Healthcare Lighting Series White Paper: #HC020
HAI Prevention: The Dynamics of Patient Room Lighting
HAI Prevention: The Dynamics of Patient Room Lighting

by Clifford J. Yahnke, Ph.D., Director, Healthcare Product Marketing

Healthcare Acquired Infections (HAIs) are a significant source of concern for today’s healthcare provider due to both their human and economic costs. Within the healthcare setting, it has been shown that surfaces with the environment play a significant role in reducing their spread. This purpose of this paper is to educate healthcare professionals (infection preventionists, epidemiologists, environmental services, etc.) and lighting specialists (specifiers, engineers, designers, architects, etc.) on the issues of common interest between two seemingly disparate topics. Its specific objectives are:

1. Summarize the dynamics of the healthcare landscape which have created acute awareness of Healthcare Acquired Infections.
2. Educate the reader regarding the basic role of the environment in HAI risk and prevention
3. Identify the characteristics of specification-grade light fixtures that can reduce the spread of pathogens within the environment
4. Identify locations in the healthcare setting which can benefit from the use of specification-grade light fixtures

Public Awareness Due To Healthcare Policy

Infection prevention is a subject that has thrust itself into the public eye for a variety of reasons that are ultimately related to the safety and well-being of the patient. While the most noble goals of any healthcare provider (HCP) are to improve the health of their patients, they do not have unlimited resources by which to do so. The Affordable Care Act (ACA) instituted several changes to US healthcare policy designed to ultimately reduce the amount of money spent on healthcare while producing better outcomes. This creates a set of competing objectives where HCP’s are being asked to do more with less. Figure 1 shows one estimate of the projected Medicare (CMS) expenditures under the ACA. To be sure, this is the subject of intense debate that crosses political boundaries; however, what can’t be argued are the specific policy elements around which the HCP’s reimbursement attention has been focused.

As a political compromise of sorts, US healthcare policy is being dictated indirectly by the government through reimbursement (or non-reimbursement) of various procedures, conditions, and activities. Hospital Acquired Conditions (HAC’s) are a broad way in which to describe a range of issues which are viewed by the CMS as “reasonably preventable” and therefore an unnecessary burden to the healthcare system.

This list has been defined by the CMS to include:
- Foreign objects retained after surgery
- Air embolisms
- Blood incompatibility
- Pressure ulcers, falls/trauma
- Manifestations of poor glycemic control
- Infections
- Thrombosis

Beginning in 2015, the HAC program is one of sev-
eral “pay for performance” initiatives under the ACA. This program will work with two other incentive programs, “Value Based Purchasing” and “Readmissions Reduction” to hopefully provide higher quality hospital care at a lower cost. Their approach is based upon two types of economic incentives:

1) non-payment of costs associated with readmissions and reasonably preventable conditions and

2) reimbursement penalties for those HCP’s with the lowest rankings amongst their peers for outcomes and HAC’s.

Together these three programs can affect up to 6% of an HCP’s Medicare reimbursement. This penalty could be millions of dollars for many providers.

It is important to understand that while non-payments are restricted to those specific incidents of readmission or HAC, the penalties apply to all of an HCP’s Medicare reimbursement based upon what amounts to a fraction of their total workload. In essence, their reimbursement for procedures that they performed correctly can be lowered based upon the adverse results of only a few.

With so much at stake, it is unsurprising that HCP’s have chosen to first focus their attention on those areas in which they have a relatively higher degree of control- HAC’s and Readmissions. According to the US Department of Health and Human Services (HHS), “Healthcare Acquired Infections are likely the most common type of complication for patients who are hospitalized.”

This is likely due to the fact that 1 in 25 hospital patients will acquire an infection during their stay. For 2011 alone, this translated to approximately 722,000 infections and 75,000 deaths. The excess costs to the system have a range of estimates typically between $25B-$45B annually.

The HCP response to this staggering problem has been to employ a “multi-modal” strategy utilizing a combination of handwashing, isolation precautions, environmental services, patient/staff education, antimicrobial stewardship, and outcome/process measurement. While many of these topics are the subjects of continual focus, there has been a resurgence of thought related to the role of the environment in HAI.

Role of the Environment in HAI Risk and Prevention
The subject of infection prevention can be illustrated using a simple model known as The Epidemiologic Triangle which has three key elements: the host, the environment, and the pathogen as shown in Figure 2.

