Tuning the Light in Senior Care

DOE SSL Healthcare Lighting Webinar Series
October 18, 2016

Connie Samla, PE, LC
Sacramento Municipal Utility District (SMUD)

Robert Davis, Ph.D., FIES

Andrea Wilkerson, Ph.D., LC
Pacific Northwest National Laboratory
GATEWAY
Demonstrations
Tunable LED Systems
0-24 and 65+ as a Percent of the Global and US Population

Energy Use Intensity

DOE Healthcare Webinar Series

The Nurses’ Perspective on Hospital Patient Room Lighting
Sept 13, 2016 Robert Davis & Andrea Wilkerson, PNNL
Pat Lydon, Legacy Health

Evidence-Based Design for Healthcare Lighting: Where’s the Evidence?
Oct 4, 2016 Robert Davis & Andrea Wilkerson, PNNL
Anjali Joseph, Clemson University

Tuning the Light in Senior Care
Oct 18, 2016 Robert Davis & Andrea Wilkerson, PNNL
Connie Samla, Sacramento Municipal Utility District
About SMUD

- Low rates
- Community focused
- Fee for service; SMUD is not tax based

Community owned, not-for-profit for over 65 years

Elected 7-member SMUD Board

- Serving 900 square miles
- Directors live in the ward they represent, ensuring local knowledge of issues

Working to benefit our community

Focused solely on customers’ needs

- No shareholders
- Priority is to keep costs low, provide reliable service, protect the environment, and help manage energy use

Strong community involvement
- Programs promoting economic development, renewable energy, and energy efficiency
Why focus on senior care?

• Enhance the quality of a life
  – Circadian disruption often occurs when a person is placed in a nursing home
  – The average daylight exposure of a nursing home resident ranges from 1 to 10 minutes per day
  – ACC Care Center staff is dedicated to improving the lives of their residents

• We are all getting older...
Why focus on senior care?

• Seniors have very specific lighting requirements:
  – Pupil is smaller and almost fixed in size
  – Less light enters the eye
  – Difficult to adjust to changes in brightness
Why focus on senior care?

- Lens thickens and becomes slight amber color
  - Difficult to focus
  - Absorbs light and cancels the blue range
  - Causes light to scatter within the eye
Why focus on senior care?

More light is needed as we age
Why focus on senior care?

but glare is less tolerated...
Why focus on senior care?

Eye diseases are also a factor

Images: National Eye Institute (NEI)
Why focus on senior care?

• Seniors have very specific lighting requirements and the existing lighting is often inadequate
• Lighting can have a big impact upon people…
• This sector is long overdue for a lighting makeover
Project description

Partner with the Department of Energy (DOE) Gateway Program, manufacturers and a local nursing facility ACC Care Center (nursing and rehabilitation center) to test:

- Tunable-white LED lighting systems (circadian)
- Indoor night lighting options (safety)
Project description

ACC Care Center

• Prominent nursing home in the Sacramento area
• 5-star rated facility
• Average age of resident is 87
• Wheelchair bound
• 2/3 of the current residents have been diagnosed with some form of dementia
Project description

Project Goals

• Investigate different lighting techniques and applications for upcoming remodel and addition

• Explore the potential benefits and challenges of circadian lighting:
  – Improve the lives of at least three residents
  – Enhance the nursing staff experience
Technologies used

Resident rooms: Fluorescent over-the-bed luminaire
Technologies used

Resident Rooms

– Tunable - white LED cove lighting above the beds and side walls
  • Cove lights hidden behind a plastic gutter
  • Commissioned controls per Lighting Research Center (LRC) protocol to change automatically (Light & Health Institute)

– LED over-the-bed light
Technologies used

Resident room schedules
7 am – 2 pm: 6000K
2 pm – 6 pm: 4100K
6 pm – 8 pm: 2700K
Nightlight option: 2400K
Technologies used

Resident Rooms

– Nightlights

• Amber LED rope lights on motion sensors under-the-bed
• Amber LED low-level lights on motion sensors in walls
Technologies used

Resident restrooms

- Glary globe on ceiling
- Glary fluorescent luminaire over vanity
Technologies used

Resident restrooms

- Removed the vanity overhead luminaire
- Replaced the existing mirror with an illuminated LED mirror
- Replaced glary globe with surface mounted LED luminaire with nature scene (leaves)
- Replaced existing handrails with new handrails with integrated amber LEDs controlled by motion sensors
Technologies used

Hallway: 4100K two lamp fluorescent luminaires
Technologies used

Hallway

– Replaced the fluorescent luminaires with tunable - white surface mounted LED luminaires
– Added automatic controls for both dimming and tunable – white lighting
Technologies used

Hallway schedules

7 am – 2 pm: 6500K @ 66% output
2 pm – 6 pm: 4000K @ 66% output
6 pm – 7 am: 2700K @ 20% output

Over 65% energy savings
Results
Visual & Non-visual effects of light

Visual Pathway
Retinal Ganglion Cells (RGCs) carry signals from the rods and cones to the visual cortex, which controls vision.

