

Novel Lighting Strategies for Optimizing Circadian Health and Alertness in Shiftworkers (New Project)



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Project Summary

Timeline:

Start date: 10/1/2017

Planned end date: 9/30/2019

Key Milestones

1. Baseline assessment of circadian health and alertness in hospital night shiftworkers (9/30/18)
2. Development of two new, evidence-based LED technologies for optimizing circadian and acute alerting effects of light (9/30/19)
3. Test the efficacy of novel lighting interventions for optimizing circadian health (9/30/2019)

Budget:

Total Project \$ to Date:

- DOE: \$345,036
- Cost Share: \$123,000

Total Project \$817,125

- DOE: \$653,625
- Cost Share: \$163,500

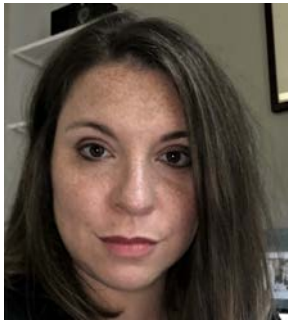
Key Partners:

UCSD
BIOS
flux
Suburban Hospital/Walter Reed
NIH

Project Outcome:

Develop and establish the efficacy of two novel light-based circadian interventions for optimizing sleep, health, alertness, performance and quality of life in hospital nightshift workers.

Team



Challenge

- 15 million individuals work outside a regular 9-5 shift (U.S. Department of Labor)
- Increased risk of accident & injury (Folkard & Tucker, 2003)
- Myriad physiological & psychological consequences (Evans et al. 2013; Brown et al., 2009; Lawson et al., 2011)
- Compromised alertness, performance and health costs ~\$200 billion annually (Kerin & Aguirre, 2005)
- Single most important reason given for premature attrition from the field of emergency medicine (American College of Emergency Physicians, 2010)
- Limited practical solutions due to the complexity of the issue
 - Need for around-the-clock hospital care; Work-hour restrictions; Heterogeneity of shiftworker physiology; Light response depends on circadian clock time

Approach

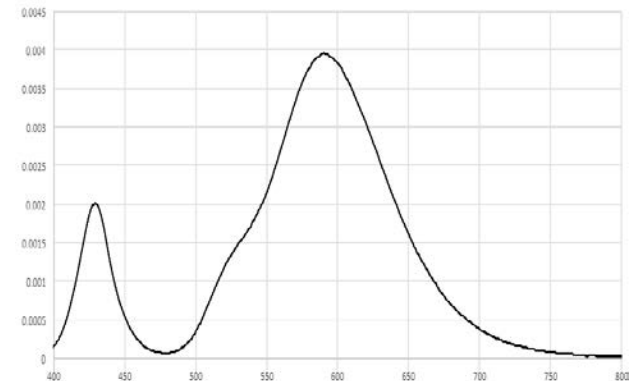
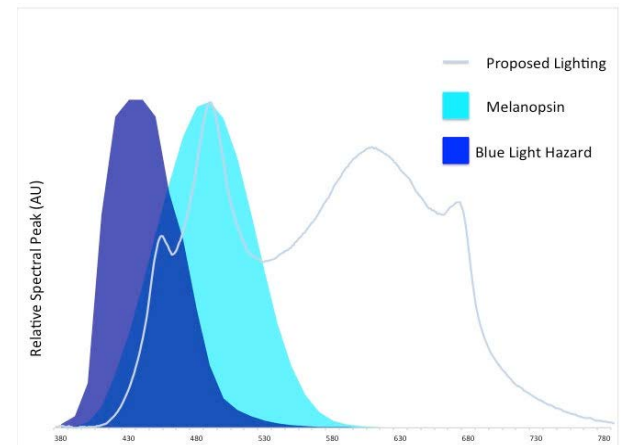
Combines two evidence-based lighting interventions that address two different responses:

Circadian Phase Resetting, architectural

- maximize input during desired day
- minimize input just before and during desired bedtime

Acute Alerting, individual

- light for alerting ONLY
- only when $KSS \geq 6$ and/or increased reaction time on PVT (*need based**)



Impact

Light Source	CCT (K)	Melanopic lux (m-lux)	Photopic lux (lux)	m-lux/lux	CRI
LA sky at 2 PM	5107	1.12e+3	662	1.69	100
3500K fluorescent	3562	50.4	100	0.504	75.2
BIOS blue-enriched	3483	93	100	0.931	84.26
Alert ONLY	TBD	~30	100	~0.30	>80

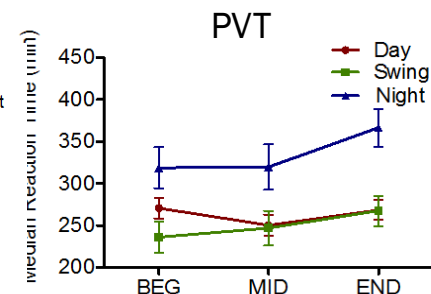
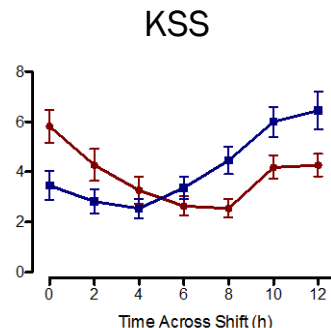
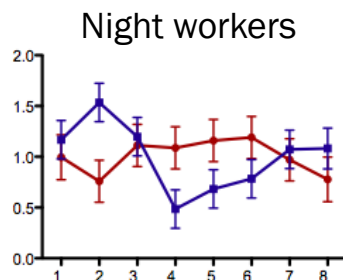
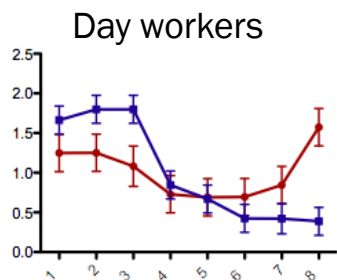
- Development of two new LED technologies as well as a method for titrating light based on need
- Better understand the circadian and acute alerting effects of light in a real-world application
- Improved circadian health and alertness in hospital night shiftworkers as demonstrated via:
 - Increased sleep duration, quality and regularity (actigraphy and diary)
 - Adjustments in hormone profiles (melatonin and cortisol fluctuations)
 - Increased alertness (PVT and KSS)
 - Increased quality of life/more effective turnover communication
- Better understand hospital staff engagement and acceptability