The mission of an infection preventionist is to disrupt the connection between the environment, the host, and/or the pathogen thereby stopping the continuation of disease. For clarity, the environment is defined to be the surroundings and conditions external to the host which facilitate survival, growth, and ultimately transmission of the pathogen. Studies such as those referenced in Figure 3 have shown that the disease condition of the room’s prior occupant play a significant role in the HAI risk of subsequent occupants.

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This is an important conclusion as it was long thought that the primary source of patient infection was their own endogenous flora or the contaminated hands of healthcare workers.

Further examination of this subject reveals that several pathogens have been found to survive for days, weeks, or even months on a variety of surfaces such as bed linens, privacy curtains, door knobs, light switches, tables, remotes, and even light fixtures—particularly those mounted on walls near the head of the patient. Each of these contaminated surfaces can act as a reservoir of pathogens for later transmission to an unsuspecting host. Figure 4 summarizes the environmental lifetime of several pathogens associated with HAIs. This ability to survive for several weeks or months outside of a host is why many surfaces used in a healthcare setting have antimicrobial coatings designed to kill pathogens and/or inhibit their growth.

<table>
<thead>
<tr>
<th>Organism</th>
<th>Survival Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>C. Diff</td>
<td>5 months</td>
</tr>
<tr>
<td>Acinetobacter sp.</td>
<td>3 days to 5 months</td>
</tr>
<tr>
<td>Enterococcus spp. Including VRE</td>
<td>5 days to 4 months</td>
</tr>
<tr>
<td>Pseudomonas aeruginosa</td>
<td>6 months to 16 months</td>
</tr>
<tr>
<td>Klebsiella sp.</td>
<td>2 hours to 30 months</td>
</tr>
<tr>
<td>Staphylococcus aureus, incl. MRSA</td>
<td>7 days to 7 months</td>
</tr>
<tr>
<td>Norovirus</td>
<td>8 hours to 2 weeks</td>
</tr>
<tr>
<td>SARS Coronavirus</td>
<td>72 hours to 28 days</td>
</tr>
<tr>
<td>Influenza</td>
<td>Hours to several days</td>
</tr>
</tbody>
</table>

Figure 4. Survival time for prominent HAI pathogens. Adapted from Kramer et. al. BMC Infect Dis 2006;6:130

It is also important to note that pathogens can be mobilized by air flow and transmitted from one surface to another (or from one room to another) through the air. Objects that are in locations that are difficult to reach (such as ceiling-mounted light fixtures), can serve as pathogen reservoirs. This understanding can be easily expanded to include surfaces which are reachable but not typically touched such as the wall-mounted light fixtures shown in Figure 5.

Surface disinfection and hygiene in this environment thus become critical elements in reducing the spread of pathogens. In fact, the Centers for Medicare/ Medicaid (CMS) has specific requirements related to infection control as a condition of participation in the program:

“The facility must establish and maintain and Infection Control Program designed to provide a safe, sanitary, and comfortable environment and to help prevent the development and transmission of disease and infection” - CMS Manual System July 20, 2009, Section 483.65

The ability to properly achieve this goal is primarily a function of the surface being cleaned, the disinfection product being used, and the person performing the cleaning. To be sure, there are additional factors such as the proper choice of the cleaning solution, its concentration, necessary contact time, method of application, personnel training, surface porosity, surface design, etc. making this a diverse topic indeed. In these situations, it is difficult for an infection preventionist or any HCP to be sufficiently educated in each of these areas so as to be able to independently determine the proper method of cleaning and/or application. One common way to overcome this challenge is to turn to independent, 3rd party standards or listings for validation of manufacturer and design features. Lighting fixtures which have these types of listings and certifications are typically referred to as Specification-Grade and are quite different from the more common lighting fixtures found in office environments and in the home. More detail on this type light fixture and its role in HAI prevention is provided in the next section.

Specification-Grade Lighting: An Unexpected Ally in the Drive to Zero

“If given a choice between improving infection control by changing human behavior or designing a technologically foolproof device to control infections, go for the device.” – Robert Weinstein, MD, Emerging Infectious Diseases Vol. 7, No. 2, March-April 2001, pg. 189.
Lighting fixtures are placed throughout the hospital to allow healthcare workers to deliver care while providing patients with comfort and security. The lighting needs for some of these locations are mundane and can be satisfied by commodity type products. In many locations, however, there are specific requirements for light levels (e.g. surgical suites, exam lights), ferrous content (e.g. imaging suites), and infection prevention (e.g. surgical suites, isolation rooms, and certainly, patient rooms). For these applications, the performance of the light fixture must be defined using best practices and standards by an individual known as a lighting specifier. Light fixtures selected for these purposes are typically referred to as specification-grade.

