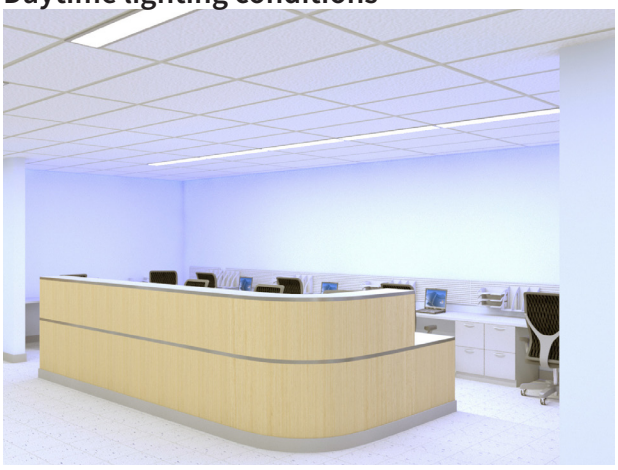
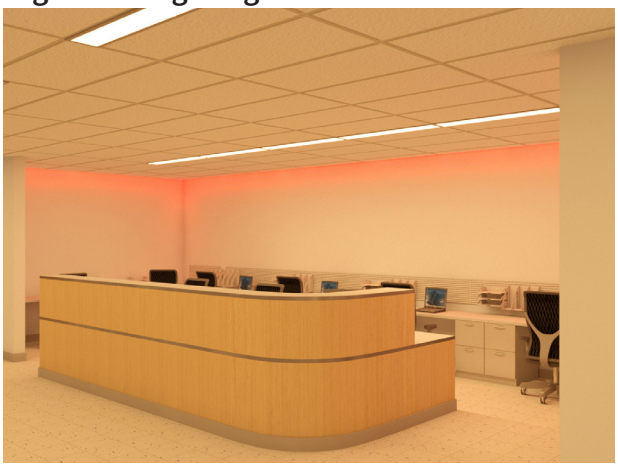
Lighting for Healthcare

Daytime lighting conditions



Night-time lighting conditions

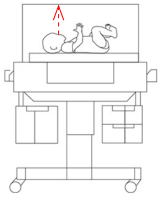


Lighting for healthcare presents unique challenges for accommodating the diverse populations who occupy this environment, as well as the need for 24-hour operation. Creating zones of light in a hospital can allow for unique circadian schedules to deliver light for dayshift and night-shift nurses, infants of 32 weeks PMA and aolder, patients, and vistors. Shift work, especially when it involves rotating and overnight shifts, has been associated with increased risks for developing serious, chronic health problems [19, 80-85]. Simply providing light levels appropriate for avoiding disruption of the circadian system can reduce this risk. Especially in a facility that operates 24/7, it is imperative to provide a robust lighting system that provides high light levels in the day for circadian entrainment, and low light levels are night to not disrupt the circadian system, while not compromising alertness. Blue light is suggested during daytime hours to promote alertness, while red light at night is suggested for its ability to provide alertness without disrupting the circadian system. Example CS schedules for general lighting for a 24-hour facility is given along with individual schedule for nurses to follow before and after his/her shift. Notably for shifts with atypical hours, assuring high CS values to promote circadian entrainment is reached during the daytime, and avoidance of high CS at night outside of work hours is key for the greatest effect. This could be done with personal light goggles and orange filter goggles.

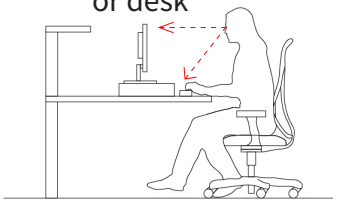
Design techniques

The direction an occupant is facing impacts greatly how much light gets to the eye. Keeping this in mind, lighting designs should be strategic to deliver light optimally for CS while avoiding glare from direct view of fixture. Nurses doing tasks at nurse's stations could be standing or sitting looking at computer screens or desk. Infants or patients laying in bed will be facing upward or possibly tilted on a patient bed.

