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Restoring Office-Based Surgical Facility Function Post-Hurricane Irma: Lessons Learned From Multiple Facilities

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Hurricane Irma made landfall in Southwest Florida on September 10, 2017, causing significant property damage, flooding, and power outages that lasted days to weeks during high heat and humidity. This created significant challenges for residents and businesses, as well as office-based surgical facilities in the area. Preparations in advance of hurricanes and other natural disasters for businesses should focus on staff, surroundings, space, systems, structure, and service. In the aftermath of a hurricane, assessment of the extent of the damage and the ability to perform restoration and mold remediation post-flooding are the immediate goals. With the return of utility services, additional cleanup and assessment of equipment, medications, and sterile supplies with subsequent repair/recertification, replacement and reprocessing, as required, are necessary to bring operations back to normal.

> Hurricane Irma had maximum sustained winds of 185 mph at its peak in the Atlantic Ocean, which it maintained for over 35 hours, making it one of the strongest storms on record in the Atlantic basin as well as the longest-lived storm of that intensity anywhere in the satellite era. Hurricane Irma's first continental U.S. landfall occurred at Cudjoe Key in the Florida Keys with maximum sustained winds of 130 mph (Category 4) at 9:10 a.m. EDT on Sunday September 10, the climatological peak of the Atlantic hurricane season. At 3:35 p.m. EDT that same day, Irma made its second continental U.S. landfall over Marco Island, FL, with maximum sustained winds of 115 mph (Category 3). A peak wind gust of 142 mph was reported at Naples Municipal Airport (KAPF) during Irma's eyewall passage…. Irma's extensive size and slow movement made for several hours of tropical storm force winds, which resulted in widespread tree and power line damage across the area. Trees fell on roofs and cars, damaging property, and sadly taking a life in southwest Georgia. While many counties across the Florida Big Bend and southwest Georgia were impacted, the greatest impacts were across the eastern portion of the area near the I-75 corridor. There were over 6.5 million customers without power in Florida, over 930,000 customers without power in Georgia, and over 45,000 customers without power in Alabama. In addition to wind impacts, Irma produced flooding across parts of Florida, Georgia, and South Carolina from storm surge and heavy rainfall. (National Weather Service, 2017)

Because of the impact of this significant weather event, many areas in southwest Florida were without power for days to weeks, with significant structural damage and flooding. Temperatures were in the 90s with high humidity, depending upon the time of day. Once the residents had an opportunity to survey their home damage and implement immediate remediation efforts, and roads were cleared and safe for travel, their attention turned to their workplaces. Some of those workplaces were office-based surgical facilities.

PREPARATION

There are many guides available from government agencies to assist residences and businesses in preparation for hurricanes and other natural disasters (Centers for Disease Control and Prevention [CDC], 2019a; Federal Emergency Management Agency (FEMA), n.d.; National Weather Service, n.d.-a; Occupational Safety and Health Administration, n.d.-a). Planning resources for residents focus on having an awareness of the impending event; purchasing adequate supplies in terms of food, water, and prescription drugs; preparing the exterior of the home to best resist the effects of the event; knowing where shelters are located in case of mandatory evacuation orders; filling gas

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tanks for transportation; gathering important documents for preservation; purchasing flashlights, batteries, and first aid kits; and charging electronic devices in advance of a potential power failure.

The FEMA (n.d.) breaks down preparations for business into staff, surroundings, space, systems, structure, and service. Staff should be trained in advance of a disaster to ensure safety and optimize the outcome for continuity of services postdisaster. Monitoring of some impending events such as hurricanes by the media allows time for advanced facility preparation to enable workers to return home and focus their energies on preparing their own homes and families. Tracking often allows for identification of potential events several days prior to impact. "Watches" are issued for storm surge, hurricane, and tropical storms 48 hr in advance. "Warnings" are issued for storm surge, hurricane, and tropical storms 36 hr in advance, and extreme wind warnings are issued within an hour of impact (National Weather Service, n.d.-b). Local officials will issue evacuation orders as needed on the basis of these predictions.

