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HOW TO AVOID COMMON VISUAL ISSUES IN AN OPERATING ROOM

USE NARROW SPECTRUM GREEN LIGHTING TO IMPROVE VISUAL CLARITY AND COMFORT

AS PRESENTED AT IES 2022

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Title: Creating an Optimal Visual Environment in an Operating Room

Subtitle: Use narrow spectrum green lighting to improve visual clarity and comfort

Learning Objectives:

1. **Explain the ways that white general lighting interfere with a surgeon's view of the patient and the ability of the surgical staff to perform their tasks.**
2. **Describe how the use of green general lighting can increase the level of light in an operating room, while enhancing the clarity of the image on the screen and eliminating afterimage and adaptation delays, which improves the vision of the surgeon and surgical staff during a procedure.**
3. **Compare the performance of fixtures that create green light by covering white LEDs with a green lens and fixtures that feature narrow spectrum LEDs that emit green light.**
4. **Apply best practices from industry experts to incorporate green lighting into an operating room.**

Sight is a critical component of surgery and, as such, lighting and the visual environment in an operating room (OR) impacts the level of medical care the staff is able to provide, patient outcomes, and operational efficiency. Unfortunately, the traditional lighting fixtures installed in these spaces are ill-equipped to accommodate the latest techniques and methodologies which rely on surgeons getting clear and crisp images on a screen, while allowing supporting surgical staff enough light to read, write, and walk safely around the space. Instead it has become common practice in many ORs to turn off overhead lights to provide the surgeon with the best view available and force everyone else to function in the dark or improvise their own sources of illumination. It is a less than optimal solution in a truly life-and-death application.

Luckily, this no longer needs to be the case. With advancements in LED technology, designers now have general lighting solutions that can provide surgeons the clear and unobstructed images they need during certain procedures, while offering surgical staff enough light to perform their jobs. This is a revolutionary idea. Operating rooms can now be equipped to offer an optimal visual environment for every procedure, which not only better accommodates the visual tasks performed in the space but allows for them to be performed with better clarity and comfort. All it requires is a little green light.

Different Procedures Require Different Visual Tasks

The optimal visual environment for an OR is determined, in large part, by the type of procedure being performed. Two types of surgery commonly performed in ORs today are open surgery and minimally invasive surgery. Each type of procedure requires that different types of visual tasks be performed in the space, which informs the levels of light that are needed and the precise locations where the light must be provided.

Open Surgery

Open surgery refers to a procedure where the skin and tissues are cut so that the surgeon has a full and plain view of the organs and internal structures involved. Examples of open surgery include Cesarean delivery (C-section), appendectomy, and open-heart surgery.

Open surgery requires a significant amount of light. According to the ANSI/IES RP-29-16 Lighting for Hospitals and Healthcare Facilities (RP-26), "Depending upon the medical procedures and equipment involved, illuminance criteria at the site of the surgery may need to be well in excess of 25,000 lx for direct view methods and is typically provided by surgical-style articulated luminaires."

RP-26 further explains, "The operating room lighting is typically provided by a combination of general-purpose lighting from fixtures mounted in the ceiling, and movable task lights, usually referred to as surgical lights, which provide a bright focused beam of light that is intended to illuminate just the immediate area of the surgical incision." The general-purpose lighting provides illumination levels that allow supporting surgical staff, such as anesthesiologists and nurses, to handle equipment, take notes, and walk around safely.

Minimally Invasive Surgery

A minimally invasive surgery, on the other hand, uses new techniques and technology that necessitate smaller incisions in the body than open surgery and require a dramatically different visual environment. During most of a minimally invasive procedure, the surgeon is not looking directly at the patient, but is, instead, looking into an eyepiece or viewing the procedure on a video monitor as it is being performed. The successful execution of these procedures requires a low glare, high contrast visual environment, so the surgeon has a clear and unobstructed view of the image on the monitor. This is created with lower levels of general light; however, the support staff still require a certain amount of light to perform their jobs.

Achieving a successful balance of these very different visual objectives is difficult with traditional lighting solutions, which explains why many teams turn off the overhead lights entirely when performing minimally invasive surgeries. This provides the low glare, high contrast solution demanded by the surgeon, but leaves the rest of the staff in the dark. Nurses and anesthesiologists in these situations often bring flashlights or walk to nearby table lamps, navigating the obstacles in the OR in the dark, when they need light to see.

