Identifying Rising Risk of Falls

Why it matters: Falls represent the leading cause of injury and injury death among older adults (age 65+) in the United States, with more than 1 in 4 experiencing a fall each year.[1] With falls prompting 3 million emergency room visits and 1 million hospitalizations per year, [1] identifying the rising risk of falls in older adults and taking action to mitigate this risk is paramount. It can be challenging to identify rising risk due to a scarcity of standardized assessment tools for fall risk identification, underreporting of fall risk factors by older adults due to fear, embarrassment, or cognitive impairment, and a lack of insight by loved ones or care providers into what is happening with the older adult when they are alone. By detecting subtle changes and trends in activity patterns, the Sovrinti system's continuous, passive monitoring provides older adults, their loved ones, and medical professionals with real-time and long-term insight into the risk of falls.

Background: The Sovrinti system utilizes high temporal, spatial, and device use change recognition to autonomously identify and quantify activities of specific individuals in a private residence or senior living facility. The examples shown are from a completed (2020 – 2023) National Institute on Aging Phase II research study (R44AG065118) where the Sovrinti system was installed in the residences of 124 older adults.

The charts below represent data from a 100-year-old male "Care Recipient" (CR) living in a five-bedroom, three-bathroom house with his son and daughter-in-law. The CR's son participated in the research study as his caregiver, with the son estimating that he actively helped his father 20 hours per week. The caregiver also completed monthly phone surveys (ADCSs) regarding the CR's health and ADL performance. The surveys were intended to provide comparative data for the validation of the Sovrinti system, which was installed in the CR's residence for 18 months.

Example data: On first consideration, the CR's health and functional status appears stable for the duration of the study. The monthly ADCS scores derived from the caregiver phone interviews across 18 months suggest little variation in ADL performance, with the CR scoring the same on the first and final caregiver surveys.

While the caregiver interviews show no concerning change, the 18 months of Sovrinti system data reveal an increase in the CR's fall risk based on his mobility and activity patterns. Figure 1 displays the CR's bathroom visits by time of day from November 2020 – May 2022, with each ring of data representing one day on the face of a 24-hour clock. Inner rings reflect earlier dates progressing to the outermost ring, 5/27/22. The collection of data points just before 10pm and the distinct line of points at 9am indicate that the CR tends to go to bed around 10pm and gets up at 9am. As can be seen from the increasing density of data points moving outward in the upper righthand quadrant, the CR progressed from not using the bathroom during the night at the beginning of the study to visiting the bathroom multiple times during his normal sleeping hours.

Figure 2 offers another representation of the CR's increased overnight bathroom activity. It compares the number of bathroom visits by time of day from the first full 6 months (gray),

second 6 months (blue), and final 6 months (orange) of the study. A distinct increase in bathroom activity between midnight (0) and 8am can be seen in the second and final 6 months of the study, with visits more frequently occurring at 1am and 3am (circled). From the first full 6 months to the final 6 months in the study, the CR's nighttime bathroom activity increased 907%.

This dramatic rise translates to an increase in the CR's overall fall risk compared to the beginning of the study. Based on prior research concerning nighttime bathroom visits and fall risk,[3] Figure 3 depicts the rising risk associated with the CR's nighttime bathrooming activity relative to no overnight bathroom activity. By the end of the study, the CR's risk of fall had doubled. Discussion with the CR's caregiver son indicated that he was generally aware of an uptick in the CR's nighttime activity, but not to the extent that the Sovrinti system reveals.

With research showing an increased likelihood of falls among older adults who frequently go to the bathroom at night,[2-3] it is recommended that in cases such as this, loved ones or other care providers use the Sovrinti system's data-driven insights to proactively intervene to reduce the risk of fall. This could involve reviewing the older adult's medications, removing trip hazards, installing grab bars, or illuminating the pathway to the bathroom using motion sensing nightlights.