Communication with staff is essential after a disaster, and often cell phone usage is limited because of high call volume and/or cell tower damages caused by high winds. The FEMA suggests setting up a telephone calling tree, a password-protected page on the company Web site, an e-mail alert or a call-in voice recording to communicate with employees in an emergency (FEMA, n.d.). Multiple forms of communication should be considered in case one or more forms are unavailable.

Another staff issue that requires advanced preparation pertains to when and under what conditions wages will be paid pre- and postdisaster. This is a significant issue, as interruptions or reductions in paychecks can result in financial hardships. There should be clear policies as to how closures of the facility will be considered in terms of employee pay. Postdisaster, employees may be dealing with significant damage to their own property. There are Federal disaster relief programs, as well as private insurance, that employees can obtain; however, application takes time, and these programs may not address immediate short-term needs (FEMA, n.d.).

Insurance coverage should be reviewed by administrative staff prior to these events to understand the amount of coverage and how to minimize facility/business interruption in the aftermath. The insurance provider can also advise the facility on steps to take and what proof of damage will be required for payment of claims if necessary (FEMA, n.d.).

Preparations for businesses also focus on preparing the exterior surroundings. Attention must be given to reinforcement of signs, flagpoles, fencing, railings, awnings, rooftop, and other structures. Landscaping and trees should be trimmed in a manner that resists damage from high winds and removes objects that can serve as projectiles, such as coconuts in tropical areas. Securing windows and doors that cannot withstand high winds or projectiles is a priority in advance of a hurricane or other high-wind event. Within the interior space, it is important to identify medical equipment and computers/servers that must be secured, protected, and elevated off the ground in case of flooding (at least 12 in. above the level to which floodwater is anticipated to rise), moved away from windows and any other openings in case of intrusion by water or debris, and unplugged to prevent damage from potential electrical surges when power returns to the system (FEMA, n.d.).

Facilities that have controlled substances stored on-site need to consider the safety and security of those medications as well. The U.S. Drug Enforcement Administration (DEA) recommends increased security during a disaster to prevent theft, which may not be available from local police due to other law enforcement priorities at the time. The DEA advises registrants to reach out to law enforcement in advance in order to make them aware of the situation and the need for added security at the office. Facilities may also contact their local DEA field office for guidance (U.S. Department of Health and Human Services, 2019).

Systems include mechanical, electrical, utility connections, communications, lighting, sewer, and water. Advanced preparation for utility disruptions may include the installation of extended backup power to maintain heating/ventilation/air-conditioning (HVAC) and refrigeration for medications. Depending upon the type of backup power installed, planning might include ensuring a full propane tank for an in-ground generator and testing the generator prior to the anticipated event. Sewer drainage systems should be assessed for potential protection with backflow valves (FEMA, n.d.). Securing an adequate supply of distilled water in advance of a natural disaster is essential for tabletop sterilizer functioning and instrument reprocessing once the facility function is restored.

Continuity of care is an important patient safety and potential liability issue, and patients need to know in advance how to best reach the surgeon or where to go for ongoing care if the office is closed because of damage and/or a power outage. Ensuring that computers are backed up to remote servers with current information and that staff members are able to retrieve these backups is important to ensure continuity of the medical record. Any paper records and logs must be secured and protected from potential flooding or water intrusion (FEMA, n.d.).

Structural risks include the building itself as well as the roof system. Historically, damage to roof coverings is the leading cause of building problems during hurricanes and other coastal storm events (FEMA, 2013). Torn roof coverings due to high winds and/or punctures due to flying debris can allow for water intrusion and subsequent internal damage and mold growth. Loose roof tiles themselves

can become projectiles in high winds, posing threats to surrounding buildings. The FEMA recommends consultation with a professional engineer to assess and implement optimal wind resistance of the roof covering and associated structures, general structural integrity of the building, as well as flood-proofing based on geographical risks (FEMA, n.d., 2013).

Service preparation includes knowing how to contact the Local Emergency Management Office. This office can be a valuable source of information regarding the status of the local area, what services have been impacted, and when they might be restored postevent. Depending upon the severity of the event, physicians may be needed at local hospitals to provide services and staff members may be asked to assist in the community (FEMA, n.d.).

