

Vital-Sign Synchrony as a Marker for Patient Circadian Rhythms in an Intensive Care Unit

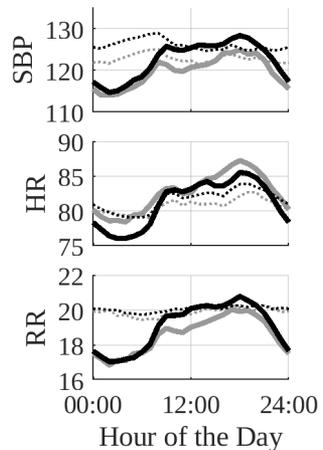
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Patient circadian rhythms are often disrupted in an intensive care unit (ICU). This disruption is associated with worsened patient outcomes. Due to the unreliability of sleep monitoring in an ICU, new methods are needed to quantify circadian rhythms and identify at risk patients. We hypothesize that the cross-correlation between vital-sign circadian profiles will allow us to stratify patients by rhythm strength, without reliance on a prior assumed rhythm shape.

We selected from the eICU-CRD and MIMIC-III databases the cohort of patients in their final 24 hours of ICU stay who subsequently recovered (35,143 eICU and 11,872 MIMIC patients). This cohort was deemed most likely to contain patients with typical vital-sign circadian profiles. We then calculated the mean cross-correlation (R) between the systolic blood pressure (SBP), heart rate (HR), and respiratory rate (RR) circadian profiles for these patients and grouped them into the following categories within each database: high ($R > 90^{\text{th}}$ percentile), low ($R < 10^{\text{th}}$ percentile), and mid (the remaining patients).

The high-correlation cohorts showed mean vital-sign profiles that closely resembled those reported in the literature for non-ICU cohorts, with peaks at awakening and in the evening, and a large trough overnight. The mid- and low-correlation cohorts, in contrast, showed less consistent and defined peaks and troughs, particularly in SBP and RR. Vital-sign peak-nadir excursions in the high-correlation cohorts were 2 - 7 times greater than those for the other cohorts. These results suggest that the cross-correlation between vital-sign circadian profiles has the potential to aid identifying patients who show typical or atypical circadian rhythms.



eICU (black) and MIMIC (grey) high- (bold) and low- (dashed) correlation vital-sign circadian profiles.