



## Report on Workshop: Shift Work at Night, Artificial Light at Night, and Circadian Disruption

NTP Board of Scientific Counselors  
Meeting

June 15-16, 2016

Ruth Lunn, DrPH, Office of the Report on Carcinogens  
Windy Boyd, PhD, MPH; Office of Health Assessment and Translation  
Division of NTP/NIEHS

# Outline

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Background information

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Workshop objectives and format

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Workshop outcomes: Issues and discussions

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NTP evaluations: Next steps

# NTP's Interest in Shiftwork, LAN & Circadian Disruption

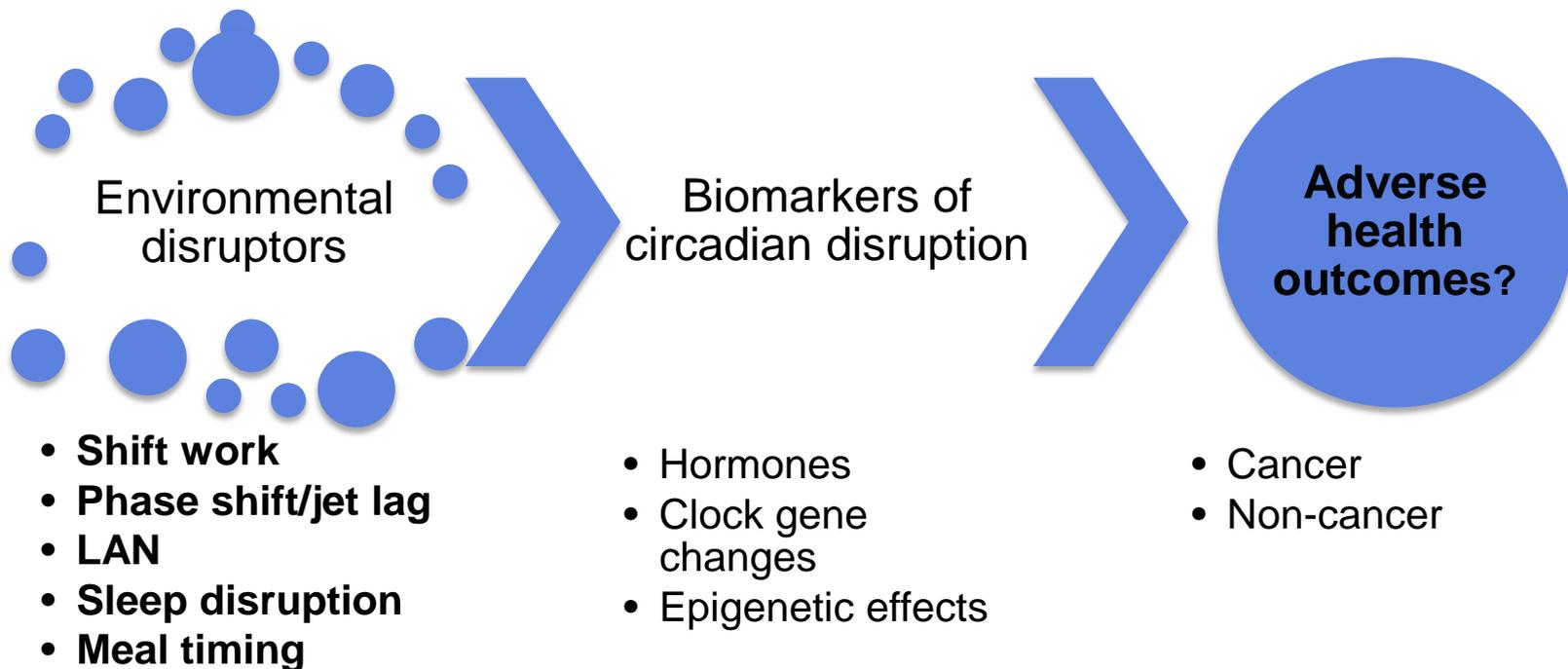
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- **Light at night (LAN)** nominated to ORoC (cancer) and OHAT (non-cancer outcomes)
  - IARC concluded that “**shiftwork that involves circadian disruption**” is probably carcinogenic to humans (Group 2A)
- NTP solicited public comment on “**shiftwork involving light at night**” (January 2012)
- ORoC presented concept at June 2013 BSC meeting “**Shift Work at Night, Light at Night, and Circadian Disruption**”
  - Workshop or webinar was proposed in the concept