As it relates to the recommended lighting practices for minimally invasive procedures, RP-29-16 is fairly vague. It states, "The prevalence of minimally invasive surgical procedures means that surgical task lights are turned off during large portions of the procedure. When the surgical lights are off there should still be enough general ambient illumination to allow the OR staff to walk safety throughout the room among the maze of medical equipment that typically surrounds the operating table." The guideline also states, "For video-view methods, dimmed architectural general lighting or background wall lighting is used. Consult vendors of the medical equipment involved or medical equipment consultants; survey state-of-the-art OR facilities."

A Note About Screens

Regardless of whether the procedure is an open surgery or minimally invasive, screens are being increasingly incorporated into the OR. They can display the ongoing procedure itself, important information about the patient's vital statistics or diagnostic images that the surgeon may wish to reference during the procedure.

As it relates to creating an optimal visual environment in an OR, this is an incredibly important trend, because bright lights and screens go together like oil and water. They do not. The inclusion of these

devices creates many important issues that can impact the quality of medical care that patients receive. The need to better accommodate the proliferation of screens in this area is one of the key drivers behind the search for better lighting solutions. Let's begin by taking a closer look at the common issues crippling the visual environments in ORs today.

Common Issues with General Lighting in an OR

Surgeons need visual clarity and visual comfort in the operating room, as do the members of their supporting surgical team. The general lighting in the space plays a pivotal role in achieving these objectives, especially during a minimally invasive procedure, but the traditional white overhead lights, even with the latest LEDs, are limited in their ability to provide enough ambient light for the team, without compromising the quality of the image on the screen. Here are some of the common issues created by the mismatch of using traditional white general lighting in an OR.

Reflected Glare

Reflected glare occurs when the bright surface of a light source is reflected off of another surface. Think of a time when reflections of overhead lights or nearby lamps were visible in a computer screen or tablet. It is often annoying and distracting, but it can be disastrous in an operating room, as the hot spot caused by the reflection of overhead lights can obstruct the surgeon's ability to see the details of the ongoing surgery.

The issue of reflected glare is even mentioned in RP-26. "The general lighting design should also consider that OR staff will frequently be viewing video monitors and the user interface screens of a wide variety of medical equipment. It is critical that diffuse lighting be provided to minimize reflected glare from these screens."

Washed Out Monitors

Surgeons depend upon getting high-quality, clear images on their monitors, especially during minimally invasive procedures, where they are trying to avoid small nerves and small blood vessels. Unfortunately, even if there is no reflection of a light source on the screen, general white lighting can still negatively affect the image on the screen by washing it out and making it less crisp.

This washed out or dulling effect occurs because the monitor is reflecting the ambient white light in the room. The effect is similar to what happens when a person has difficulty seeing the screen on their smart phone or tablet outside on a bright, sunny day. Even if the orb of the sun is not creating a hot spot on the screen, the image on the screen can still be washed out by the level of the ambient white light.

Compromised Visual Acuity

The human eye is uniquely sensitive to both the intensity and color of light and is evolutionarily preprogrammed to function differently in different visual environments. For example, under bright light conditions, where the ambient lighting level of the room is greater than 100 lux, the visual system has a heightened ability to see contrast and distinguish colors and fine details. When the light level in a room falls to less than 0.1 lux, the sensitivity in the eye shifts from fine detail detection to light detection, making it more sensitive to the low level of light that is available, but less able to see details and colors. When light levels in a space fall between 0.1 lux and 100 lux, the eye elicits a combination response,

allowing objects in the line of sight to be viewed in a greater level of detail and color. Objects in the peripheral vision will be less clearly seen and colors will be more difficult to discern.

This means that there is a relationship between the available level of light in a space and the clarity with which the human eye can see. Too little overhead light, although minimizing reflected glare and washed out screens, may negatively impact the visual acuity of the surgeon. An optimal solution is to find a way to provide a higher level of general illumination, so that the eye can see images in greater detail, without creating hot spots or a washed-out effect.

Too Little Light for Support Staff

When the overhead white lights are turned off to provide the low glare, high contrast environment needed during a minimally invasive procedure, much of the support staff struggle to complete their assigned tasks and avoid tripping hazards. Nurses can have problems finding the necessary pieces of equipment, which is especially problematic as the equipment they work with either contains or is a needle. Circulating nurses may have trouble delivering supplies and navigating a dark room. Anesthesiologists have greater difficulty seeing their patients, making notes, and reading labels. In many ORs it has become a common practice for anesthesiologists and nurses to bring flashlights in order to get the level of light they need, without compromising the surgeon's view on the screen.