AFTERMATH

Safety for all is the overriding concern in the aftermath of a disaster event. It is important that staff and management personnel await clearance from local authorities before returning to the facility. Going out into flood waters can be dangerous, as moving water only 6-in. deep can sweep a person off his or her feet. Vehicles can be swept away in only 2 ft of water or may stall in moving water. There are other hazards in flood waters such as live fallen power lines, rodents, insects, parasites, reptiles, chemicals, sewage, sharp objects including glass or metal fragments, and potentially harmful microorganisms (CDC, 2017a; Erdman, 2015).

Because of the effects of standing water and structural damage, contamination of the building, equipment, and supplies with mold, mold spores, and bacteria is a major concern. Depending on the extent of the damage, initial assessment should focus on whether to condemn the building or perform remediation. The decision to perform restoration should be reached with the input of engineers, building inspectors, the local fire marshal, professionals trained in building remediation, and health care equipment manufacturers (CDC, 2013, 2019b).

Once the facility has been assessed and deemed safe to enter by local authorities (e.g., no gas leaks, dangerous structural damage, or electrical fire/hazards) and determination has been made to repair and reoccupy the building, damaged or contaminated materials and structures must be removed and discarded. Salvageable materials and items can be dried, cleaned, and repaired. Drying the facility and removing water-damaged items are the most important steps for preventing mold damage. An important consideration is whether there is a source of safe electrical power available to assist in this effort. A working sewage system is required for extraction of standing water (CDC, 2013). Before cleanup begins, it is important to contact the insurance company and take photographs of the facility and its contents for claims purposes (Association of periOperative Registered Nurses [AORN], 2019).

If the facility was flooded and drying was not accomplished within 24–48 hr (including furniture, curtains, and other items), mold growth is assumed, even if not visible. If the damage was minimal, the owner or staff members may decide to perform cleanup themselves. However, if mold covers more than 10 ft^2, it is recommended that this task be performed by professionals (Occupational Safety and Health Administration, n.d.-b). The CDC (2013) recommends hiring a mold inspection or remediation professional affiliated with or certified by the National Environmental Health Association, the American Industrial Hygiene Association, the Institute of Inspection, Cleaning and Restoration Certification, or the American Council for Accredited Certification to inspect, repair, and restore the damaged parts of the building. State regulations may also address mold remediation. After the cleanup, professionals can assess for residual moisture in structural materials using moisture detection devices. The HVAC system components, including ductwork that may not have been submerged, still need to be thoroughly cleaned and disinfected to remove bacteria and mold that could be dispersed when the system resumes function (CDC, 2013).

For minimal cleanup, the CDC recommends wearing an N-95 respirator at a minimum (half-face or full-face respirator), goggles with complete eye protection, and protective gloves (nonlatex, vinyl, nitrile, or rubber). Long-sleeve shirt and long pants as well as rubber boots are also recommended. Exposure to mold can lead to asthma attacks, eye and skin irritation, and allergic reactions, as well as severe infections in people with weakened immune systems (CDC, 2019b; Occupational Safety and Health Administration, n.d.-b; U.S. Environmental Protection Agency, 2017;). The CDC (2017b) recommends adhering to the following steps when attempting cleanup of *small areas*:

1. Don personal protective equipment as described earlier to protect eyes, nose, mouth, and skin.
2. Remove standing water and wet materials. Use a wet vacuum to remove water from floors, carpets, and hard surfaces. Dry the building and everything in it within 24–48 hr, if possible. Wet carpeting, furniture, bedding, and any other items holding moisture or water inside the building can develop mold within 24–48 hr.
3. If an item has been wet for less than 48 hr, help control mold growth by cleaning with a phenolic or pine oil cleaner (nonammonia detergent, soap, or commercial cleaner) and disinfecting with a bleach solution (one cup of bleach in a gallon of water made fresh daily in a well-ventilated area). Items should then be completely dried and monitored for

several days for any fungal growth and odors. If any mold develops, throw the item away.