# How to evaluate health hazards

## Strategies for synthesizing evidence across a large, complex database



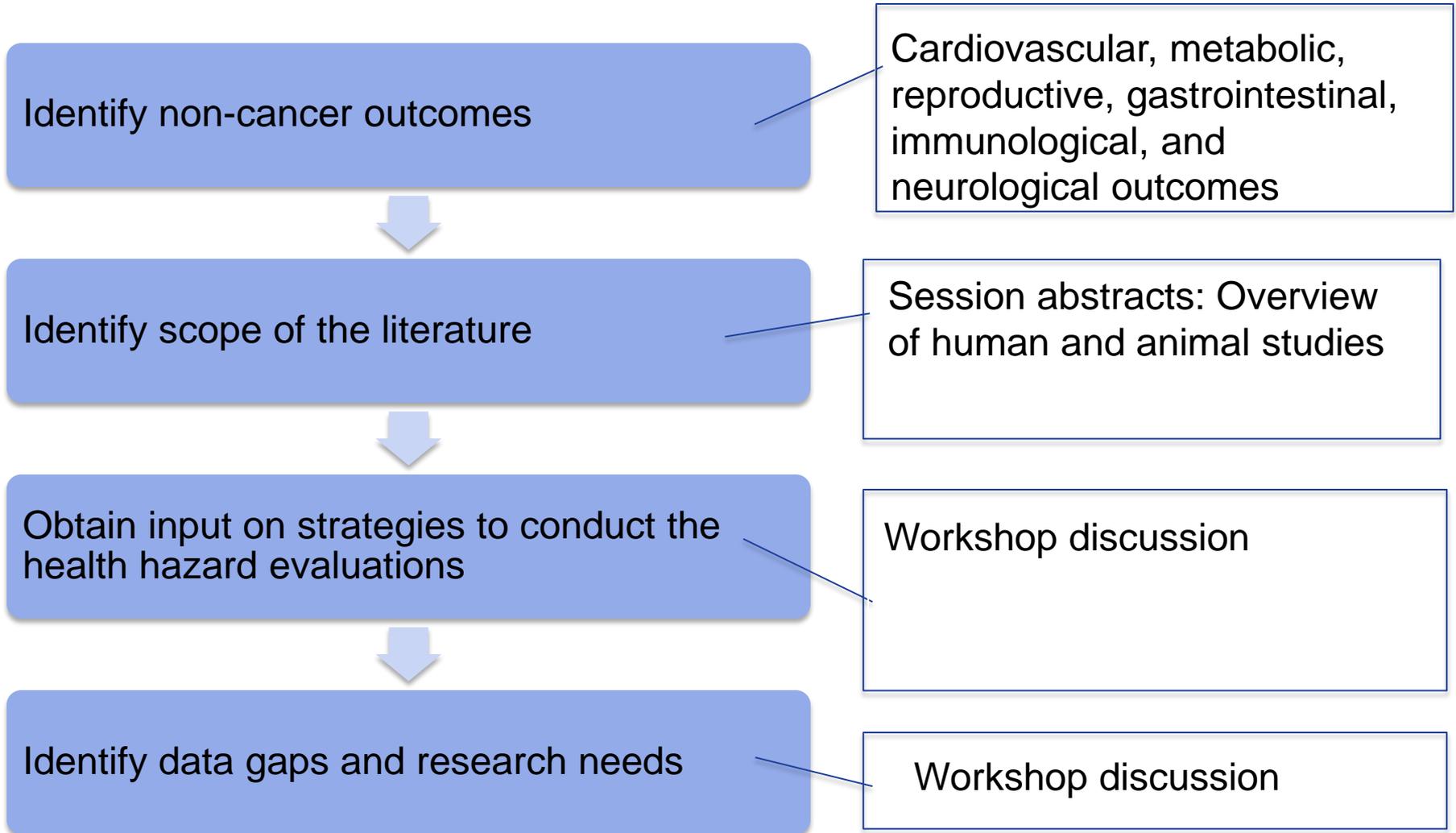
Human epidemiological studies of health outcomes