The Sovrinti system also allows for alerts that would notify care providers in real time when an older adult gets up in the night for any reason. Otherwise, alerts can be restricted to a certain period of the night after the older adult goes to bed, or caregivers can receive a daily/weekly report outlining nighttime activity. In addition to real-time notification, the system provides for long-term pattern/trend identification, such as the rising risk of fall discussed above.

Summary: In these examples, rising fall risk is identified based on the nighttime bathroom activity of a 100-year-old male. Bathroom event data shows significantly increased nighttime bathroom visits over time, translating to a greater overall fall risk. Offering real-time alerts and long-term trend identification, the Sovrinti system helps facilitate a shift from reactive to proactive care, thereby improving outcomes and supporting older adults aging in place.

For further analysis: Corresponding mobility, real time location, and bathroom sink/hot water event data is available for greater insight into nighttime bathroom activity and fall risk. Additional analyses might investigate patterns in the duration or timing of the CR's nighttime bathroom visits (e.g., Are his bathroom visits taking longer over time? Are there certain days of the week the CR is more likely to have nighttime bathroom visits?). Other analyses might examine patterns in the CR's daytime activity/mobility that are associated with greater numbers of nighttime bathroom visits. More generally, analyses might explore other potential nighttime activity (e.g., living room/kitchen lights, television on/off) to identify possible wandering behavior.

Sources

1. CDC. Older adult fall prevention: CDC's injury center uses data and research to save lives. https://www.bcit.ca/files/library/pdf/bcit-ama_citation_guide.pdf. Published September 2022. Accessed June 19, 2023.

2. Stone KL, Ewing SK, Lui LY, et al. Self-reported sleep and nap habits and risk of falls and fractures in older women: the study of osteoporotic fractures. *J Am Geriatr Soc*. 2006;54(8):1177-1183. doi: 10.1111/j.1532-5415.2006.00818.x

3. Kim SY, Bang W, Kim MS, Park B, Kim JH, Choi HG. Nocturia is associated with slipping and falling. *PLoS One*. 2017;12(1):e0169690. doi: 10.1371/journal.pone.0169690.