4. Do not mix cleaning products together. *DO NOT mix bleach and ammonia because it can create toxic vapors.*
5. Open all doors and windows when working and leave as many doors and windows open as is safe when leaving.
6. Open inside doors, especially closets and interior rooms, to let air flow to all areas. Take doors off their hinges, if necessary.
7. Open cabinet doors; remove drawers, wipe them clean, and stack them to dry.
8. When electricity is safe to use, use fans and dehumidifiers to remove moisture. Do not use fans if mold has already started to grow, because the fans may spread the mold.
9. Painting or caulking over mold will not prevent mold from growing. Fix the water problem completely and clean up all the mold before painting or caulking.
10. Discard items that cannot be cleaned and dried.
11. Discard anything that was wet with flood water and cannot be cleaned and dried completely within 24–48 hr.
12. After remediation, there should be no signs of water damage or mold growth. If mold is still seen or smelled, contact a mold remediation professional to determine whether the mold problem has been completely resolved.
13. If existing health problems worsen when occupying the space (e.g., asthma, allergy attacks, skin or eye irritation), mold may still be present.

The AORN provides specific information regarding the integrity of sterile supplies. Moisture in contact with a sterile package is considered a contaminating event and therefore the AORN (2019) recommends that the facility reprocess or discard any sterile items with condensation or suspected water damage. Many of the facilities affected during the Hurricane Irma power outage were subjected for days to weeks to heat in the 90 °F range and high humidity. In consultation with AORN (Sharon Van Wicklin, MSN, RN, CNOR, CRNFA[E], CPSN-R, PLNC, Senior Perioperative Practice Specialist, personal communication, September 19, 2017), we were advised to reprocess all items that were not commercially sterilized and to contact the manufacturers of commercially sterilized items for their recommendations as to whether the items could be returned to stock or whether they needed to be discarded. The manufacturers we contacted agreed that unless the item had been in direct contact with water or other contamination, it was not necessary to discard it. The following is an excerpt from a letter from K. Mueller, CISS ES, CISS-RAD, Medline Technical Affairs, where she explains that heat and humidity will not affect the sterility of their commercial processed products:

> Storage in an area with varying ambient room and environmental conditions will not compromise the sterility or integrity of products contained within intact medical device packaging. The sterile medical devices and custom procedure packs that Medline manufactures are designed to withstand both very low and very high temperature and humidity conditions that they are subjected to during the ethylene oxide sterilization process. During ethylene oxide sterilization, products are exposed to temperatures above 115 °F and humidity conditions as high as 95%. The Tyvek® (or medical grade paper) on our sterile barrier packaging is a microbial barrier which prevents the entry of microorganisms and liquid water. As long as the packaging does not become physically wet and remains intact (subject to labeling disclaimers), exposure to varying temperature and relative humidity conditions in your central supply room or operating room will not impact the sterility or integrity of Medline's sterile medical devices. For Medline's distributed medical devices, it is extremely uncommon for these products to include any storage guidelines or warnings on the instructions for use or other product materials. Should a manufacturer have storage requirements, these guidelines would be included on the product's labeling and/or instructions for use. (Personal communication, April 2, 2019)

A significant issue in the aftermath of a disaster is the quality of the water supply. Three days prior to Hurricane Irma's landfall, an advisory regarding the risks of water supply contamination due to the impending hurricane was posted on the Collier County Health Department Web site.

Areas in Southwest Florida maintained boil water notices for up to 10 days following the hurricane due to concerns about potential water line breach contamination with microorganisms such as fecal coliform bacteria, *Escherichia* coli, *Cryptosporidium*, *Giardia*, and other bacteria, parasites, and viruses, as well as potential chemical contamination. Compounding this issue is the loss of power, making boiling difficult, if not impossible (Florida Department of Health, 2017; Florida Department of Health in Collier County, 2017).

