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COMMENTARY

Sleep Disruption in the NICU: When Natural Sleep Behavior Looks Like Distress

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A newborn rat lies quietly on its side, eyes sealed and body still. Suddenly, it twitches—its four limbs, tail, and whiskers moving in brief bursts that recur throughout the day and night. No contemporary sleep scientist would regard these movements as pathological. Instead, twitches are defining features of active, or rapid eye movement (REM), sleep and are increasingly recognized as playing important roles in sensorimotor development (Blumberg et al. 2022).

However, in premature human infants in the neonatal intensive care unit (NICU), similar movements often provoke concern. The contrast between how sleep scientists and clinicians interpret twitches reflects a persistent misalignment between basic and clinical science that may have practical implications for bedside interpretation of infant behavior. For example, twitching during sleep is sometimes confused with seizures, a situation familiar to many neonatal caregivers. Also, when sleep-state context is not explicitly incorporated into assessment, healthcare professionals can misclassify the facial and limb twitches of active sleep as indicators of distress. Indeed, commonly used pain and agitation scales explicitly score these movements as signs of discomfort. In response, caregivers may interrupt sleep and even initiate interventions intended to relieve the perceived distress. Although well intentioned, such interventions can alter and even suppress normal sleep.

The recognition of sleep-related movements as normal infant behavior dates back nearly a century. In the 1950s, Aserinsky and Kleitman (1955) identified active sleep and its accompanying motility cycles in infants, establishing a foundation for modern sleep science. In 1966, Roffwarg et al. (1966) proposed the ontogenetic hypothesis of active sleep, positing that the high prevalence of that sleep state in early life promotes endogenous stimulation of the developing brain. Subsequent work showed that brainstem activity generates the phasic motor events characteristic of active sleep, including rapid eye movements and twitches of the limbs and face. In human preterm and full-term infants, twitches occur many thousands of times each day across the body, including the face (Figure 1A; Sokoloff et al. 2026).

Evidence accumulated over recent decades indicates that sleep-related twitching likely benefits, rather than burdens, the developing nervous system. Studies in neonatal rodents and human infants demonstrate that twitches are structured outputs of brainstem motor networks rather than random by-products of dreaming (Blumberg et al. 2022; Sokoloff et al. 2026). Their discrete, single-joint character distinguishes them from the more complex, multi-joint movements of wakefulness. Each twitch produces sensory feedback that propagates through the spinal cord, cerebellum, thalamus, cortex, and hippocampus. Together with internal copies of motor commands, these signals are thought to contribute to the refinement of sensorimotor maps and the formation of internal models.

Despite this long-standing body of work, clinical practice developed along a different trajectory. In a recent nationwide survey, 91.8% of neonatal healthcare professionals in the Netherlands reported that they adapt care based on perceived sleep state, reflecting broad recognition of sleep's importance. However, fewer than 15% of healthcare professionals correctly distinguished active sleep from wakefulness using objective knowledge questions (De Groot et al. 2023). These findings likely reflect the

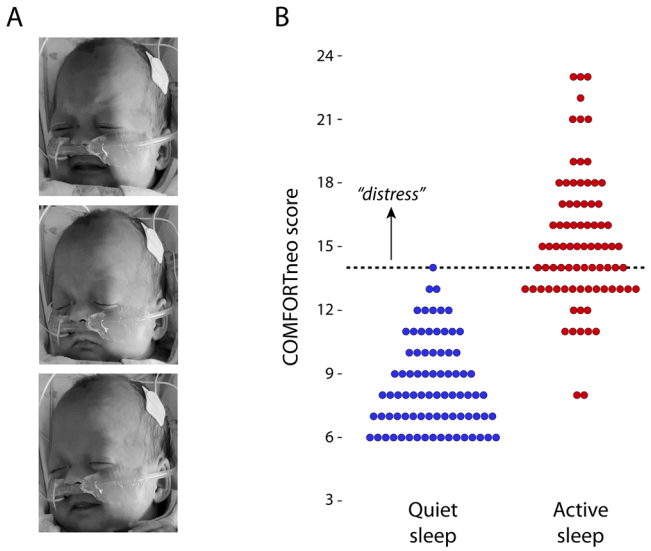

FIGURE 1 | Facial expressions during sleep and observations from an exploratory video-based assessment of distress in premature infants. (A) Representative facial expressions during active (REM) sleep extracted from a video of a premature infant in the NICU born at 24 weeks postmenstrual age and recorded at 34 weeks postmenstrual age. Facial expressions co-occurred with other standard features of active sleep, including limb twitches and rapid eye movements. Note the expression of apparent distress in the top-most image. (B) Distribution of COMFORTneo scores in three clinically stable preterm infants (median postmenstrual age: 30 weeks) during quiet sleep (blue dots) and active sleep (red dots). Each infant contributed a pair of 2-min videos, one showing quiet sleep and the other active sleep, and each pair of videos was judged independently by 27 NICU nurses. Sleep states were classified using the validated BeSSPI framework (De Groot et al. 2023). Videos of active sleep, but not quiet sleep, were frequently assigned COMFORTneo scores exceeding the commonly used intervention threshold (dotted horizontal line).

limited integration of neonatal sleep physiology into routine clinical education and bedside assessment frameworks. This challenge may be compounded when bedside pain and discomfort tools are applied that do not carefully consider sleep–wake context.