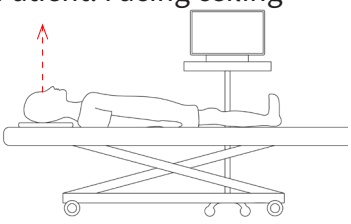
Infant: Facing ceiling



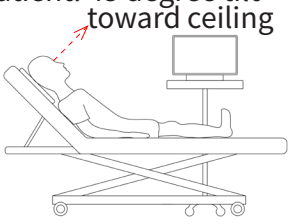
Nurse: Facing computer or desk



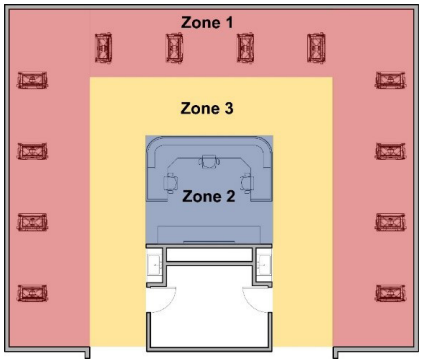
Patient: Facing ceiling



Patient: 45 degree tilt toward ceiling

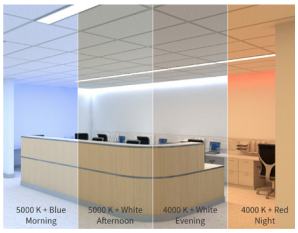


Zoning spaces within the facility is important to provide proper circadian entrainment for different user types. Supplying separate lighting controls for fixtures above the nurse's desk and the incubators can allow for dimmer light at night in the infant zone 1 without compromising visibilty and alertness for nurses in zone 2.



CS schedules

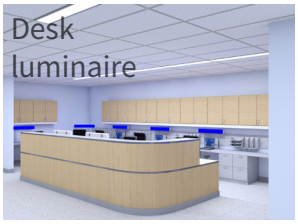
24-hour



24-hour hospital lighting: 8-hour shifts			
Time of day	**CS**	**Add-on color**	**Shift**
7:00 AM - 1:00 PM	0.4	Blue	Shift 1
1:00 AM - 2:00 PM	0.4 → 0.3	Transition	
2:00 AM - 3:00 PM	0.3	White	
3:00 PM - 9:00 PM	0.3	White	Shift 2
9:00 PM - 10:00 PM	0.3 → 0.1	Transition	
10:00 PM - 11:00 PM	0.1	Red	
11:00 PM - 6:30 AM	0.1	Red	Shift 3
6:30 AM - 7:00 AM	0.1 → 0.4	Transition (orange glasses)	

24- hour hospital lighting: 12-hour shifts			
Time of day	**CS**	**Add-on color**	**Shift**
7:00 AM - 1:00 PM	0.4	Blue	Shift 1
1:00 PM - 2:00 PM	0.4 → 0.3	Transition	
2:00 PM - 4:00 PM	0.3	White	
4:00 PM - 5:00 PM	0.3 → 0.2	Transition	
5:00 PM - 6:30 PM	0.2	Dimmer white	
6:30 PM - 7:00 PM	0.2 →	Transition (orange glasses)	
7:00 PM - 7:30 PM	→ 0.3	Transition	Shift 2
7:30 PM - 11:00 PM	0.3	White	
11:00 PM - 12:00 AM	0.3 → 0.1	Transition	
12:00 AM - 6:30 AM	0.1	Red	
6:30 AM - 7:00 AM	0.1 → 0.4	Transition (orange glasses)	

Nurse's personal schedules



7:00 AM - 3:00 PM			
Time of day	**CS**	**Add-on color**	**Shift**
Wake - 7:00 AM	0.4		Shift 1
7:00 AM - 1:00 PM	0.4	Blue	
1:00 PM - 2:00 PM	0.4 → 0.3	Transition	
2:00 PM - 3:00 PM	0.3	White	
3:00 PM - 4:00 PM	0.3 → 0.2		
4:00 PM - 7:00 PM	0.2		
7:00 PM - 8:00 PM	0.2 → 0.1		
8:00 PM - EOD	0.1		

3:00 PM - 11:00 PM			
Time of day	**CS**	**Add-on color**	**Shift**
Wake - 3:00 PM	0.4		Shift 2
3:00 PM - 9:00 PM	0.3	White	
9:00 PM - 10:00 PM	0.3 → 0.1	Transition	
10:00 PM - 11:00 PM	0.1	Red	
11:00 PM- EOD	0.1		

11:00 PM - 7:00 AM			
Time of day	**CS**	**Add-on color**	**Shift**
Wake - 7:00 PM	0.4		Shift 3
7:00 PM - 8:00 PM	0.4 → 0.2		
8:00 PM - 10:00 PM	0.2		
10:00 PM - 11:00 PM	0.2 → 0.1		
11:00 PM - 7:00 AM	0.1	Red	
7:00 AM - EOD	< 0.1	Orange glasses	