Progress

Early stages:

Phase 1. Baseline assessment of sleep, circadian health and alertness in shiftworkers

- IRB protocol has been drafted and approved (NMCSO/NIH “One Protocol”)
- Preliminary baseline assessment of dayshift and nightshift workers at hospital:



Phase 2. Adapt new BIOS lighting technologies for installation in a hospital setting

- Technological development with BIOS, including finalizing SPDs and creating a simple mechanism for switching SPDs of architectural lighting via dimming
- Meetings between UCSD, BIOS and hospital facility administrators have begun to identify the optimal location and method of installation
- Various brands and tints of blue blocker glasses have been characterized with flux, in order to select the best option for the study (leading to a manuscript in process)

Stakeholder Engagement

Early Stages:

- Collaboration between researchers (UCSD, NIH), industry (BIOS, flux) and healthcare facilities (Suburban Hospital, Water Reed Med Center, NIH Clinical Center)
- Regular meetings with all immediate collaborators and additional coordination with Suburban Hospital's Director of Capital Renovation Planning & Space Management, Director of Facilities Management, Vice President/Chief Nursing Officer, Director of Professional Practice and Quality, CAPRES Divisional Coordinator as well as Walter Reed's USN EMS/Disaster Regional Medical Director
- Attendance/presentation at DOE SSL workshops and other academic and industry meetings (e.g. IES, SRBR, SLEEP)
- Plans to include a formalized sub-study to develop lighting interventions that are not only effective for our defined purpose but also feasible, practical and acceptable to this population

Remaining Project Work

Phase 2.

- UCSD and hospital(s) will finalize the optimal department for data collection
- Facilities and BIOS will finalize the fixtures and plans for installation
- Radiometric measurements will be taken before and after the new architectural lighting has been integrated. Additional measures related to subjective experience, including visual comfort, chromatic discrimination and observer preference, will be collected for light sources and may guide further modifications.

Phase 3.

- Data collection will begin in late summer/early Fall and will implement a randomized, cross-over design.
- Data collection will occur across ~1.5/2 months, including:
 - 2 weeks of baseline assessment under standard fluorescent lighting
 - 2 weeks of BIOS blue-enriched LED architectural lighting
 - 2 weeks of BIOS architectural + Alert ONLY individualized lighting (as needed)
- Processing and analysis of data will be completed as well as dissemination of results via conference presentations and peer-reviewed publications

Thank You

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References

The American College of Emergency Physicians. (2010) Circadian rhythms and shift work - policy resource and education paper (PREP). Retrieved on Feb. 12, 2015.

Brown DL, Feskanich D, Sanchez BN, Rexrode KM, Schernhammer ES, Lisabeth LD (2010) Rotating night shift work and the risk of ischemic stroke. *American Journal of Epidemiology*. 16911:1370–1377.

Evans J & Davidson A (2013) Health consequences of circadian disruption in humans and animal models. *Progress in Molecular Biology and Translational Science*, 119, 283–323.

Folkard S & Tucker P (2003) Shift work, safety and productivity. *Occup. Med. (Lond.)* 53: 95.

Kerin A & Aguirre A (2005) Improving health, safety, and profits in extended hours operation (shiftwork) *Ind Health* Jan;43(1):201-8.

Lawson C, Whelan E, Lividoti Hibert E, Spiegelman D, Schernhammer E, Rich-Edwards J (2011) Rotating shift work and menstrual cycle characteristics. *Epidemiology*. 22:305–312.

Project Budget

Project Budget: FY18: 468,036; FY19: 349,089

Variations: Personnel costs have been shifted (later start at increased percent time due to administrative delays as well as necessary changes to study site)

Cost to Date: 1814.72

Additional Funding: Seeking additional (non-DOE) funds to cover transportation to/from work for duration of study

Budget History

FY18 OCT 1 2017 (current)		FY19 SEPT 30 2019 (planned)	
DOE	Cost-share	DOE	Cost-share
345,036	123,000	308,589	40,500

Project Plan and Schedule

Project Start: 10/1/2017	Completed Work							
Projected End: 9/30/2019	Active Task (in progress work)							
	◆ Milestone/Deliverable (Originally)							
	◆ Milestone/Deliverable (Actual)							
	FY2018				FY2019			
Task	Q1 (Oct-Dec)	Q2 (Jan-Mar)	Q3 (Apr-Jun)	Q4 (Jul-Sep)	Q1 (Oct-Dec)	Q2 (Jan-Mar)	Q3 (Apr-Jun)	Q4 (Jul-Sep)
Past Work								
IRB Protocol Approval	■	◆	■	■				
Phase 1: Baseline Assessment (Go/No-Go)			■	◆				
Current/Future Work								
Baseline light measurements		■	◆	■				
Phase 2: Lighting Installation				■	◆			
Conference presentation/technical report				■	◆	■		
Phase 3: Test efficacy of lighting interventions				■	◆	■		
Analysis of Results						■	◆	■
Manuscript preparation and submission							■	◆