These challenges may have implications for bedside interpretation and clinical decision-making. When sleep-related behaviors are interpreted as possible distress signals, infants may undergo additional interventions, including pharmacological treatment. Although effective pain management is essential in neonatal care, overtreatment carries risks. Observational evidence suggests that prolonged or high-dose opioid exposure in very preterm infants is associated with altered cerebellar growth and less favorable cognitive and motor outcomes. Such findings underscore the need to carefully balance adequate analgesia with avoidance of unnecessary pharmacological exposure. Misinterpretation of natural sleep behaviors may shift that balance in unintended ways. Importantly, abnormal movements in infants with neurological injury or suspected seizures require careful clinical evaluation, and sleep-related twitching should always be interpreted within that broader neurological context.

To explore how active-sleep behaviors might influence bedside interpretation of infant comfort, we conducted a preliminary video-based assessment examining how neonatal nurses interpret typical sleep behavior using the COMFORTneo scale (Van Dijk et al. 2009). The COMFORTneo scale is widely used in the NICU and is often recorded multiple times each day to guide assessments of comfort and the potential need for intervention. In our exploratory analysis, 27 NICU nurses were asked to assign COMFORTneo scores to three pairs of 2-min videos, each pair showing active sleep or quiet sleep from one of three clinically stable preterm infants (median postmenstrual age: 30 weeks), filmed during care-free periods. In our assessment, videos of active-sleep periods were more likely to receive COMFORTneo scores exceeding a commonly used distress threshold (Figure 1B). Whereas the ratings for the quiet-sleep videos had a median COMFORTneo score of 8 with only 1 of 81 ratings (1.2%) reaching the distress threshold, ratings for the active-sleep videos had a median score of 15 with 56 of 81 ratings (69.1%) reaching or greatly exceeding the distress threshold. Of course, these short video recordings do not replicate the broader clinical context available during routine bedside care, where caregivers integrate prolonged observation and physiological monitoring. Nevertheless, our observations suggest that sleep-related twitches can influence clinical assessments in some contexts.

Our perspective is consistent with classic neonatal behavioral assessment frameworks in which the infant's behavioral state is considered a prerequisite for the interpretation of neurological or behavioral examinations. Prechtl emphasized that the evaluation of behavioral state should precede formal assessment, as motor activity, facial expressions, and autonomic responses vary substantially across state (Prechtl 1974). Assessing behavioral state remains challenging in modern NICU environments characterized by high clinical workload and intermittent bedside observation. The development of these competencies should be viewed as an adjunct to core NICU care.

Integrating sleep physiology into neonatal care should build upon existing neurodevelopmental and behavioral frameworks. Behavioral observation systems and validated comfort and pain scales have substantially improved the quality of neonatal care and are indispensable. At the same time, targeted education in behavioral-state recognition together with emerging objective monitoring approaches may help clinicians interpret infant behavior within its developmental context and further support individualized care.

Technological developments will further accelerate progress. Automated analysis of infant behavior and physiology is becoming increasingly feasible and may soon provide real-time support for bedside decision-making. Progress in this area will depend on continued collaboration between basic scientists, clinicians, and engineers, as well as careful clinical validation.

Sleep in early life is not passive: It is active, dynamic, and developmentally meaningful. As neonatal care continues to evolve toward individualized and evidence-informed practice, greater integration of sleep physiology into routine clinical workflows deserves renewed attention. Accordingly, a simple first step would be to modify current training practices so that behavioral-state identification is treated as an essential component of clinical

assessments of pain and discomfort. We believe that such a relatively simple adjustment will enable clinicians to more accurately and reliably distinguish actual distress from normal sleep behavior.

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Conflicts of Interest

The authors declare no conflicts of interest.

References

Aserinsky, E., and N. Kleitman. 1955. "A Motility Cycle in Sleeping Infants as Manifested by Ocular and Gross Bodily Activity." *Journal of Applied Physiology* 8: 11–18. https://doi.org/10.1152/JAPPL.1955.8.1.11.

Blumberg, M. S., J. C. Dooley, and A. Tiriac. 2022. "Sleep, Plasticity, and Sensory Neurodevelopment." *Neuron* 110: 3230–3242. https://doi.org/10.1016/J.NEURON.2022.08.005.

De Groot, E. R., M. A. Ryan, C. Sam, et al. 2023. "Evaluation of Sleep Practices and Knowledge in Neonatal Healthcare." *Advances in Neonatal Care* 23: 499–508. https://doi.org/10.1097/ANC.0000000000001102.

Prechtl, H. F. R. 1974. "The Behavioural States of the Newborn Infant (A Review)." *Brain Research* 76: 185–212. https://doi.org/10.1016/0006-8993(74)90454-5.

Roffwarg, H. P., J. N. Muzio, and W. C. Dement. 1966. "Ontogenetic Development of the Human Sleep-Dream Cycle." *Science* 152: 604–619. https://doi.org/10.1126/science.152.3722.604.

Sokoloff, G., T. G. Christiansen, H. C. Long, et al. 2026. "Twitching in Sleeping Premature Infants Provides a Sensitive Behavioral Assay of Early Motor Control." *iScience* 9: 115878. https://doi.org/10.1016/j.isci.2026.11587.

Van Dijk, M., D. W. E. Roofthooft, K. J. S. Anand, et al. 2009. "Taking up the Challenge of Measuring Prolonged Pain in (Premature) Neonates: The COMFORTneo Scale Seems Promising." *Clinical Journal of Pain* 25: 607–616. https://doi.org/10.1097/AJP.0B013E3181A5B52A.