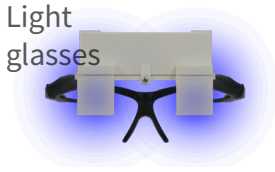
7:00 AM - 7:00 PM			
Time of day	**CS**	**Add-on color**	**Shift**
Wake - 7:00 AM	0.4		Shift 1
7:00 AM - 1:00 PM	0.4	Blue	
1:00 PM - 2:00 PM	0.4 → 0.3	Transition	
2:00 PM- 4:00 PM	0.3	White	
4:00 PM - 5:00 PM	0.3 → 0.2	Transition	
5:00 PM - 7:00 PM	0.2	Dimmer white	
7:00 PM - 8:00 PM	0.2 → 0.1		
8:00 PM - EOD	0.1	Orange glasses	

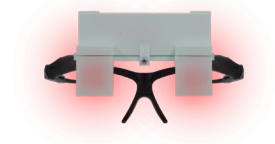
7:00 PM - 7:00 AM			
Time of day	**CS**	**Add-on color**	**Shift**
Wake - 7:00 PM	0.4		Shift 2
7:00 PM - 11:00 PM	0.3	White	
11:00 PM - 12:00 AM	0.3 → 0.1	Transition	
12:00 AM - 7:00 AM	0.1	Red	
7:00 AM - EOD	< 0.1	Orange glasses	

Blue or white light can be used to promote circadian entrainment during the day, and red light can provide alertness at night without disruption.

Nurse's personal schedules

Light glasses





Orange-filter glasses

7:00 AM - 3:00 PM			
Time of day	**CS**	**Add-on color**	**Shift**
Wake - 7:00 AM	0.4		Shift 1
7:00 AM - 3:00 PM	0.4	Blue	
3:00 PM - 4:00 PM	0.3 → 0.2		
4:00 PM - 7:00 PM	0.2		
7:00 PM - 8:00 PM	0.2 → 0.1		
8:00 PM - EOD	0.1		

3:00 PM - 11:00 PM			
Time of day	**CS**	**Add-on color**	**Shift**
Wake - 3:00 PM	0.4	Blue	Shift 2
3:00 PM - 9:00 PM	0.4	Blue	
9:00 PM - 11:00 PM	0.1	Red	
11:00 PM - EOD	0.1		

11:00 PM - 7:00 AM			
Time of day	**CS**	**Add-on color**	**Shift**
Wake - 11:00 PM	0.4	Blue	Shift 3
11:00 PM - 7:00 AM	0.1	Red	
7:00 AM- EOD	< 0.1	Orange glasses	

7:00 AM - 7:00 PM			
Time of day	**CS**	**Add-on color**	**Shift**
Wake - 7:00 AM	0.4	Blue	Shift 1
7:00 AM - 4:00 PM	0.4	Blue	
4:00 PM - 7:00 PM	0.2	Dimmer white	
7:00 PM- EOD	0.1	Orange glasses	

7:00 PM - 7:00 AM			
Time of day	**CS**	**Add-on color**	**Shift**
Wake - 7:00 PM	0.4	Blue	Shift 2
7:00 PM - 11:00 PM	0.3	White	
11:00 PM - 7:00 AM	0.1	Red	
7:00 AM - EOD	0.1	Orange glasses	

Light glasses are portable lighting devices that provide circadian effective lighting to individual users. Orange-tinted glasses are particularly helpful for night-shift workers who wish to remain entrained to the night shift and avoid circadian disruption by filtering out the wavelengths of light that stimulate the circadian system.

Infants in NICU

Lighting for incubator zone	
Time of day	**CS**
7:00 AM - 9:00 AM	0.3
9:00 AM - 10:00 AM	0.3 → 0.2
10:00 AM - 5:00 PM	0.2
5:00 PM - 6:00 PM	0.2 → 0.1
6:00 PM - EOD	0.1

Patient

Lighting for patient rooms	
Time of day	**CS**
7:00 AM - 10:00 AM	0.3
10:00 AM - 11:00 AM	0.3 → 0.2
11:00 AM - 4:00 PM	0.2
4:00 PM - 5:00 PM	0.2 → 0.1
5:00 PM - EOD	0.1

References

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