

## **Bibliographic Sources - Pediatric grand Rounds - Why won't the baby just go to sleep? Understanding the neurobiology of sleep difficulties in infants with in utero opiate exposure.**

- Arditi-Babchuk H, Feldman R, Eidelman AI. Rapid eye movement (REM) in premature neonates and developmental outcome at 6 months. *Infant Behav Dev.* 2009;32(1):27-32. doi:10.1016/j.infbeh.2008.09.001
- Bada HS, Bauer CR, Shankaran S, et al. Central and autonomic system signs with in utero drug exposure. *Arch Dis Child Fetal Neonatal Ed.* 2002;87(2):106-112. doi:10.1136/fn.87.2.f106
- Bakhireva LN, Holbrook BD, Shrestha S, et al. Association between prenatal opioid exposure, neonatal opioid withdrawal syndrome, and neurodevelopmental and behavioral outcomes at 5–8 months of age. *Early Hum Dev.* 2019;128(October 2018):69-76. doi:10.1016/j.earlhumdev.2018.10.010
- Barbeau DY, Weiss MD. Sleep disturbances in newborns. *Children.* 2017;4(10). doi:10.3390/children4100090
- Bauer CR, Langer J, Lambert-Brown B, et al. Association of prenatal opiate exposure with youth outcomes assessed from infancy through adolescence. *J Perinatol.* 2020;40(7):1056-1065. doi:10.1038/s41372-020-0692-3
- Benninger KL, Borghese T, Kovalcik JB, et al. Prenatal Exposures Are Associated With Worse Neurodevelopmental Outcomes in Infants With Neonatal Opioid Withdrawal Syndrome. *Front Pediatr.* 2020;8(August):1-10. doi:10.3389/fped.2020.00462
- Bier JB, Finger AS, Bier BA, Johnson TA, Coyle MG. Growth and developmental outcome of infants with in-utero exposure to methadone vs buprenorphine. *J Perinatol.* 2015;35(8):656-659. doi:10.1038/jp.2015.22
- Boardman JP, Mactier H, Devlin LA. Opioids and the developing brain: Time to rethink perinatal care for infants of opioid-dependent mothers. *Arch Dis Child Fetal Neonatal Ed.* 2022;107(1):F98-F104. doi:10.1136/archdischild-2020-320102
- Bosch-Bayard J, Biscay RJ, Fernandez T, et al. EEG effective connectivity during the first year of life mirrors brain synaptogenesis, myelination, and early right hemisphere predominance. *Neuroimage.* 2022;252(August 2021):119035. doi:10.1016/j.neuroimage.2022.119035
- Buckley AW, Scott R, Tyler A, et al. State-Dependent Differences in Functional Connectivity in Young Children With Autism Spectrum Disorder. *EBioMedicine.* 2015;2(12):1905-1915. doi:10.1016/j.ebiom.2015.11.004
- Caritis SN, Panigrahy A. Opioids affect the fetal brain: reframing the detoxification debate. *Am J Obstet Gynecol.* 2019;221(6):602-608. doi:10.1016/j.ajog.2019.07.022
- Casavant SG, Meegan T, Fleming M, Hussain N, Gork S, Cong X. Integrated Review of the Assessment of Newborns With Neonatal Abstinence Syndrome. *JOGNN - J Obstet Gynecol Neonatal Nurs.* 2021;50(5):539-548. doi:10.1016/j.jogn.2021.04.014
- Conradt E, Crowell SE, Lester BM. Early life stress and environmental influences on the neurodevelopment of children with prenatal opioid exposure. *Neurobiol Stress.* 2018;9(March):48-54. doi:10.1016/j.ynstr.2018.08.005
- Coyle MG, Brogly SB, Ahmed MS, Patrick SW, Jones HE. Neonatal abstinence syndrome. *Nat Rev Dis Prim.* 2018;4(1). doi:10.1038/s41572-018-0045-0