Hand hygiene during cleanup efforts is a challenge as, again, clean water may not be available. According to the CDC:

> After completing the cleanup, wash your hands with soap and clean water. Use water that has been boiled for 1 minute (allow the water to cool before washing your hands); or you may use water that has been disinfected for personal hygiene use:
>
> - When using 6% unscented liquid household chlorine bleach—add a little less than $\frac{1}{8}$ teaspoon (8 drops or about 0.5 milliliters) per 1 gallon of clear water. Stir

well, and let it stand for 30 minutes before using. If the water is cloudy, add a little less than 1/4 teaspoon (16 drops or about 1 milliliter) per 1 gallon of water.
- When using 8.25% unscented liquid household chlorine bleach—add a little less than 1/8 teaspoon (6 drops or about 0.5 milliliters) per 1 gallon of clear water. Stir well, and let it stand for 30 minutes before using. If the water is cloudy, add 12 drops (or about 1 milliliter) per 1 gallon of water. (CDC, 2017b).

Reprocessing of sterile supplies on-site requires adequate supplies of distilled water for the tabletop sterilizer. This is one commodity that is difficult to find immediately prior to and after a hurricane, which is why prepurchase is a necessity. Once power was restored, per AORN (2019) recommendations, we performed quality control on our tabletop steam sterilizers by cleaning them using bottled distilled water per manufacturer's instructions and then performing three consecutive biological spore tests with negative results prior to usage.

The question of using medications stored in the facility during this time was raised. The Center for Drug Evaluation and Research at the U.S. Food and Drug Administration (FDA) addresses the issue of medications potentially affected by extremes of temperature and flooding. It advises inspecting all drugs after a disaster and replacing any drugs exposed to excessive heat. Drugs exposed to flood waters or contaminated municipal water should also be discarded and replaced. When a drug may be required because of a life-threatening emergent situation, the FDA allows for the drug to be used (even if the medication has been stored without the necessary refrigeration) as long as its appearance has not changed. For example, a bottle of pills may be wet, but the pills within the bottle remain dry. In this case, the appearance of the drug has not changed and the pills may be used. Because temperature-sensitive drugs lose potency if not refrigerated, they should be replaced with a new supply as soon as possible. The FDA also advises that drugs that have to be reconstituted (using water) *should be mixed only with purified or bottled water* (U.S. Food and Drug Administration, 2017).

The DEA provides emergency assistance to registered facilities responding to a disaster. It can relocate a DEA registration, facilitate replacing damaged or destroyed controlled medications, and provide information on disposal of damaged medications. It operates a disaster relief e-mail account (natural.disaster@usdoj.gov) that is monitored 24 hr a day, 7 days a week (U.S. Department of Health and Human Services, 2019).

Once power was restored, terminal cleaning and disinfection of the operating room and other clinical areas were performed before resuming patient care and other activities. Medical equipment was assessed to determine whether there was any contamination and depending upon the circumstances, the appropriate cleaning, disinfection, and recertification were performed per manufacturers' instructions (CDC, 2013).

As soon as the boil water alert was lifted, the recommendations from the CDC (2017c) were followed where applicable:

- Flush and restart all fixtures (e.g., faucets, drinking fountains) and equipment. Flush faucets and fixtures for 5 min or more until the odor of chlorine can be detected. Notably, if chlorine cannot be detected after thorough flushing, supplemental disinfection may be required.
- Discard ice from ice machines and clean and sanitize the ice machines per manufacturer's instructions.
- Remove point-of-use filters, and flush outlets for several minutes before installing new filters (e.g., ice machines, sinks, and showers, if present).
- Run water softeners through a regeneration cycle.
- Drain, disinfect, flush, and refill water storage tanks if present.
- Change pretreatment filters, backwash carbon tanks, regenerate softener, and clean and disinfect reverse osmosis membranes.
- Corrective decontamination of the hot water system may also be required after a prolonged disruption in service or a cross-connection with sewer lines has occurred.

All too often we take for granted the basics that allow us to do our jobs and take care of our patients—clean running water, functioning sewer systems, lighting and electricity, air-conditioning and heating, and an intact building with a functioning roof. When these support systems and structures are down, we gain a true appreciation of their importance. Preparation is key in helping mitigate the effects of natural disasters and, in the aftermath, taking the time and care to ensure a safe environment for staff and patients is the overriding goal.

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