Figure 1
Bathroom Visits
11/7/20 – 5/27/22

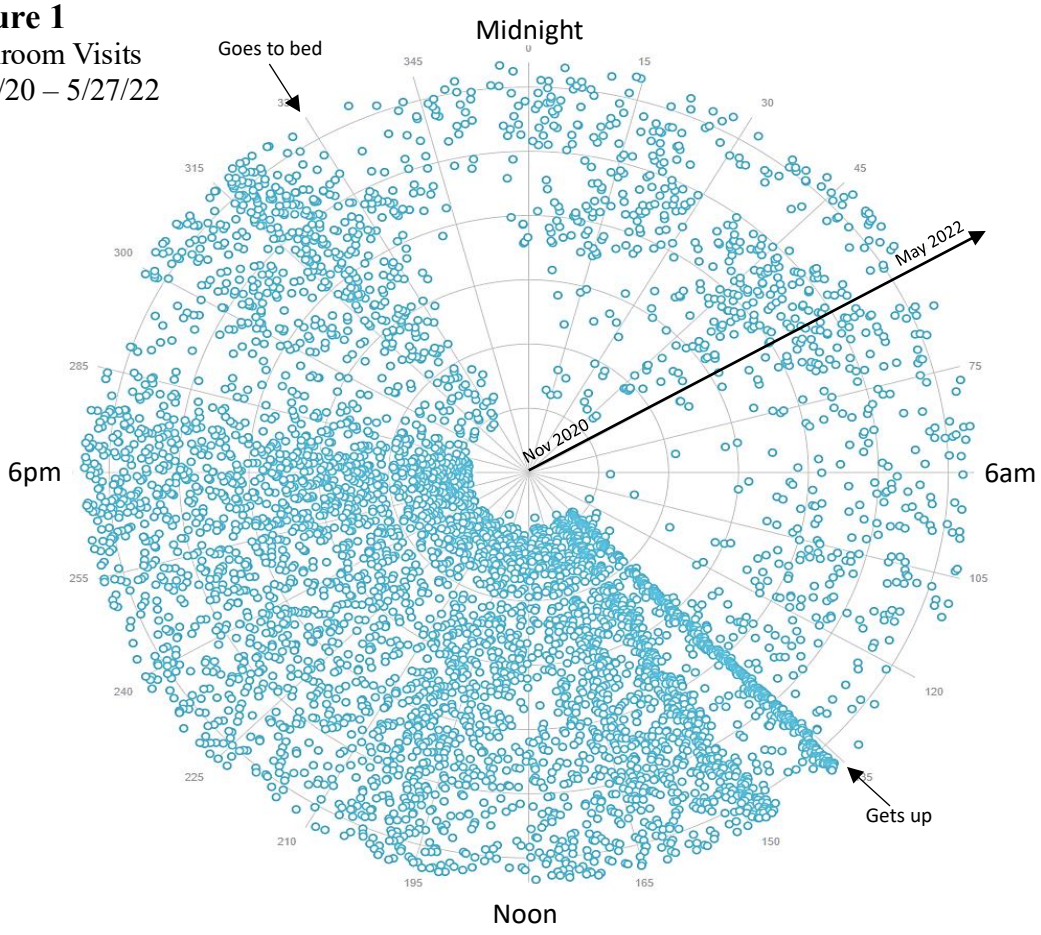

Figure 2
Dec 2020 – May 2022

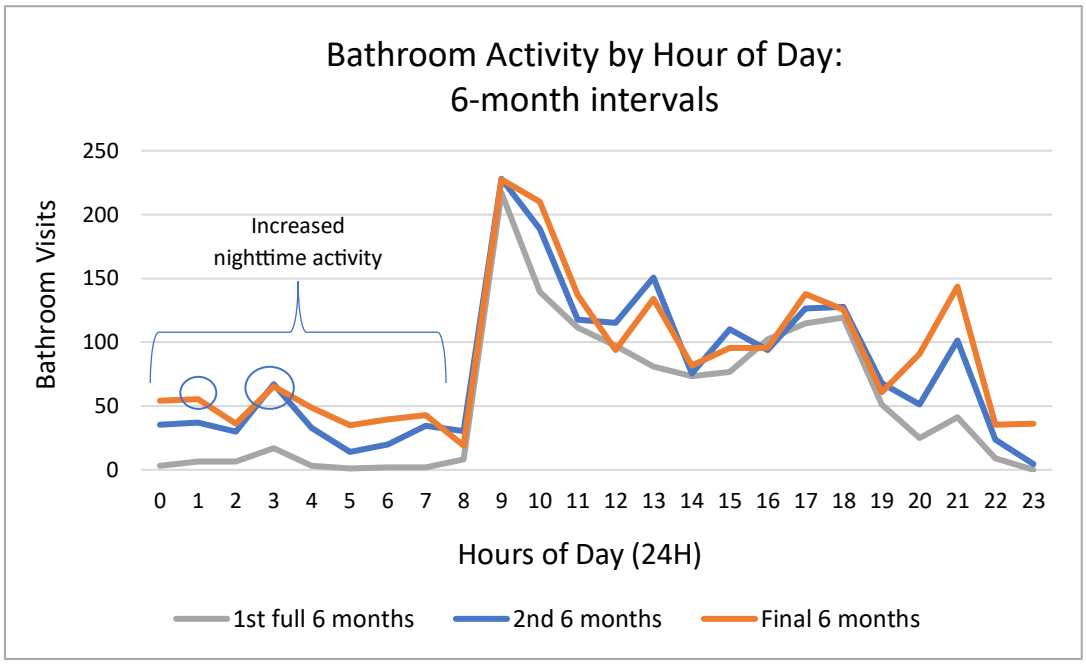

Figure 3
Dec 2020 – May 2022