Light Adaptation Delay and Eye Fatigue

Another issue can occur when a surgeon is working in a brightly lit operating room, but continually looking at an area of the room that is more dimly lit, perhaps an area with a video display. The toggle between high levels of light and low levels of light can cause light adaption delay, because they eye uses different photoreceptors to see in bright and dim situations. The delay refers to the time that it takes for the eye to shift from one photoreceptor to the other, depending upon the conditions of the view. For example, dark adaptation describes going from a well-lit area to a dark area. Initially, blackness is seen, because the photoreceptors (the cones) used to see in bright conditions do not function in low levels of light. Light adaptation also occurs when a person moves from a dark environment into bright light. The switch momentarily dazzles the eye and only white light is seen, until the necessary adaptation can occur.

During the adaptation process, there are reflexive changes that occur in the size of the pupil. The dilation and constriction of the pupil is controlled by the muscles in the eye. When a surgeon constantly shifts between bright and dim conditions during a surgery, this continuous state of adaptation causes the pupils to constrict and dilate constantly in response, and the work of the eye muscles can cause eye fatigue and headaches.

Per RP-26, "The lighting design should reduce the occurrence of eye fatigue and light adaptation delay for the surgical staff when switching focus from the brightly lit operating room table to the video display monitors or other surfaces within the OR."

The occurrence of light adaptation delay can be reduced in an environment by avoiding extreme visual conditions within a single space. Instead of putting the surgeon in a situation to shift focus between the brightly lit table and much dimmer areas around the perimeter, provide higher levels of illumination around the perimeter to reduce the disparity and make it easier for the eyes to adapt to the change.

Afterimage

There is another natural response that can disrupt a surgeon's field of vision during surgery. It is called an afterimage. The photoreceptors in the retina respond to either blue, green or red. An afterimage occurs when the photoreceptors in the retina become fatigued from staring at one color for an extended period of time. When a person looks away from that color, an image appears as a mix of the two more rested color receptors. For example, when a surgeon is performing open surgery, the organs and internal structures they see are red. When they look away from the surgical site, the surgeon will see an afterimage appear in cyan (mix of blue and green). Experience the effects of afterimage firsthand at www.animations.physics.unsw.edu.au/jw/light/complementary-colours.htm#1.

RP-26 describes the afterimage effect in this way. "When the eyes focus on a particular color and then look away, an afterimage in the complementary color (on the opposite side of the color wheel) is created. In this case, when a surgeon focuses on a surgical site, he or she is focusing on a predominantly red color. When the surgeon looks up from the surgical site, a blue-green afterimage is seen. If the new field of view is the same color hue, the afterimage effect is mitigated. It is believed this may contribute to the prevalent use of green and blue surgical scrubs. The use of green light in the OR has been suggested to reduce this afterimage effect, but the practice should be discussed with the facility's medical professionals prior to use."

It may be surprising that there are so many issues in the visual environment of an OR. It may be more surprising to learn that they are difficult to remedy with overhead fixtures that produce white light. The white light emitted from the fixtures reduces the contrast, a.k.a. washes out the video monitors and can produce hot spots (reflected glare) on the screen, so the surgeons are forced to dramatically reduce the light levels, and in many cases turn them off. While this approach effectively eliminates the interference with the image on the screen, it leaves their co-workers fumbling around in the dark. In brightly lit operating rooms, surgeons looking up from the surgical site into a room illuminated with white light will see a blue-green afterimage. When they shift their gaze between the brightly-lit operating table and the dimly-lit perimeter and back again, they will experience adaptation delays. There has to be a better approach that can solve the many issues in the visual environment surgeons and surgical staff currently struggle with.

OR Solution: Green General-Purpose Lighting

Fortunately, continued advancements in LED lighting have produced a solution that can deliver an optimal visual environment for the various procedures performed in an OR. There is a type of general lighting that can increase the general level of illumination in an OR, so that support staff can see during the procedure, while reducing reflection and glare on the monitors and enhancing the depth and contrast of the image on the screen. This new lighting can also minimize the effect of afterimages during open surgeries. The solution is to specify green general-purpose lighting for the OR.

