitting. As an example, if L&D

instruments are not quickly transported to the SPD for processing and proper point-of-use care was not performed, the instruments become high risk for corrosion. *Author's note: I have seen instruments fresh from repair corrode after being used on a single patient and left to sit overnight in the SPD. This is because the chlorides in the blood damaged the passivation layer.*

This cycle can be prevented by effective point-of-use care (wiping instruments with sterile water during the procedure, and using an appropriate point-of-use cleaning solution or gel after the procedure).[2,3] The instruments should then be transported to the SPD for cleaning with as little delay as possible, in accordance with AAMI standards and the surgical instrument manufacturer's instruction for use.[2,3] For all these reasons, point-of-use care should be included in the risk assessment when corrosion is found on surgical instruments.

Objective 3: Identify steps for preventing common types of pitting and corrosion on surgical instruments

Now that we know how to conduct the risk assessment and which systems and processes should be included, let's look at specific types of corrosion and what can be done to resolve them.

Pitting can be prevented with effective point-of-use care, using low-chloride water and steam during reprocessing, and by preventing saline solution from coming in contact with surgical instruments (and ensuring it is promptly rinsed off if contact does occur).[1] If the device cannot be repaired, it should be removed from service and replaced. Corrosion holes like pitting cannot be effectively cleaned and should be removed from service until they are repaired and/or replaced. Pitting can lead to stress corrosion and cracking.[1]

In the event of wear friction corrosion, it is important to ensure instruments are allowed to cool to room temperature. Also, be sure to implement an effective instrument repair program and lubricate the surgical instruments routinely. Instrument milk or an instrument lubricant (one that is approved by the device manufacturer and appropriate for sterilization) should be applied during the functional check at the SPD's assembly workstations, prior to sterilization.[1] The lubricant should be applied to the joint area and then the instrument should be opened and closed to ensure the lubricant hits all areas of the surface and is able to help restore the passivation layer.[1] Instruments with wear friction cannot function well for the surgical team. Think about a Crile hemostat that is too tight to open or close effectively. These instruments should be repaired, if possible, or replaced. Friction corrosion can lead to pitting.

For stress corrosion and cracking, ensure instruments are not washed or sterilized in a ratcheted or locked position.[1] Ensure low-chloride water and steam are in all areas of the SPD, and also ensure the instrument repair company is authorized by the surgical instrument manufacturer and is qualified to repair surgical instruments. If they are not, they could be overstressing the instruments and causing this type of damage. Corroded instruments should always be removed from service and repaired or replaced, and the cause of the corrosion should be determined and eliminated.[1]

For surface corrosion, ensure disposable instruments are not being reprocessed.[1,2,3] Replace instruments with damaged surfaces. Ensure instruments are dried properly after washing and that instruments are not in a high humidity environment that could lead to condensation forming on their surfaces. Finally, ensure there are no condensation issues after sterilization. If the instrument cannot be repaired, it must be replaced because the corrosion will return and potentially spread to other instruments.[1]

For film rust, discard single-use items; do not reprocess them.[1,2,3] Separate non-stainless-steel instruments to ensure material incompatibility is not causing the corrosion. Work with the Facilities department to ensure there are no iron or rust particles in the water piping, water or steam. Add water or steam filters, if necessary. Again, instrument rust can spread to other instruments that were not previously affected.[1]

To prevent crevice corrosion, ensure the joints and crevices are cleaned effectively and that no biomatter is left in the hinges, joints or crevices.[1] Ensure gaps and joints are dried properly. Point-of-use care practices should be reviewed to ensure biomatter is not drying in these gaps.[2,3] If so, these instruments should be repaired.[1]

Conclusion

Surgical instruments are a large capital investment for healthcare facilities. Corrosion can lead to a shortened life expectancy for surgical instruments and increase risk for SSIs. An effective inspection process should be implemented in the SPD to ensure no damaged instruments remain in circulation. In the event of corrosion on surgical instruments, an interdisciplinary team should conduct a risk assessment to determine the type of corrosion, its root cause, and effective solutions to resolve the type of corrosion identified. Ⓒ

REFERENCES

1. Working Group Instrument Reprocessing 2017. Reprocessing Instruments to Retain Value.
2. Association for the Advancement of Medical Instrumentation. ANSI/AAMI ST79:2017, *Comprehensive guide to steam sterilization and sterility assurance in healthcare facilities.*
3. Association of periOperative Registered Nurses. AORN 2020 Guidelines for Perioperative Practice.

CIS Self-Study Lesson Plan Quiz - Eliminating Corrosion on Surgical Instruments

Lesson No. CIS 280 (Instrument Continuing Education - ICE) • Lesson expires July 2023

1. Which of the following does not cause surgical instrument pitting?
a. Bioburden left on surgical instruments for extended periods of time
b. Ineffective point-of-use care
c. Chlorides in water or steam
d. Using instrument lubricants on joints of surgical instruments

2. Which type of corrosion can be caused by sterilizing surgical instruments in the ratcheted position?
a. Crevice corrosion
b. Pitting
c. Stress corrosion
d. Film corrosion

3. Corrosion typically is identified at which stage of sterile processing?
a. Decontamination case cart receipt
b. Surgical instrument inspection
c. Sterilization
d. Distribution

4. Which instruments have a higher risk for corrosion because of a thinner passivation layer?
a. New instruments
b. Heavily-used instruments
c. Instruments that are at least several years old
d. Instruments that are at least 10 years old

5. Which type of corrosion can be caused by poor drying?
a. Pitting
b. Crevice corrosion
c. Film corrosion
d. Stress corrosion

6. Which of the following should be included in a risk assessment for surgical instrument corrosion?
a. Sterile Processing professional
b. Facilities representative
c. Infection Prevention/Control representative
d. All the above

7. Before identifying solutions, the risk assessment team should identify:
a. The type of surgical instrument corrosion
b. The root cause of the corrosion
c. The nature of the corrosion
d. All the above

8. Ineffective point-of-use care can lead to surgical instrument corrosion.
a. True
b. False

9. Delayed reprocessing can lead to surgical instrument corrosion.
a. True
b. False

10. Surgical instrument corrosion caused by iron, rust or chlorides in water or steam can be solved by which of the following?
a. Steam filters
b. Clean steam systems
c. Using reverse osmosis or deionized water in the final rinse cycles of the washers
d. All the above

11. Routine and effective surgical instrument maintenance repair systems can:
a. Prevent surgical instrument corrosion
b. Decrease instrument processing time
c. Reduce the need for a risk assessment
d. Reduce the need for point-of-use enzymatic spray

12. Film corrosion is:
a. Presented as irregularly dispersed brown particles
b. Caused by iron particles in the steam pipes
c. Caused by rust particles in the steam lines
d. All the above

13. Which type of corrosion can be caused by biomatter/bioburden that remains in gaps in surgical instruments?
a. Pitting
b. Crevice corrosion
c. Wear friction corrosion
d. Stress corrosion

14. Which type of corrosion can be resolved by applying an approved instrument lubricant to the hinge of the surgical instrument?
a. Pitting
b. Crevice corrosion
c. Wear friction corrosion
d. Stress corrosion

15. Which type of corrosion can spread to other surgical instruments?
a. Film
b. Crevice corrosion
c. Stress corrosion
d. All the above

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