Specification-grade light fixtures can have four features of potential interest to the infection preventionist:

- **IP65**: IP65 refers to a standard for ingress protection and indicates the fixture is sealed using gaskets, door designs, and welds to prevent the flow of particles (such as pathogens) into it. IP65 is the standard currently used in most surgical suites and isolation rooms.

- **NSF**: An NSF Listing denotes that the fixture has been evaluated for corrosion resistance, cleanability and the ability of exposed material to withstand normal wear. This supports the infection control standards established by healthcare facilities as indication that the luminaire is easy to sanitize.

- **K230**: K230 refers to a standard which ensures that a fixture can restrict the flow of particles (such as pathogens) into or out of a pressurized environment such as a surgical suite or an isolation room.

- **Antimicrobial coating**: Antimicrobial coatings can reduce the growth of pathogens on fixtures coated with it.

These features collectively benefit the infection preventionist by:

1) restricting the flow of pathogens into/out of the room (Figure 6),

2) ensuring that they can be easily cleaned without damage; and,

3) reducing the ability of pathogens to multiply in the event that they are not cleaned.

It is important for HCP’s and lighting specialists to understand that with the Affordable Care Act’s move to Value Based Purchasing, hospitals will be rewarded for following best clinical practices (to achieve better outcomes). As discussed in the previous section, lighting fixtures are part of the environment and can serve as pathogen reservoirs. Therefore, any discussion of best practices will need to be expanded to include lighting. Unfortunately, light fixtures are not thought of as high-touch surfaces and therefore not prioritized for cleaning. The CDC indicates that surfaces or equipment in close proximity to the patient should be cleaned and disinfected. This would apply to any light fixture mounted on the wall over the patient’s head paying particular attention to horizontal surfaces as these can easily accumulate pathogens. When possible, fixtures using LED technology (as opposed to fluorescent tubes) should be selected as this will reduce their horizontal thickness.

**Figure 6: Showing how a sealed light fixture (or luminaire) restricts the flow of pathogens into/out of a room thereby improving infection prevention efforts.**
Finally, the use of fixtures which can be touched by the patient and/or staff should be avoided or, failing that, noted in the room cleaning protocols as they will likely become a contaminated touch point.

Carefully Chosen Locations for Maximum Benefit
The decision to use specification-grade lighting in order to reduce the spread of infection should be based on three factors: the susceptibility of the patient in the room to acquire an infection, the need to restrict the flow of pathogens into/out of the room, and the need to reduce the fixture as a source of pathogens. In addition to expected locations, such as the OR, ICU, PACU, and isolation rooms, there are several other locations which should be considered. For example, in the oncology department, people have their immune system compromised thereby increasing their susceptibility to acquiring an infection. A very different example is the Emergency Room which handles approximately 75% of all admissions with people from all departments coming into and out of the area to treat patients. The potential for cross-contamination to other areas of the hospital is therefore quite high. Also, the waiting room and/or lobby for these areas have light fixtures on the wall which can act as pathogen reservoirs. People can touch them leaving behind their own set of pathogens and picking up whatever was previously left behind. Finally, consider dialysis clinics and burn wards. Both have a relatively high risk of infection due to breakage of the skin barrier. Again, one would want as many specification grade fixtures in this area to reduce the risk of infection.

Bringing It All Together
The key learning objectives of this paper can be summarized in the following points:
1) Public healthcare policy has created a focus on reducing healthcare acquired infections
2) The environment has been identified as a critical element in the transmission of HAIs and light fixtures are an often overlooked part of that environment in close proximity to the patient
3) Specification-grade light fixtures designed for infection prevention have multiple features which can help to reduce the transmission of HAI
4) The decision to use specification-grade lighting in order to reduce the spread of infection should be based on three factors: the susceptibility of the patient in the room to acquire an infection, the need to restrict the flow of pathogens into/out of the room, and the need to reduce the fixture as a source of pathogens.

About Kenall Manufacturing
Founded in 1963 by Ken Hawkins, Kenall Manufacturing carved a niche within the lighting industry by creating the first impact and vandal-resistant lighting products. Kenall produces and supports high quality and durable lighting solutions for the most challenging environments; providing sealed enclosures for food processing, containment, and specialized healthcare applications and high-abuse/rough service lighting for transportation applications and security lighting for detention facilities. Kenall products are designed and manufactured in the USA and meet the guidelines established under the Buy American Act and the North American Free Trade Agreement.

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Citations
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