Minimize reflected glare

Green lighting reduces the occurrence of reflected glare on the monitors. Even if the monitor is positioned in such a way that the surface of the overhead fixtures can be detected on the screen, the green light does not create a blinding hot spot that obstructs the surgeon's view of the procedure.

Improve contrast on the monitor

Another way that green general lighting improves a surgeon's view of an image on a monitor is by offering better contrast. The presence of ambient green lighting in a space, and reflecting off of a monitor, improves the depth and contrast of the image on the screen instead of washing it out like general white lighting does. Being able to better see the image on the monitor enables surgeons to see small nerves and blood vessels more easily, which enables them to avoid hitting these elements and making mistakes.

Increase perimeter lighting levels

The use of green lighting in an OR allows general lights to be on, providing support staff with the light they need to perform their jobs and safely move through the space, without compromising the surgeon's view of the procedure. **WHAT CAN WE SAY ABOUT THE LEVEL OF LIGHT THAT CAN BE PROVIDED WITHOUT PRODUCING REFLECTED GLARE OR NEGATIVELY IMPACTING THE QUALITY OF THE IMAGE ON THE MONITOR?**

Improve visual acuity and comfort of the surgeon

Incorporating green general lighting into an OR can help to improve the visual acuity and comfort of the surgeon during a procedure by providing the surgeon with higher levels of light, which allows the human eye to see in greater level of detail and reduces the disparity between bright and dimly lit areas that can cause eyestrain. The higher levels of ambient light have also been noted to reduce the fatigue that many surgeons feel while performing long procedures in dimly lit or dark operating rooms.

Reduce afterimage

Green general lighting combats the experience of afterimage during an open procedure. When a surgeon looks up from the surgical site, the room has a green hue, which immediately engages the rested blue and green photoreceptors that would usually be responsible for creating the afterimage in a white light environment. The green ambient lighting allows the red photoreceptors to rest until the surgeon looks back down to the surgical site.

The Success of Green Lighting in Massachusetts General Hospital (MGH)

In 2011, at the annual meeting of the American Society of Anesthesiologists, research was presented which concluded that bathing an OR in dim green light allowed surgeons to have a clear view of the monitors and allowed support staff to have enough light to do their jobs. These findings were also published in the February 2012 issue of *Anesthesiology News.*

The study profiled a pilot project at Massachusetts General Hospital (MGH) in Boston, where Dr. Julian Goldman, MD, was the principal anesthesiologist. Surgeons at MGH were struggling. The fluorescent fixtures in the operating rooms were often too bright, creating glare on the screens during minimally invasive procedures and washing out the image of the procedure. In an effort to avoid the potentially catastrophic effect of washout, surgeons were turning overhead lights completely off, which improved their image quality, but was not ideal for the other members of the team.

Aware of previous experiments using green light, Dr. Goldman decided to incorporate green light at MGH to combat these common and problematic issues in the visual environment. The pilot project was a success. In an article in *General Surgery News* titled "Seeing the (Green) Light In the Operating Room by John Dillon, Dr. Goldman explained, "The interna surgical site is unaffected because it is still

illuminated under white light. No glare or screen washout was seen. Anesthesiologists were able to read labels and plunger lines without walking over to a reading light and potentially tripping en route. They could also better assess the patient to see whether his or her head or limbs moved." After the success of the trial, MGH expanded its use of green lights into 28 ORs. "Once you go green, it's hard to go back," stated Dr. Goldman.

Options for Incorporating Green General Lighting into the OR

In 2011, when the team at MGH first incorporated green general lighting into the OR, they did so by slipping green sleeves over a few of the white fluorescent tubes installed in the room. An engineer at MGH created a new circuit in the lighting system that allowed the team to turn on just the green lights to create a green-lit visual environment. Today, there are two types of LED lighting fixtures that can be used to produce green light more efficiently and in a longer lasting solution than the fluorescent models first tested.

White LEDs with a Green Lens

Some manufacturers create green light for an operating room by taking LEDs that emit white light, the entire visible spectrum of light (380 to 700 nanometers (nm)) and put a green lens over the fixture. The green lens filters out the wavelengths in the white light and only allows the green light out of the fixture and into the operating room.

