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## Noise and Light Pollution in the Hospital: A Call for Action

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“Unnecessary noise is the most cruel abuse of care which can be inflicted on either the sick or the well.”

–Florence Nightingale<sup>1</sup>

Motivated by the “unsustainable” rise in noise pollution and its “direct, as well as cumulative, adverse health effects,” an expert World Health Organization (WHO) task force composed the *Guidelines for Community Noise*, outlining specific noise recommendations for public settings, including hospitals.<sup>2</sup> In ward settings, these guidelines mandate that background noise (which is defined as unwanted sound) levels average <35 decibels (dB; ie, a typical library) during the day, average <30 dB at night, and peak no higher than 40 dB (ie, a normal conversation), a level sufficient to awaken someone from sleep.

Since the publication of these guidelines in 1999, substantial new research has added to our understanding of hospital noise levels. Recent research has demonstrated that few, if any, hospitals comply with WHO noise recommendations.<sup>3</sup> Moreover, since 1960, hospital sound levels have risen ~4 dB per decade; based on the logarithmic decibel scale, if this trend continues, this translates to a 528% increase in loudness by 2020.<sup>3</sup>

The overwhelming majority of research on hospital noise has focused on the intensive care unit (ICU), where beeping machines and busy staff often push peak nighttime noise levels over 80 dB (ie, a kitchen blender).<sup>4</sup> When evaluated during sleep, noise in the ICU causes frequent arousals and awakenings. When noise is combined with other factors, such as bright light and patient care interactions, poor sleep quality invariably results.<sup>4</sup>

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While it has been known for years that critically ill patients experience markedly fragmented and nonrestorative sleep,<sup>5</sup> poor sleep has recently gained attention due to its potential role as a modifiable risk factor for delirium and its associated consequences, including prolonged length of stay and long-lasting neuropsychological and physical impairments.<sup>6</sup> Due to this interest, numerous interventions have been attempted,<sup>7</sup> including multicomponent bundles to promote sleep,<sup>8</sup> which have been shown to reduce delirium in the ICU.<sup>9–12</sup> Therefore, efforts to promote sleep in the ICU, including interventions to minimize nighttime noise, are recommended in Society of Critical Care Medicine clinical practice guidelines<sup>13</sup> and are listed as a top 5 research priority by an expert panel of ICU delirium researchers.<sup>14</sup>

In contrast to the ICU, there has been little attention paid to noise in other patient care areas. Existing studies in non-ICU ward settings suggest that excessive noise is common,<sup>3</sup> similar to the ICU, and that patients experience poor sleep, with noise being a significant disruptor of sleep.<sup>5,15,16</sup> Such poor sleep is thought to contribute to uncontrolled pain, labile blood pressure, and dissatisfaction with care.<sup>16,17</sup>

In this issue of the *Journal of Hospital Medicine*, Jaiswal and colleagues<sup>18</sup> report on an important study evaluating sound and light levels in both non-ICU and ICU settings within a busy tertiary-care hospital. In 8 general ward, 8 telemetry, and 8 ICU patient rooms, the investigators used meters to record sound and light levels for 24 to 72 hours. In each of these locations, they detected average hourly sound levels ranging from 45 to 54 dB, 47 to 55 dB, and 56 to 60 dB, respectively, with ICUs consistently registering the highest hourly sound levels. Notably, all locations exceeded WHO noise limits at all hours of the day. As a novel measure, the investigators evaluated sound level changes (SLCs), or the difference between peak and background sound levels, based on research suggesting that dramatic SLCs (> 17.5 dB) are more disruptive than constant loud noise.<sup>19</sup> The authors observed that SLCs >17.5 dB occur predominantly during daytime hours and, interestingly, at a similar rate in the wards versus the ICU.

Importantly, the authors do not link their findings with patient sleep or other patient outcomes but instead focus on employing rigorous methods to gather continuous recordings. By measuring light levels, the authors bring attention to an issue often considered less disruptive to sleep than noise.<sup>6,10,20</sup> Similar to prior research,<sup>21</sup> Jaiswal and colleagues demonstrate low levels of light at night, with no substantial difference between non-ICU and ICU settings. As a key finding, the authors bring attention to low levels of light during daytime hours, particularly in the morning, when levels range from 22 to 101 lux in the wards and 16 to 39 lux in the ICU. While the optimal timing and brightness of light exposure remains unknown, it is well established that ambient light is the most potent cue for circadian rhythms, with levels >100 lux necessary to suppress melatonin, the key hormone involved in circadian entrainment. Hence, the levels of morning light observed in this study were likely insufficient to maintain healthy circadian rhythms. When exposed to abnormal light levels and factors such as noise, stress, and medications, hospitalized patients are at risk for circadian rhythm misalignment, which can disrupt sleep and trigger a complex molecular cascade, leading to end-organ dysfunction including depressed immunity, glucose dysregulation, arrhythmias, and delirium.<sup>22–24</sup>

What are the major takeaway messages from this study? First, it confirms that sound levels are not only high in the ICU but also in non-ICU wards. As hospital ratings and reimbursements now rely on favorable patient ratings, future noise-reduction efforts will surely expand more vigorously across patient care areas.<sup>25</sup> Second, SLCs and daytime recordings must be included in efforts to understand and improve sleep and circadian rhythms in hospitalized patients. Finally, this study provides a sobering reminder of the challenge of meeting WHO guidelines and facilitating an optimal healing environment for patients. Sadly, hospital sound levels continue to rise, and quiet-time interventions consistently fail to lower noise to levels anywhere near WHO limits.<sup>26</sup> Hence, to make any progress, hospitals of the future must entertain novel design modifications (eg, sound-absorbing walls and alternative room layouts), fix common sources of noise pollution (eg, ventilation systems and alarms), and critically evaluate and update interventions aimed at improving sleep and aligning circadian rhythms for hospitalized patients.<sup>27</sup>

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