Implementation of an In-Patient Unit Circadian Entrainment Lighting System

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Learning Objectives

Understand the goals of why a circadian entrainment system would be used for a lighting system.

Understand the owners concerns around design, commissioning, operations, risk management, future proofing systems.

Understand the challenges facing designers when designing circadian entrainment systems.

Understand how to develop metrics for measuring the success of a circadian entrainment system.
The Project – Medical Behavioral Unit

Features of the MBU
- Arrival / Entry
- Family Lounge
- Patient Neighborhoods
- Activity Room
- Play Room
- Care Team Stations
- Meditation Rooms
- Staff Lounge

MBU Design PROGRAM

SPACE TYPES
- Building Support
- Caregiver
- Circulation—Indoor
- Circulation—Vertical, Public
- Family
- Patient Areas
- Staff
- Support
- Waiting
Safety Zones – Medical Behavioral Unit

PATIENT SAFETY AND SECURITY MATRIX

<table>
<thead>
<tr>
<th>Room Attribute</th>
<th>Self - Harm Risk</th>
<th>Self - Harm Risk</th>
<th>Self - Harm Risk</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harm to Others</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anti-Rape Code</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tamper-Resistant Electrical Outlets</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EFP Protection</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arc Fault Protection</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gypsum Board Intact</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Security Orientation</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glass Break Panel</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Monolithic Glazing</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impact Resistant Gypsum Board</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Integral Blinds</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Base Screened for Wall With Temper Resistant Glazing</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anti-Slip Door Hardware</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tamper-Resistant Light Fixtures</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tamper-Resistant Plumbing Fixtures/Furniture</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tamper-Resistant Receptacles and Fire Alarm Systems</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P/T, Clocks, and Card Readers Located in Proper Enclosures or Cubicles</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Risk Resistant Receptacle or Cubicle</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ignition-Resistant Diffusers</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Laminated Safety Glass</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Polycarbonate Safety Glass</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ignition-Resistant Cubicle Hardware</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

PATIENT SAFETY AND SECURITY NOTES

1. IMPACT RESISTANT GYPSUM BOARD ON FACE OF WALLS TOUCHING RED OR YELLOW ZONES. STANDARD GYPSUM BOARD ON FACE OF WALLS TOUCHING GREEN ZONES.

Safety and Security Level

- **High**
- **Medium**
- **Low**
Lighting Design

Medical Behavioral Unit
Patient control over color changing light in room
White Tunable LED Lighting
Daylight in Activity Spaces
Circadian Impact

Features

- Patient-Focused Circadian Solutions
- Staff-Focused Circadian Solutions
- Experiential Solutions to Support Patients and Staff

MBU Design LIGHTING CONCEPTS

Patient Focused Circadian Solutions
Goal: Circadian Rhythm Entrainment
Combination of Dimming with Color Shifting Fixtures
Example Schedule (Actual Schedule to Be Determined)
8 am - 12 pm - Cool CCT with High Illumination Levels
12 pm - 3 pm - Neutral CCT with Medium Illumination Levels
3 pm - 8 pm - Warm CCT with Medium Low Illumination Levels

Staff Focused Circadian Solutions
Goal: Circadian Rhythm Entrainment
Alerting Effect
Combination of Dimming with Color Shifting Fixtures
Example Schedule (Actual Schedule to Be Determined)
8 am - 12 pm - Cool CCT with High Illumination Levels
12 pm - 3 pm - Neutral CCT with Medium Illumination Levels
3 pm - 8 pm - Warm CCT with Medium Low Illumination Levels

Experiential Solutions to Support Patients and Staff
Goal: Experientially Support Occupant Schedules
Rise Schedule towards Patients
Serve as an Intermediate Space between the Patient and Staff
Combination of Dimming with Color Shifting Fixtures

Illumination levels and color controls should be time-clock based with a simple user override.

The shortened winter daylight hours will be expanded to be more aligned with the equinox daylight duration.