Narrow Spectrum Green LEDs

LEDs can now be manufactured to emit very specific wavelengths of light. Some manufacturers design their green lighting fixtures to feature LEDs that have been engineered to emit a very narrow spectrum of light. For example, there is an LED on the market that only emits green light in the wavelength of 540 nm. A green lighting fixture with narrow spectrum LEDs then uses a clear or frosted lens to diffuse the green light it emits.

Compare/Contrast Performance of Green LED Lighting Fixtures

There can be a dramatic difference in the way that green light fixtures with a white light LED and a green lens and green light fixtures that feature narrow spectrum LEDs and a frosted lens perform, the quality of light they provide, and the level of flexibility they offer.

Green Hue Saturation

The benefits that green lighting fixtures are able to provide to the operating room—offering higher levels of illumination, without compromising or washing out the image on the screen during a minimally invasive procedure—is very specific to the green light they emit. White light is so incapable of achieving these simultaneous objectives that many ORs shut off white lights completely during these procedures. This helps to explain why a more saturated green hue is preferable to one that is watered down mixture of green light and white light.

The term saturation describes the intensity or purity of the color. As saturation increases, the color appears purer. As saturation decreases, the color appears paler or washed out. Green lighting fixtures that emit light from a narrow spectrum LED and frosted lens provide cleaner light in a more saturated green hue than the lights that emit a white light and rely on a green lens to filter light appropriately.

White light leaks are another issue that can affect the green light emitted by the fixtures with white LEDs and green lenses. If the green lens isn't fit correctly, or it degrades over time (most filters begin degrading as soon as the fixture is energized due to the plastic make-up of the lens and the heat from the fixture), or there is another circumstance where the lens is compromised, white light will escape the fixture and trespass into the visual environment of the OR. This mix of white light and green light will make the ambient light appear a duller green and it can impact the contrast the light provides with the image on the screen.

It is worth noting that white light leaks do not occur when the fixture only produces green light with a narrow spectrum LED.

Emits Green and White Light

In some cases, it is preferable to have general lighting in an OR that is capable of emitting green light or white light. In these dual function fixtures, the green lighting is used during minimally invasive procedures and some open procedures, and the white lighting is used during some open surgeries and during cleaning and maintenance. There are green fixtures with narrow spectrum LEDs and frosted lenses that also contain white LEDs that can be used to fill a space with diffuse white light. The green fixtures that use white LEDs and a green lens are only capable of providing green light wherever they are installed.

Dual-function fixtures are available that can deliver as many as 5,000 lumens of narrow spectrum green light (540 nm) onto the target surface, but these fixtures can be dimmed down to 1 percent, or 50 lumens. These fixtures can also deliver over 22,000 lumens of high-quality white light with a 90+ CRI value and a color temperature of 4000K. The white light can also be dimmed to 1 percent.

This functionality and type of available light aligns well with the recommendations from the IES for surgical suites. RP-26 includes the following recommendations for selecting the right lighting fixtures for these important and sophisticated spaces:

- Since surgical task lighting is so bright, this (reducing eye fatigue and light adaptation delay) can be accomplished by providing higher levels of illumination throughout the room than might otherwise be required.
- Both the general lighting and the task lighting should provide excellent color rendering and it is preferable for them to closely match in chromaticity. Practically, this means that the color rendering index (CRI) and the correlated color temperature (CCT) of the general room lighting should be chosen to match that of the surgical task lights as closely as possible.
    - Surgical task lights typically have color temperatures in the range of 4000K to 4500K and these values are generally preferred. A similar color temperature range is also preferred for ambient lighting.
    - The general color rendering index (CRI or R_9) shall be above 85, as required by the IEC 60601-2-41.
- Ideally the general room lighting is designed to control the luminance of the walls such that the walls can be well lit during open procedures and dimly lit during minimally invasive procedures.

Efficiency

fficiency is an interesting discussion point when designing a lighting system for an operating room, because it is often less critical in this type of application. Even RP-29 says, “While minimizing energy consumption and fixtures costs are always important lighting design goals, the operating room is one place where lighting quality outweighs other considerations.”

In dual-function narrow spectrum green LED lighting fixtures, the white mode can deliver impressive energy performance with some fixtures offering 105 lumens per watt. The green LEDs are not as efficient, and the efficacy is closer to 70 lumens per watt.

Controllability

Controllability is an important aspect of all of the lighting in an OR. RP-29 recommends that, “Both the general room lighting and the surgical task lighting should provide widely adjustable levels of illumination to accommodate the various visual needs of different procedures and personnel. The multi-functional nature of ORs, individual illumination needs, preferences of the surgeon, and changes in lighting requirements during a surgical procedure necessitate the ability to easily adjust the lighting levels. The best way to accomplish this is through dimming.”

