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EBOLA Outbreak

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Design for contagions in autopsy suites

Introduction

In 2003, the outbreak of Severe Acute Respiratory Syndrome (SARS) received much attention as a highly contagious airborne disease ravaging China and other Asian nations. Jinhee experienced the level of precaution firsthand while traveling to Asia at the time of the outbreak. All airline passengers were fumigated on the plane 20 minutes prior to landing in Guangzhou, China. Upon exiting the aircraft, before entering the terminal, health officers clad in Tyvek suits scanned every passenger with a body temperature gauge to identify those potentially infected. Recently the rampant Ebola outbreak in West Africa has received similar attention. According to CNN Ebola is less contagious than SARS, in theory, as Ebola does not spread infection through the air. However, direct contact with infected bodily fluids or other biological materials can lead to severe infection with an exceptionally high mortality rate.[1] During the current outbreak only 47% of people who contract the virus have survived. Statistics from previous outbreaks have shown survival rates as low as 10% since Ebola's discovery in 1976.[2]

We will specifically review the design strategy for a single table high containment autopsy suite, based partly on the Centers for Disease Control (CDC) and National Association of Medical Examiners (NAME) standards. Our best practices are in an effort to create a facility that is prepared for the worst case scenario, which could result from any highly contagious disease outbreak. These events may combine two traditionally

difficult circumstances: mass casualty scenarios and high containment requirements.

Design Challenges Such As Ebola

Design of space plays a significant role in controlling the spread of disease in and around autopsy suites. Surprisingly there are no set standards or guidelines for high containment autopsy suites. The accreditation requirements per NAME apply typically to general autopsy spaces and do not address the specific requirements for pathogen containment. As of October 8, 2014, according to the CDC all "autopsies on patients who die of Ebola should be *avoided*. If an autopsy is necessary, the state health department and CDC should be consulted regarding additional precautions [emphasis in original]."[3]

The use of a high containment autopsy suite to examine a potentially infectious decedent is a necessary but infrequent occurrence. During normal use, a high containment space can be utilized as an additional isolation, VIP case, and Bariatric or decomposition autopsy space. However, in the event of a mass casualty bioterrorism event or an Ebola outbreak the space would be too small to handle multiple cases simultaneously. In this scenario, cases would be managed and autopsied sequentially within the suite. It is important to recognize that the decedent does not pose particularly high risk during storage and transport as it is double-bagged. However, the risk is not always known until the autopsy begins. In recognition of this, there should be direct access from the primary autopsy suite into the high containment suite to offer isolation as quickly and effectively as possible.

A suite designed to contain health hazards during an autopsy requires greater security than other autopsy spaces. Only trained personnel are allowed in the contaminated area through the use of control devices such as swipe cards, key fobs, and automatic locking self-closing doors.

One of the first steps in designing and planning the high containment suite is to separate the various processes to be performed in the spaces and determine what each process requires in the way of infrastructure and support.

There are three main types of movement throughout this type of facility: Personnel, decedent, and materials. Personnel enter through the "clean" airlock for gowning and hand washing before entering contaminated areas. Gowning includes personal protective equipment (PPE) such as Tyvek suiting with shoe covers, powered air-purifying respirators, and additional hand protection against laceration or puncture. Next the procedures are performed in the contamination zone of the suite. At conclusion of the procedure, all items are gathered and removed. Personnel then exit into the "dirty" airlock, where PPE is removed and disposed of. Items are sent through the pass-through to be sterilized. All personnel exposed to the contaminated work zone must shower and exit the suite through the dirty airlock.

The observation room is in a clean zone entirely separate from the containment suite. It does not factor into the personnel flow for the controlled area, and individuals with access to the observation room would not necessarily have access to the secure autopsy suite.

Decedents enter the facility double-bagged from the sally port and move through receipt and into the cooler for holding. When ready for autopsy, a decedent is wheeled into the high containment autopsy suite directly from the cooler. The bags are opened and the autopsy is performed. After the autopsy, all disposable materials are red-bagged. The decedent is again placed in a double-bag for secure transport. The decedent is returned to the cooler for holding until pickup, exiting through the sally port. General practice for decedents which may be a source of infection is for them to be cremated, although this is typically performed off-site.

