Ethylene Oxide (EO)
Overview of EO use with medical devices

Background on Ethylene Oxide (EO)

Ethylene oxide is a flammable, colorless gas used to make other chemicals that are employed in making a range of products, including textiles, plastics, detergents and adhesives. Ethylene oxide also is used to sterilize equipment and plastic devices that cannot be sterilized by steam, gamma and other sterilants such as medical devices.

As a low-temperature sterilizer, ethylene oxide gas won't damage these types of medical devices. Ethylene oxide also is used to disinfect other health care products such as bandages and ointments, reducing potential damage to the product that may occur from other means of sterilization.

Medical Device Sterilization

AdvaMed members' products range from needles and bandages to replacement joints, heart valve replacements and imaging equipment. Safety and effectiveness of medical technologies, encompassing the manufacture, sale and use of devices is regulated by the Food and Drug Administration (FDA) and other global regulatory bodies. For many medical devices that come in contact with patients and health care providers, product sterility is critical for preventing infections. A very high percentage of surgeries involve at least one device that has been sterilized with EO.

Universally, approximately 50% of all medical devices are sterilized with EO, accounting for more than 20 billion devices annually. Due to material sensitivities, EO is the only option for sterilizing a large number of life-saving and life-enhancing devices, primarily those made of plastics or containing electronics, that cannot tolerate exposure to the extreme temperatures, radiation and moisture present in other sterilization methods.

The effects of steam and radiation on anti-microbial coatings on single-use plastic devices makes them an unacceptable alternative. Material integrity and degradation and damage to sensitive, sophisticated electronic devices and their components are also major concerns. Another benefit of sterilization with EO is for medical devices used in surgical procedures that need to be sterilized inside of packaging. EO vapor allows sterilization through a variety of packaging materials.

Examples of Medical Devices that Require EO Sterilization

- Fiberoptic endoscopes
- Specula
- Surgical kits
- Syringes
- Sutures
- Catheters
- IV sets
- Plastic tubing
- Inhalation therapy supplies
- Surgical telescopes
- Anesthesia masks and circuits
- Renal Peritoneal Dialysis sets
- Renal Hemodialysis sets
- Tubing sets/bloodlines
- Gowns and drapes
- Heart valves
- Pacemakers
- Surgical Drills
- Pumps
- Respirators
- Electrical equipment
- Uterine monitors
- Surgical staplers
- Diagnostic electrode catheter

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FDA's Role in Device Sterilization

The FDA and other global regulators play an important role in assuring that manufacturers' sterilization methods are properly validated. FDA regulations, guidance and harmonized international standards have provisions that address the use of ethylene oxide and other sterilants for medical devices. Manufacturers must conduct exhaustive studies to validate that the required sterility assurance levels are achieved by the process and to confirm that exposure to the sterilization process does not adversely affect the device's performance, safety or effectiveness. For this reason, manufacturers must choose sterilization methods that are both effective and compatible with device materials and components.

Standards

Manufacturers using established sterilization methods, such as EO, comply with voluntary consensus standards recognized by the FDA and global regulatory authorities. An international standard (ISO 11135:2014) specifies requirements for the development, validation and routine control of an ethylene oxide sterilization process for medical devices in both the industrial and health care facility settings. Under the standard, manufacturers must identify factors that can affect the sterilant's effectiveness, assess the effects of product exposure to the sterilizing agent, and identify ways to ensure the safety of personnel and protection of the environment during the sterilization process.

Good Manufacturing Practices

Manufacturers using established sterilization methods, such as EO, comply with consensus standards recognized by the FDA. Manufacturers must follow Good Manufacturing Practices (GMPs), that adhere to the Quality Systems requirements relative to the methods used in, and facilities and controls used for, designing, manufacturing, packaging, labeling, storing, installing and servicing of medical devices. This includes the use of contract sterilization firms, as the contract sterilizers are considered to be a part of the manufacturing process.

As part of the U.S. Quality Systems Regulations and other global requirements, manufacturers must validate their sterilization processes and provide evidence that their process is validated at the site where they intend to routinely sterilize in pre-market submissions. Any change to the sterilization method, or location, would typically require a resubmission of validation data and require the product to be cleared by FDA anew, which would be a lengthy process. It must be demonstrated that the sterilization method used will not compromise device safety and effectiveness, and the demonstration of effectiveness must be shown to be acceptable throughout the life of the product, typically 3-5 years. Manufacturers must also choose sterilization methods that are compatible with components and device packaging.

The FDA may deny use of an alternative sterilization process if it determines that either the validation process or subsequent product validation is inadequate. In addition, with many products sold globally, getting approval to move processes often involves approval of multiple regulators outside of the United States.

Biocompatibility

Manufacturers' finished products must meet global standards for material biocompatibility including assessment of EO residuals remaining on the finished product post-sterilization. These requirements ensure patients and health care providers are not exposed to unacceptable levels of chemical residues from the sterilization process, which is an important part of the sterilization validation process. The methods for determining acceptable levels of for product release are well-established. Changing sterilization methods requires manufacturers to reestablish product biocompatibility through repeat studies.

Impact of an EO Ban

For the reasons stated above (e.g., device integrity), for many devices sterilized with EO there is no acceptable alternative.

Manufacturers would also have to redesign many medical devices. Any changes to the mode of sterilization for many products would require major changes to product design, material selection, manufacture and distribution – all regulated by FDA. The redesign process could take several years and require lengthy regulatory approval. The direct impact of any elimination or severe restriction would potentially threaten the entire health care system, as low product inventories and severe backorders of sterile single-use devices could result, putting patients at risk.

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Sources: EPA, FDA, American Chemistry Council

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