There are dual-function narrow spectrum green LED lights that are dimmable down to 1 percent, offering designers with a solution that easily satisfies the IES recommendation for general lighting and equips an OR space with the flexibility to best match the lighting level in the space with the needs of the surgeon, staff, and patient.

Asymmetric Optic Distribution

Another distinguishing feature of a general operating room light is an asymmetric lens which creates an asymmetric distribution of light from the fixture. According to RP-29, this asymmetric lens is particularly useful in an OR setting, “Because the ceiling directly above the surgical table is often not available for locating light troffers, the asymmetric lensing helps direct the light to the surgical table.”

Antimicrobial finish

Infection and the spread of disease are common, dangerous and well documented aspects of the healthcare environment. According to the Centers for Disease Control and Prevention (CDC), approximately one in 25 patients contract a healthcare-associated infection (HAI) on any given day in the United States. HAIs are infections people get while receiving health care for another condition. It is estimated that these infections lead to the loss of tens of thousands of lives and cost the U.S. health care system billions of dollars each year.

Designers working on healthcare projects today have more tools than ever to equip the interior space to combat the growth and spread of virulent pathogens on environmental surfaces. In the article, “2019 Top Healthcare Interior Design Trends Modern Facilities Should Embrace,” the team at HMC Architects wrote, “Today, hospital designers focus not only on creating beautiful spaces, but also on using materials in those areas that protect against the spread of infection. Healthcare facility designers often use antimicrobial coatings on finishes of hard surfaces and lighting that fights the spread of disease.”

Antimicrobial coatings contain biologically active agents that interfere with the growth and reproduction of bacteria on a surface. There are narrow spectrum green LED fixtures that feature an antimicrobial-

impregnated powder coating on the exposed painted surfaces. This means that if bacteria lands on the door frame of the overhead light, it will not be able to grow and reproduce on the surface of the fixture.

One-piece sealed housing

Another important lighting fixture feature that supports infection control in the OR is a one-piece sealed housing. According to RP-29, "Ceiling-recessed light fixtures shall be sealed so that dust and gasses from the ceiling plenum cannot enter the room. Recessed fixtures are used to eliminate edges that collect dust and debris and to prevent conflicts with medical equipment attached to ceiling-mounted adjustable booms. Exposed surfaces, including lenses, should be smooth and capable of withstanding decontamination procedures."

RF Filtered circuit

Operating rooms often contain measuring equipment that is sensitive to electromagnetic fluctuations, such as an Electrocardiogram (EKG), which records the electrical signals in a patient's heart. To ensure that the line voltage coming into the space for the lighting circuits does not interfere with the measurements taken by this important equipment, RF-filtered circuits are used to filter and suppress any noise that may exist. Look for narrow spectrum green LED fixtures that are available with standard RF-filtered circuits.

Emergency

One important scenario that a designer must consider is how the operating room is equipped to function if there was a loss of power. Hospitals often have back-up generators that will come online, if the hospital loses power, but the generator doesn't turn on right away. There is a lag between when the power goes out and when the generator restores it. This lag must be avoided in an OR, so lighting systems are often designed with battery backup that will keep the lights on in the event of a power outage, until the generated power is available. There are narrow spectrum green LED fixtures that are available with battery packs designed specifically for this functionality.

It is not surprising that RP-29 also has a few recommendations on how lighting in a surgical suite should be equipped to handle a disruption in power. "Emergency power requirements for the lighting circuits include emergency critical branch power with battery backup to bridge the gap between the normal power loss and the generator start. The battery backup may be provided using integrated battery ballasts or drivers, or remote central battery units. Lighting controls shall not interfere with the automatic transfer to the battery backup system."

Best Practices for Designing an OR with Green Lighting

Narrow spectrum green lighting fixtures deliver a special blend of important benefits to an OR and, as a result, they are increasingly being incorporated into these spaces. For designers, and the lighting sales teams who support them, best practices are emerging that help to inform the selection of product and identify optimal layouts for these highly specialized areas. Scott Parkinson, Partner at ESL-Spectrum in Indianapolis, has been involved in a number of OR projects and shared some of the best practices he has seen often employed. "Hospitals in our territory require 2x4 lay-in troffers and we look for narrow spectrum green lighting fixtures that can deliver approximately 2,500 lumens per fixture to the target surface."