Animal models, mechanistic studies: humans, animals, *in vitro*



# Workshop Objectives

## Stepwise approach leading up to meeting





- 6 successive sessions
  - Circadian disruption (session 1)
  - Exposure scenarios - light, shift work, sleep and other exposures (sessions 2 to 4)
  - Strategies for conducting the cancer hazard evaluation (session 5)
  - Data gaps and research needs (session 6)
- Session format:
  - Panel presentations (sessions 1 to 3) related to state of the science
  - Moderator-led discussions related to advancing the science
- March 10 (afternoon) to 11, 2016
- Webcast [http://ntp.niehs.nih.gov/go/workshop\\_ALAN](http://ntp.niehs.nih.gov/go/workshop_ALAN)



# Workshop Panel

**David Blask, PhD, MD**

Tulane University

**Andrew Coogan, PhD**

Maynooth University, Ireland

**Mariana Figueiro, PhD**

Rensselaer Polytechnic Institute

**Michael Gorman, PhD**

University of California, San Diego

**Janet Hall, MD**

NIEHS

**Johnni Hansen, PhD**

Danish Cancer Society

**Randy Nelson, PhD**

The Ohio State University

**Satchin Panda, PhD**

The Salk Institute

**Michael Smolensky, PhD**

University of Texas-Houston

Health Sciences Center

**Richard Stevens, PhD**

University of Connecticut

**Fred Turek, PhD**

Northwestern University

**Roel Vermeulen, PhD, MSc**

Utrecht University

NTP BSC Liaison: Iris Udasin, MD



- Input on conducting the NTP health hazard evaluations
  - Suggested light as unifying factor as it is both an **effector and enabler**
  - Identified information and issues relevant for evaluating studies and protocol development
- Data gaps and research needs for the field
  - Suggestions for characterizing exposures and study designs
- Studies on interventions



# Panel Input for NTP Evaluations

## Light as an effector and enabler

- Electric light as an effector
  - Direct effects on circadian disruption and nocturnal melatonin suppression
- Electric light as an enabler
  - Paved the way for individuals to eat, sleep, and conduct other activities 24/7
- Shift work: light as an effector and enabler, as it is a complex exposure scenario



NASA Earth Observatory image of the city lights across the continental U.S. in 2012 via partnership between NASA, NOAA, and DoD



## Health consequences of electric lighting practices in the modern world

### Impact on monograph development

- Reasonable to consider all studies related to light in the same monograph because of the overlapping nature of the exposures
- Separate assessments (or conclusions) will likely be conducted for studies evaluating direct effects of light vs. studies evaluating effects from activities of light as enabler
- Assessments determined by nature and scope of the databases, which vary by health outcome



## Issues related to evaluating studies and protocol development

- Light
  - Multiple characteristics: intensity, amount, spectrum, distribution, timing, duration, and photic history are related to circadian disruption
  - Total light exposure is important, not just LAN; light exposure during day influences night-time sensitivity
- Human studies
  - Meta-analyses not informative
  - Selection bias: “healthy shift worker survival effect”
- Animal models
  - Although don’t fully replicate complex, overlapping exposure scenarios in humans, they play a key role in understanding specific exposures, mechanisms, and provide input for intervention
  - Important to translate light metrics from animals to humans because nocturnal animals are more sensitive to light
  - Not all animals produce melatonin or have melatonin receptors



