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### THE TWO MAJOR PROBLEMS

facing residents in senior health care facilities are poor sleep quality and falls. Lighting offers solutions to both problems, as we discovered in a recent study.

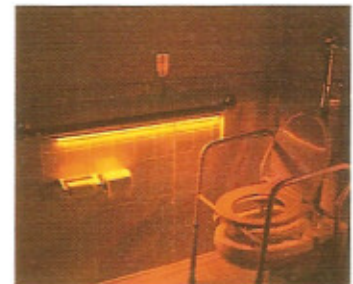
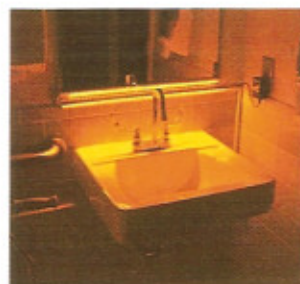
**Why are older adults more likely to show sleep disruption?** A regular, robust pattern of light and dark is needed to synchronize the circadian system to the solar day. Many older adults are more likely to experience problems sleeping because this pattern can be muted by their sedentary lifestyle of dim days and dim nights from electric lighting. Moreover, less light reaches their retina (IESNA, 1998, Figueiro, 2001), their master clock may become less sensitive to light (Swaab et al., 1985) and reductions in the amplitude and timing of melatonin and body temperature rhythms occur more frequently as we age (Skene and Swaab, 2003; Van Someren et al., 2002). As I discussed in "Research Matters" a few months ago, blue light exposure in the evening improved sleep efficiency of older adults, including those with Alzheimer's disease (Figueiro, 2005).

More commonly, perhaps, poor lighting design in the bedrooms of nursing homes directly disrupts residents' sleep (Figueiro and Rea, 2005). In the facility we studied, a single fluorescent lamp luminaire, operated by a switch at the bedroom door, was located above the heads of the sleeping resident. When the nursing staff came in to perform mandatory bed checks during the night, residents were usually awakened. Since these bed checks were made every two hours, it is no wonder sleep disruptions are so common in senior health care facilities!

**How can well-designed night-lighting help minimize sleep disruption at night?** To address this problem, the Lighting Research Center conducted a small study to explore the application of lighting controls and light emitting diodes (LEDs) to more effectively support nursing staff and help senior residents sleep throughout the night (Figueiro and Rea, 2005). In four bedrooms, we mounted strings of amber-colored LEDs to the underside of the bed frame,



Figures 1a and 1b: Motion-sensor controlled amber LEDs installed under bed (left) and around doorway (right). The LED array under the bed provided general, low-level ambient light in the bedroom at night; illuminance levels between 10 and 15 lux were measured on the floor next to the bed. The LED array framing the bathroom door contributed approximately two to 10 lux on the floor near the door and when standing at the door frame, 10.5 lux was measured at the plane of the cornea. Notes: 1) photosensors were disconnected for the photos; 2) overhead fluorescent luminaire was kept off after installation of night-lighting. Photo: Dennis Guyon



Figures 2a and 2b: Motion-sensor controlled amber LEDs installed at sink (left) and toilet (right) areas. The array of LEDs in the bathroom provided five to 10 lux at the center of the bathroom floor and about two to four lux at the cornea when standing at the sink. Based on survey results, it is recommended that slightly higher light levels be used in the bathroom. Photos: Dennis Guyon.

around the adjacent bathroom door frame, and under the mirror and handrail in the bathroom (Figure 1a and b, and Figure 2a and b). Amber lights were selected because they are more efficient and less expensive than

white LEDs, give enough light to see and are still relatively close in color to the very familiar incandescent light source.

Each system was controlled by a photosensor that ensured that the

| NURSING STAFF SURVEY   |      |     |            |
|--|------|-----|------------|
| Before Night-lighting Installation   | Yes  | No  | No opinion |
| Do you turn on the room lights for performing checks on the residents at night?    | 100% | 0%  | 0%         |
| When checking on the residents at night, are they likely to wake up?               | 94%  | 6%  | 0%         |
| Do the residents find the room lights uncomfortably bright at night?               | 82%  | 0%  | 18%        |
| After Night-lighting Installation  | Yes  | No  | No opinion |
| There is enough light for performing checks on residents during the night.         | 81%  | 19% | 0%         |
| The (colored) lighting is useful.  | 93%  | 0%  | 7%         |
| There is enough light in the bathroom without having to turn on overhead lighting. | 62%  | 38% | 0%         |
| It is convenient to have the lighting on a motion sensor.                          | 100% | 0%  | 0%         |