Materials flow through the spaces in a similar way as personnel and enter through the clean airlock. Preference is for disposable supplies wherever possible, including personal protective equipment. After completion of the autopsy, disposable materials are collected and red-bagged. Both red-bagged and non-disposables are sent through a pass-through autoclave for sterilization. Autoclaved items are sterile and removed on the clean side of the unit. Red-bagged items can be disposed of in a normal manner.

Constructability

The finish surfaces of the wall, floor, and ceiling, as well as

mechanical, electrical, and plumbing (MEP) must be carefully thought out for a suite designed to contain possible health hazards during an autopsy. The materials and finishes selected need to consider maintainability, durability, and decontamination. Monolithic wall construction such as filled concrete blocks or poured concrete walls with 2-coat troweled surface finishes and epoxy top coating with coved bases are ideal for cleanup and infiltration resistance to isolate the suite.

All work surfaces, casework, and built in equipment such as autopsy sinks should be stainless steel for maximum decontamination ability. Walls are epoxy painted in the laboratories and service areas where wall cleanup is necessary.

Epoxy flooring is recommended for the high containment suite. Epoxy is impervious to water making it a great finish for areas that will require wash down. Though it is more expensive than many other floor choices, it is the most durable and most effectively decontaminated.

Ceilings in the containment suite require forethought for security, cleanup, and light reflectivity. The ceiling system should be hard dry-wall with epoxy paint and gasketed lighting fixtures used. Color definition is important to autopsy and diagnoses, so true-color rendition bulbs are important.

Isolation: Eliminating Cross-Contamination
According to NIH, ASHRAE, and CDC guidelines, all MEP systems must be protected and sealed to help prevent pathogens from crossing into the rest of the building or other dedicated autopsy systems.

The use of wet fire protection, such as ceiling sprinklers, is a risk for building contamination during a discharge. So for these types of spaces we recommend a waterless fire suppression system. A 72 hour emergency power backup system is recommended, which is used to facilitate proper storage of the decedents in a negative pressure temperature controlled environment. All fixtures (such as lighting, plumbing, and other electrical) are recommended to be surface mounted to minimize penetrations through the walls. Treatment using Hydrogen Peroxide Vapor (HPV) is the preferred method of decontamination within the suite.

Mechanical and Plumbing Systems

High containment suites should eliminate cross-contamination by providing single-pass air. This means that all of the air must be supplied from outside air and 100% of the lab air is exhausted directly to the outdoors. None of the lab air can be recirculated within the building. The air should be supplied high (near the ceiling) and exhausted low (at floor level). This allows air to flow from top to bottom and move putrid odors down and out of the room, bringing fresh air past the noses of those working at the table. Redundant supply, exhaust fans, and HEPA filtration is recommended. All diffusers and grills should be stainless steel, and return air grills should never be located at the ceiling level as this churns the air and makes it difficult to remove malodorous smells. The mechanical design should provide good airflow in the suite including increased frequency of air changes per hour over standard spaces. High containment suites must maintain negative air pressure in the lab so that air can't escape. Air being exhausted out of the suite should pass through a HEPA filter, with gas tight isolation housing and dampers with decontamination ports and bag-in / bag-out capability.

Closing Remarks

The ideas and overall guidelines above provide general insights for a well-designed high containment suite. By designing to allow for the safe flow of persons, decedents, and materials in and out of the space, the risk of contamination during autopsies is reduced. The spaces are always secured so only authorized and trained personnel can enter. Materials and finishes in the suite are selected to suit decontamination needed in these spaces. The HVAC systems are designed to eliminate contaminates from leaving the controlled suite, providing a healthier and safer space for all occupants of the building.

References

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Jinhee Lee (jinheel@crimelabdesign.com) *and* ***Matt Willmus*** (mattw@crimelabdesign.com) *are Laboratory Designers with Crime Lab Design which provides full architectural and engineering services for forensic and medical examiner facilities worldwide.*

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