

# Lighting for Healthcare

## Daytime lighting conditions



## Night-time lighting conditions

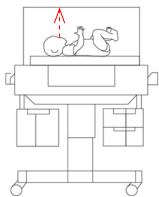


Lighting for healthcare presents unique challenges for accommodating the diverse populations who occupy this environment, as well as the need for 24-hour operation. Creating zones of light in a hospital can allow for unique circadian schedules to deliver light for dayshift and night-shift nurses, infants of 32 weeks PMA and older, patients, and visitors. 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 at 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.

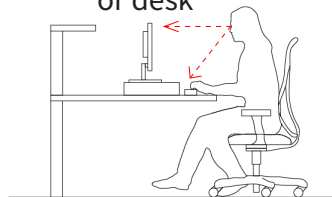
## Design techniques

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.

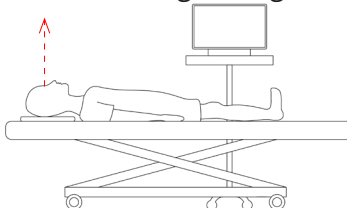
Infant: Facing ceiling



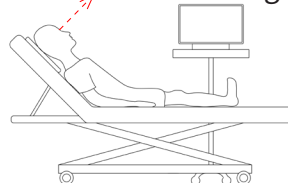
Nurse: Facing computer or desk



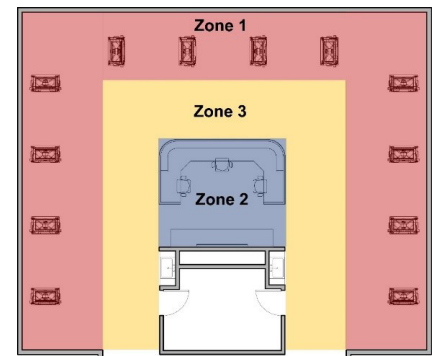
Patient: Facing ceiling



Patient: 45 degree tilt toward ceiling

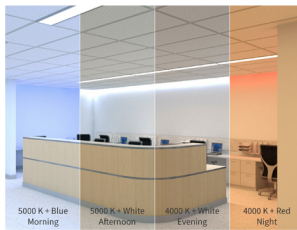


Zoning spaces within the facility is important to provide proper circadian entrainment for different user types. Supplying separate lighting controls for fixtures above the nurse's desk and the incubators can allow for dimmer light at night in the infant zone 1 without compromising visibility and alertness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



CS schedules

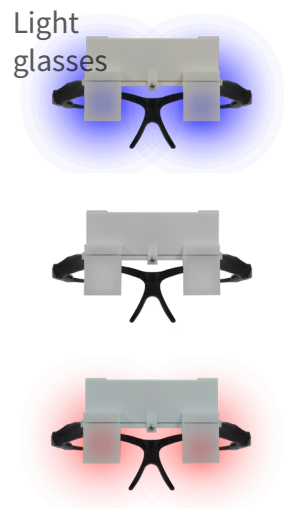
24-hour



Nurse's personal schedules



Nurse's personal schedules



Infants in NICU



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)	

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 - 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	

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



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)	Shift 2
7:00 PM - 7:30 PM	→ 0.3	Transition	
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)	

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	

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	

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

- [19] Figueiro MG (2017) Disruption of circadian rhythms by light during day and night. *Curr. Sleep Med. Rep.* 3, 76-84. doi:10.1007/s40675-017-0069-0
- [80] Bonde JP, Hansen J, Kolstad HA, Mikkelsen S, Olsen JH, Blask DE, Härmä M, Kjuus H, de Koning HJ, Olsen J (2012) Work at night and breast cancer-report on evidence-based options for preventive actions. *Scand. J. Work Environ. Health* 38, 380-390.
- [81] Cordina-Duverger E, Koudou Y, Truong T, Arveux P, Kerbrat P, Menegaux F, Guénel P (2016) Night work and breast cancer risk defined by human epidermal growth factor receptor-2 (HER2) and hormone receptor status: A population-based case-control study in France. *Chronobiol. Int.* Apr 14, 1-5. doi:10.3109/07420528.2016.1167709
- [82] Lin Y, Nishiyama T, Kurosawa M, Tamakoshi A, Kubo T, Fujino Y, Kikuchi S (2015) Association between shift work and the risk of death from biliary tract cancer in Japanese men. *BMC Cancer* 15, 757. doi:10.1186/s12885-015-1722-y
- [83] Lin X, Chen W, Wei F, Ying M, Wei W, Xie X (2015) Night-shift work increases morbidity of breast cancer and all-cause mortality: a meta-analysis of 16 prospective cohort studies. *Sleep Med.* 16, 1381-1387. doi:10.1016/j.sleep.2015.02.543
- [84] Papantoniou K, Castaño-Vinyals G, Espinosa A, Aragonés N, Pérez-Gómez B, Ardanaz E, Altzibar JM, Sanchez V, Gómez-Acebo I, Llorca J, Muñoz D, Tardón A, Peiró R, Marcos-Gragera R, Pollán M, Kogevinas M (2016) Breast cancer risk and night shift work in a case-control study in a Spanish population. *Eur. J. Epidemiol.* 31, 867-878. doi:10.1007/s10654-015-0073-y
- [85] Hunter CM, Figueiro MG (2017) Measuring light at night and melatonin levels in shift workers: A review of the literature. *Biol Res Nurs* 19, 365-374. doi:10.1177/1099800417714069