Figure 3a: Survey results

LED lighting did not come on during the day or when the overhead lights were on, and by a motion sensor that slowly turned the lights on when the residents put their feet on the floor and when nurses walked into the room. The new lighting minimized waking the residents while allowing the nursing staff to perform their mandatory bed checks (Figure 3a and 3b). If the residents were awoken by the nurse, however, they no longer had to experience discomfort from bright overhead lights (Taylor, 2005).

Before-and-after surveys for residents and nursing staff were developed to evaluate the new bedroom and bathroom lighting. Seventeen night staff members completed the survey about the pre-existing lighting conditions and 16 completed surveys about the LED lighting two weeks after installation. Four residents were interviewed prior to and two weeks after the night-lighting was installed. The results of the surveys shown in Figure 3a and 3b speak for themselves; overall, there was a dramatic

positive impact on users from the lighting design change.

**Why are older adults at risks for trips and falls?** Nursing staff and administrators noted that most falls occur when the residents are getting in and out of bed unattended. Because the light switches could not be reached from the bed, the residents often attempted to reach the bathroom in very dim conditions. After they reached the bathroom and turned on the bright overhead lights, they then had to get back to their beds without the benefit of dark adaptation! The motion-sensor controlled LEDs effectively solved this problem, but we went one step further to reduce the possibility of trips and falls at night.

**How can well-designed night-lighting help minimize trips and falls at night?** Illumination of a space provides a person with information about his/her location within the immediate environment (IESNA, 1998, Figueiro, 2001). Vertical and horizontal cues, linear perspective, and

motion flow are all major sources of information for spatial perception and, thus, for orientation, balance and locomotion (Gibson, 1966). An aging visual system is less able to extract these valuable cues from the environment, leading, presumably, to a greater propensity for disorientation and then falls.

One solution is to increase light levels to help older people better see their environment. At night, however, bright illumination is counterproductive to sleep quality. This important spatial information can be provided in another, much more effective way. We used LED arrays to frame the bathroom door. These arrays not only provided low, ambient illumination in the bedroom at night, they also provided perceptual information to the residents about the location of the bathroom as well as important vertical and horizontal cues needed for spatial orientation.

We believe that night-lighting specifically and thoughtfully used to provide spatial information about the

| RESIDENT SURVEY  |      |      |            |
|--|------|------|------------|
| Before Night-lighting Installation   | Yes  | No   | No opinion |
| Does the staff turning on the lights at night wake you up?                       | 83%  | 0%   | 17%        |
| Do you find the overhead lighting bright or glaring at night?                    | 91%  | 0%   | 9%         |
| Is it difficult to find or reach the lighting controls at night?                 | 83%  | 8%   | 9%         |
| After Night-lighting Installation  | Yes  | No   | No opinion |
| Does the colored light wake you up at night when the nurses come in?             | 0%   | 100% | 0%         |
| Is the colored light uncomfortable at night if you get up to go to the bathroom? | 0%   | 100% | 0%         |
| Do you like the colored light?   | 100% | 0%   | 0%         |

Figure 3b: Survey results

environment can reduce the number of residents' falls while getting out of bed. Moreover, as shown by the survey results, this approach promoted sleep quality without affecting the responsibilities of the nursing staff.

**Why should we care?** It's a shame that lighting systems that can reduce falls and improve sleep quality of our parents and grandparents are not being incorporated in senior care facility designs. And to a large extent the lighting industry is at fault. We do not produce the lighting products, we allow the lighting designs to be value-engineered, and, most importantly, we do not systematically build public awareness of how lighting can make an important contribution to this social problem. Large amounts of public funds are being spent on codes and standards to promote sustainability and energy-efficiency. If a fraction of this money were spent more thoughtfully on improving the lighting in senior care facilities around the country, we would not only be promoting sustainability and energy efficiency, but also providing better quality of sleep, and thus, better quality of life to this growing segment of the population.

If guilt is not enough to motivate this industry, remember that all of us, if we're lucky, become old and could find ourselves live in a senior care facility one day.

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