# Research Needs for the Field

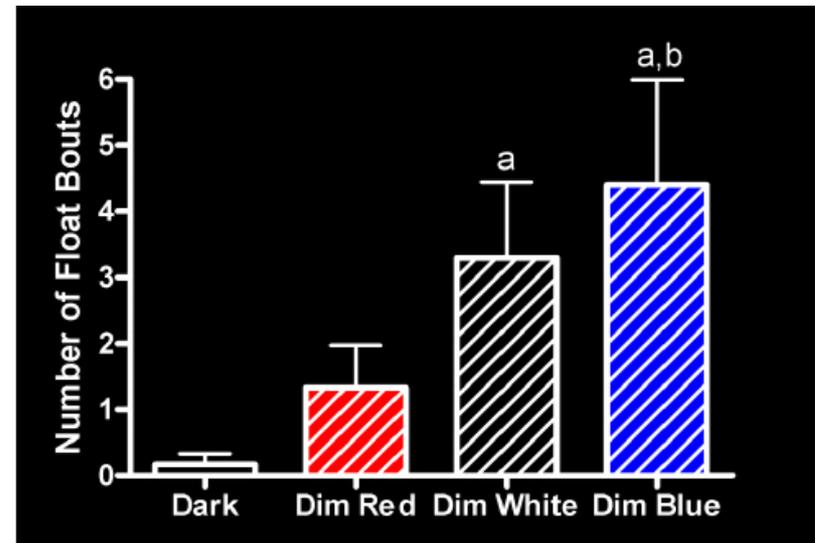
- Human epidemiological studies
  - Conduct field studies on light exposure using calibrated devices and detailed questionnaire data, which can be scaled up for use in large epidemiology studies
  - Collect information (questionnaire, biomarkers, etc.) that provide comprehensive characterization of shift work (e.g., scheduling and nature) as well other “exposures” such as light exposure, sleep and eating patterns
- Animal studies
  - Conduct studies on dim LAN at lower intensity and using diurnal models to more closely replicate human exposures/effects
  - Conduct preliminary studies measuring biomarkers at multiple time points to determine optimal times for larger scale studies
  - Evaluate experimentally induced diseases (e.g., using known toxicants) under different light conditions



## Reducing adverse effects from LAN

- Light and shift work are essential to our society
- Experimental human studies
  - Light characteristics and biomarkers of circadian disruption
  - Interventions such as using blue light-blocking goggles
- Studies in experimental animals
  - Evaluated interventions on health outcomes
  - Examples: Red light and neurological and cardiovascular disease

## Red Wavelength is less Detrimental



Forced swim test for assessing depression

Bedrosian et al. 2013; Journal of Neuroscience  
Nelson presentation



- Workshop report in preparation
- OHAT plans to present a concept for the December 2016 NTP BSC meeting
  - Outline research questions for review
- NTP is using input from the workshop to develop protocols for conducting health hazard evaluations
- Identify potential interventions by summarizing existing evidence



- **Organizers (NIEHS)**

- Windy Boyd\*
- Ruth Lunn
- Kris Thayer

- **Moderators**

- Tania Carreón-Valencia (NIOSH)
- Claire Caruso (NIOSH)
- Michael Twery (NHLBI)

- **Rapporteurs**

- Gloria Jahnke (NIEHS)
- Tina Lawson (NIOSH)
- Katie Pelch (NIEHS)
- Kyla Taylor (NIEHS)

\* Also served as a moderator or rapporteur

- **Technical support**

- Andy Ewens (ILS)
- Sandy Garner (ILS)
- Whitney Mitchel (ICF)
- Pam Schwingl (ILS)\*
- Courtney Skuce (ICF)

- **Administrative support**

- Ella Darden (ILS)
- Anna Lee Mosley (Kelly Services)
- Tracy Saunders (ILS)

- **Webcast support**

- Nathan Mitchiner (NETE Solutions)

- **NTP Web Team**