The sensitive environment of the OR also requires that the physical housing of the fixture possess certain features and functionalities. “Housings placed in an OR must have an antimicrobial finish and be constructed as a one-piece housing with a one-piece door frame. In addition, the light fixture must be IP65 rated, so finding a product with a closed microcellular Nitrile gasket with vulcanized corners is mandatory. We also look for fixtures that produce a 90+ CRI and can be mounted either independently or in a continuous row,” he explained.

Mr. Parkinson also shared a few design tips. “We will design an operating room so that the operating table receives between 250-300 foot candles using an asymmetric lens. Typically, we find that specifying twelve (12) 2x4 narrow spectrum green LED troffers in a square pattern will enable the operating room to provide an optimal visual environment for the various procedures taking place there.”

Closing

It is interesting to note that green general-purpose lighting creates a better visual environment for the surgeon and surgical staff during both minimally invasive and open surgery procedures. During a minimally invasive procedure, green lighting increases the level of illumination in the room, while improving the contrast of the image on the screen. This helps the support staff to perform their tasks safely and improves the view the surgeon has of the procedure as it is happening. During open surgery, green general-purpose lighting enables the lighting level at the perimeter of the room to be higher, reducing light adaptation delay and eye fatigue, without creating glare or washing out any screens that the surgeon may use for reference. In either case, the dramatic benefits of the narrow spectrum green LED fixtures are causing many specifiers working on operating room projects to incorporate a little more green light into their designs.

QUIZ

1. Which of the following types of lighting are typically found in an operating room?
    a. Floor lamps
    b. General-purpose lighting
    c. Surgical lights
    d. General-purpose lighting and surgical lights
2. Which of the following has become a common practice in operating rooms with white general-purpose lighting during minimally invasive procedures?
    a. The general-purpose lights are turned off to provide the surgeon with the best view of the screen possible and surgical support staff must function in the dark or improvise their own sources of illumination.
    b. General lights are dimmed to 50% and the surgeon does the best he/she can do with the washed-out image on the screen.
    c. The general lights are left at full on and the surgeon ignores the hot spots on the screen.
    d. The general lighting is left at full on and does not compromise the image on the screen at all.
3. What issue can occur when a surgeon is working in a brightly lit operating room, but continually looks at an area of the room that is more dimly lit?
    a. Afterimage
    b. Light adaptation delay
    c. Washed out monitors

   d. Reflected glare
4. What is the term for the natural response of an eye that can disrupt a surgeon's field of vision after staring at one color for an extended period of time and then looking away?
   a. Afterimage
   b. Shadow image
   c. Photoreceptor fatigue
   d. Light adaptation delay
5. How do green general-purpose lights improve the visual environment in an operating room during a procedure?
   a. Improves contrast on the monitor
   b. Increases perimeter light levels
   c. Reduces afterimage
   d. All of the above
6. What was the result of the pilot project at Massachusetts General Hospital where green general-purpose lighting was incorporated into an operating room?
   a. MGH removed all green lighting from the operating room.
   b. MGH kept the green lighting in the one operating room, but did not expand the program.
   c. MGH expanded its use of green lighting into 10 operating rooms.
   d. MGH expanded its use of green lighting into 28 operating rooms.
7. Which of the following correctly explains how a narrow-spectrum green LED fixture produces green light?
   a. LEDs that create white light are covered with a green lens.
   b. LEDs that emit a very specific wavelength of green light are covered with a frosted lens.
   c. LEDS that emit a very specific wavelength of green light are covered with a green lens.
   d. None of the above.
8. Which of the following describes the functionality of a dual-function fixture?
   a. It emits green light only that can be dimmed.
   b. It emits white light only that can be dimmed.
   c. It can emit both green light and white light.
   d. It can emit both green light and white light and both colors can be dimmed.
9. Which of the features listed below helps to direct the light from the troffer to the surgical table?
   a. Asymmetric optic distribution
   b. Antimicrobial finish
   c. One-piece sealed housing
   d. RF filtered circuit
10. Which of the following features does Scott Parkinson look for when selecting green general-purpose lighting for operating rooms?
   a. Narrow spectrum green LED lighting
   b. Antimicrobial finish
   c. One-piece housing
   d. All of the above