- Writing
- Reading
- Watching
- Communicating
- Learning
- Focusing
- Appreciating
- Enjoying
Resident room - Double

<table>
<thead>
<tr>
<th>LED</th>
<th>WALL</th>
<th>COVE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ambient</td>
<td>280 lx</td>
<td>70 lx</td>
</tr>
<tr>
<td>Bed center HOR</td>
<td>790 lx</td>
<td>110 lx</td>
</tr>
<tr>
<td>Bed reading VERT</td>
<td>1340 lx</td>
<td>55 lx</td>
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</table>
Resident room - Single

<table>
<thead>
<tr>
<th>LED</th>
<th>WALL</th>
<th>COVE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ambient 1</td>
<td>130 lx</td>
<td>25 lx</td>
</tr>
<tr>
<td>Ambient 2</td>
<td>320 lx</td>
<td>70 lx</td>
</tr>
<tr>
<td>Bed center HOR</td>
<td>560 lx</td>
<td>80 lx</td>
</tr>
<tr>
<td>Bed reading VERT</td>
<td>1400 lx</td>
<td>60 lx</td>
</tr>
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**FLUORESCENT**

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<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Ambient 1</td>
<td>35 lx</td>
</tr>
<tr>
<td>Ambient 2</td>
<td>90 lx</td>
</tr>
<tr>
<td>Bed center HOR</td>
<td>190 lx</td>
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<tr>
<td>Bed reading VERT</td>
<td>400 lx</td>
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<tr>
<td>AREA</td>
<td>FLUOR</td>
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<tr>
<td>--------------</td>
<td>-------</td>
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<tr>
<td>Bath average</td>
<td>140 lx</td>
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Visual & Non-visual effects of light

Visual Pathway
Retinal Ganglion Cells (RGCs) carry signals from the rods and cones to the visual cortex, which controls vision.

Non-Visual Pathway
ipRGCs are photoreceptors connected to the hypothalamus, which controls many biological effects:
- Suppressing melatonin (sleep hormone)
- Enhancing alertness
- Affecting cognition

Activities:
- Writing
- Reading
- Watching
- Communicating
- Learning
- Focusing
- Appreciating
- Enjoying

Types:
- Photic
- Non-photic
Photoreceptor responses

intrinsically photosensitive retinal ganglion cells (ipRGCs)
Peak melanopic response

Lucas et al, Trends in Neuroscience, 2014
2700K LED, 100% output

6500K LED, 100% output

Lucas et al, Trends in Neuroscience, 2014
Effective illuminance for human photopigments
## Equivalent Melanopic Illuminance (at 100 lx)

<table>
<thead>
<tr>
<th>Light Source</th>
<th>Melanopic Illuminance (m-lx)</th>
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</thead>
<tbody>
<tr>
<td>Fluorescent 4100K</td>
<td>61</td>
</tr>
<tr>
<td>LED 4500K</td>
<td>79</td>
</tr>
<tr>
<td>LED 6500K</td>
<td>98</td>
</tr>
<tr>
<td>LED 2700K</td>
<td>43</td>
</tr>
<tr>
<td>LED Amber</td>
<td>11</td>
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<td></td>
<td>FLUORESCENT</td>
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<tr>
<td>------------------</td>
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</tr>
<tr>
<td>Ave. HOR</td>
<td>330 lx</td>
</tr>
<tr>
<td>Ave. VERT Eye</td>
<td>120 lx</td>
</tr>
<tr>
<td>Ave. VERT Eye Melanopic</td>
<td>73 m-lx</td>
</tr>
<tr>
<td>Ave. VERT Melanopic</td>
<td>98 m-lx</td>
</tr>
</tbody>
</table>
At least five important factors affect our response:

1. Spectral content of the light source
2. Intensity level of the light source
3. Duration of exposure
4. Timing of the exposure
5. Age / health of individuals
Awesome outcomes!
Awesome outcomes!

Reduction in Falls

“The quarter before the lights were installed we had 5 falls on Cherry Lane. The quarter after installation the number reduced to 3 but, more importantly, there were no falls on Cherry Lane in the last three months.”

- ACC Administrator
Awesome outcomes!

• Residents are sleeping through the night
  – Sleeping in their beds
  – They LOVE the night lights
  – Reduction in psychotropic and sleep medications

• 41% reduction in behaviors
  – Yelling
  – Agitation
  – Crying

• 71% reduction in behaviors in one particular dementia resident
Awesome outcomes!

• Other residents hanging out in “Cherry Lane”

• Nurses embracing the new lighting for both the residents and the late night shift

• Attending Physician is highly involved
  – Currently prescribes daylighting
  – Taking this information to the medical community

• Family members and staff are being educated on circadian lighting
  – Many have asked when their loved one will receive the new lighting
Awesome outcomes!

“ACC will be incorporating many of the lighting solutions piloted in this project as best practices in terms of fall risk, sleep enhancement and non-pharmacological approaches for behaviors related to dementia.”

ACC Administrator
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