The schedule between the spring and fall equinoxes will default to actual sunrise and sunset.

02/14/2016
The Schedule – Medical Behavioral Unit

**2016**

**DESIGN**
- Design Completion
  - April 2016

**CONSTRUCTION**
- Construction Kick-off
  - May 2016
- Substantial Completion
  - November 2016

**2017**

**COMMISSIONING**
- MBU Opens
  - January 2017

Next Steps
The Team

- Design Oversight Committee
- Clinical Leadership
- Maintenance
- IS
- Family Partners
- OSMO (Safety and Medical Operations)

- Architect
- Engineer
- Lighting Designer
- Commissioning Agent
- Construction Manager
- Electrical Contractor
- Lighting Vendors / Representatives
• Personalizing the room with colored light was overwhelmingly well received
• Circadian Lighting System or Tunable White Lighting System simulating Daylight presented to family consultants
Research or Case Study

- Researcher collaboration important to inform the Sequence of Operations
- Difficult to identify Base Case
- Do not want to compromise project goals, medical needs or patient family control over environment
- Institutional Review Board approval is required
Circadian Design - Lighting

Lighting Fixture Selection
1 - Wide CT Range
2 - Multiple lumen packages
3 - Luminaires from the same manufacturer
4 - Does not rely on proprietary lighting controls
5 - Built for flexibility
Circadian Design - Controls

Control Approach

1 - Time Clock
   a. illumination levels and CT varies throughout the course of day

2 - Simple Overrides
   a. only ON/OFF and illumination levels
   b. CT is locked by the schedule

3 - Flexible controls package
   a. allow the system to be adjusted if needed
   b. be able to adapt to new research findings
How do we determine sequence of operations?

- Patient vs Staff
- Night Shift workers
- Varying Schedules
- Illumination levels
- Color temperature
- Direction from the experts
### Circadian Design – Sequence of Operations

<table>
<thead>
<tr>
<th>Setting</th>
<th>Starting CCT (K)</th>
<th>Ending CCT (K)</th>
<th>Starting III (fc)*</th>
<th>Ending III (fc)*</th>
<th>Starting CS</th>
<th>Ending CS</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sunrise 6 am to 7 am</td>
<td>2400</td>
<td>4000</td>
<td>0</td>
<td>20</td>
<td>&gt;&gt;0.1</td>
<td>~0.15</td>
<td></td>
</tr>
<tr>
<td>Morning 7 am to 12pm</td>
<td>4000</td>
<td>6000</td>
<td>20</td>
<td>50</td>
<td>0.15</td>
<td>0.3</td>
<td>Gradual increase of illumination and color temperature with peak illumination and color temperatures occurring at 10 am and holding until noon</td>
</tr>
<tr>
<td>Midday 12 pm to 4pm</td>
<td>6000</td>
<td>3500</td>
<td>50</td>
<td>30</td>
<td>0.3</td>
<td>0.15</td>
<td></td>
</tr>
<tr>
<td>Evening 4 pm to 8pm</td>
<td>3500</td>
<td>3000</td>
<td>30</td>
<td>20</td>
<td>0.15</td>
<td>0.1</td>
<td></td>
</tr>
<tr>
<td>Sunset 8 pm to 9pm</td>
<td>3000</td>
<td>2400</td>
<td>20</td>
<td>5</td>
<td>&gt;0.1</td>
<td>&gt;&gt;0.1</td>
<td></td>
</tr>
<tr>
<td>Night 9 pm to 6 am</td>
<td>2400</td>
<td>2400</td>
<td></td>
<td>&gt;&gt;0.1</td>
<td>&gt;&gt;0.1</td>
<td></td>
<td>Off in patient’s room. Minimal illumination in corridors</td>
</tr>
</tbody>
</table>

*illumination to be measured perpendicular to the eye

Changes in color and intensity should be gradual and nearly imperceptible, with the exception of sunrise and sunset, which have a greater change in color and intensity over a shorter time frame.
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