# CIRCADIAN – ICU Trial Proposal

Circadian-Targeted ICU Lighting to Improve Delirium-Free Survival in Mechanically Ventilated Adults

# Background:

Critically ill ICU patients often experience:

* Minimal daytime light exposure
* Frequent overnight light disruptions
* Circadian misalignment, which is linked to:
  + Higher delirium rates
  + Longer ICU stays
  + Poor cognitive outcomes

ICU light–dark patterns are modifiable

Prior observational studies and pilot trials suggest timed bright light during the day and darkness at night may support circadian health and reduce brain dysfunction

# Aim:

To determine whether strategically implemented ICU lighting (bright daytime, dark nighttime) improves delirium-free and coma-free ICU survival in mechanically ventilated, sedated adult ICU patients.

Using Android Phone sensors to collect robust evidence on light conditions (illumination) at patient eye level.

# Hypothesis:

Optimized ICU lighting improves circadian regulation, leading to lower delirium incidence, shorter sedation/coma duration, and better recovery outcomes.

# Design:

* Type: Prospective, randomized, controlled, multicenter clinical trial
* Duration: 24 months
* Groups:
  + Intervention: Circadian lighting (dynamic, 1000–2000 lux 07:00–20:00, <20 lux 22:00–06:00, amber/red overnight care lights)
  + Control: Standard ICU lighting (unregulated)

# IC:

Fulfilling all of the following criteria:

* Adults ≥18 years old
* Mechanically ventilated within 24h of ICU admission
* GCS <13 or RASS ≤ –3 on enrollment

# EC:

Fulfilling any of the following criteria:

* Blindness or severe visual impairment
* Brain death or imminent palliation
* Known chronic sleep/circadian disorders
* Expected ICU discharge <48h
* Individuals where consent is not obtainable due to national regulations

# Primary Outcome

Composite Outcome

* Any of the following occurring
  + death on ICU
  + Delirium (≥1 positive CAM-ICU assessment) within 7 days of ICU admission
  + Coma (RASS ≤ –4 for ≥24 hours) within 7 days of ICU admission:

# Secondary outcomes:

* ICU and hospital length of stay
* 30-day and 90-day survival
* Ventilator-free days at day 28

# Sub-studies

Substudy 1:

* 90 day cognitive function with Questionnaire

Substudy 2:

* 12-hourly Melatonin and Cortisone Biomarker sampling within first 72 hours on ICU

# Sample Size

1:1 random allocation to control and intervention group

Assuming α = 0.05, power = 0.80, with baseline composite outcome rate of 40%, reduced to 25% in intervention group.

152 patients per arm, total: 304 patients

Add 10% dropout 🡪 340 patients

# Data Collection

eCRF implemented in RedCap including:

* Screening form, Randomization form (with notification), Baseline form, Daily ICU forms, Outcomes, (S)AE forms and PD forms.

Importantly, these include:

* Lighting measurements: Bed-level lux sensors (every 10 min)
* Delirium/coma assessments: CAM-ICU, RASS (once per shift, i.e. three times daily)
* Medications: Sedatives, antipsychotics, melatonin
* Baseline variables (admission diagnosis, APACHE)

# Interventions:

* smart LED ceiling lighting, with bedside dimmable task lights
* Auto-controlled light cycles synced to ICU clock
* Overnight nursing task lights use red-spectrum bulbs (<20 lux)
* Staff trained on preserving dark environment (curtains, monitor dimming)

# Statistical Analysis

Primary outcome analysis, as well as Kaplan–Meier for survival; linear regression for LOS; Cox regression for readmission. Additional subgroup analysis: stratify by severity (APACHE >25), sedation depth and neurological admission diagnosis.