- Davis JM, Shenberger J, Lester B. Comparison of Safety and Efficacy of Methadone vs Morphine for Treatment of Neonatal Abstinence Syndrome. *JAMA Pediatr.* 2018;172(8):741-748.
- Davis KF, Parker KP, Montgomery GL. Sleep in infants and young children - Part one: Normal sleep. *J Pediatr Heal Care.* 2004;18(2):65-71. doi:10.1016/S0891-5245(03)00149-4
- Dereymaeker A, Vervisch J. Review of sleep-EEG in preterm and term neonates. *Early Hum Dev.* 2017;113:87-103. doi:10.1016/j.earlhumdev.2017.07.003.Review
- Dickinson A, Daniel M, Marin A, et al. Multivariate neural connectivity patterns in early infancy predict later autism symptoms. *Biol Psychiatry Cogn Neurosci Neuroimaging.* 2021;6(1):59-69. doi:10.1016/j.bpsc.2020.06.003.Multivariate
- Dinges DF, Davis MM, Glass P. Fetal exposure to narcotics: Neonatal sleep as a measure of nervous system disturbance. *Science (80- ).* 1980;209(445):619-621. doi:10.1126/science.7190326
- Fodor A, Tímár J, Zelena D. Behavioral effects of perinatal opioid exposure. *Life Sci.* 2014;104(1-2):1-8. doi:10.1016/j.lfs.2014.04.006
- Frers A, Shaffer J, Edinger J, Wachholtz A. The relationship between sleep and opioids in chronic pain patients. *J Behav Med.* 2021;44(3):412-420. doi:10.1007/s10865-021-00205-1
- Fries P. A mechanism for cognitive dynamics: Neuronal communication through neuronal coherence. *Trends Cogn Sci.* 2005;9(10):474-480. doi:10.1016/j.tics.2005.08.011
- González JJ, Mañas S, De Vera L, et al. Assessment of electroencephalographic functional connectivity in term and preterm neonates. *Clin Neurophysiol.* 2011;122(4):696-702. doi:10.1016/j.clinph.2010.08.025
- Grisham LM, Stephen MM, Coykendall MR, Kane MF, Maurer JA, Bader MY. Eat, Sleep, Console Approach: A Family-Centered Model for the Treatment of Neonatal Abstinence Syndrome. *Adv Neonatal Care.* 2019;19(2):138-144. doi:10.1097/ANC.0000000000000581
- Grossman MR, Berkwitz AK, Osborn RR, et al. An initiative to improve the quality of care of infants with neonatal abstinence syndrome. *Pediatrics.* 2017;139(6). doi:10.1542/peds.2016-3360
- Hardin JS, Jones NA, Mize KD, Platt M. Parent-Training with Kangaroo Care Impacts Infant Neurophysiological Development & Mother-Infant Neuroendocrine Activity. *Infant Behav Dev.* 2020;58. doi:10.1016/j.infbeh.2019.101416
- Heller NA, Shrestha H, Morrison DG, et al. Neonatal sleep development and early learning in infants with prenatal opioid exposure. In: *Advances in Child Development and Behavior.* ; 2021:199-228.
- Hirai AH, Ko JY, Owens PL, Stocks C, Patrick SW. Neonatal Abstinence Syndrome and Maternal Opioid-Related Diagnoses in the US, 2010-2017. 2021;325(2):146-155. doi:10.1001/jama.2020.24991
- Holditch-Davis D. The development of sleeping and waking states in high-risk preterm infants. *Infant Behav Dev.* 1990;13(4):513-531. doi:10.1016/0163-6383(90)90020-9
- Holditch-Davis D, Scher M, Schwartz T, Hudson-Barr D. Sleeping and waking state development in preterm infants. *Early Hum Dev.* 2004;80(1):43-64. doi:10.1016/j.earlhumdev.2004.05.006
- Holmes AV, Atwood EC, Whalen B, et al. Rooming-In to treat neonatal abstinence syndrome: Improved family-centered care at lower cost. *Pediatrics.* 2016;137(6). doi:10.1542/peds.2015-2929

- Hunt RW, Tzioumi D, Collins E, Jeffery HE. Adverse neurodevelopmental outcome of infants exposed to opiate in-utero. *Early Hum Dev.* 2008;84:29-35. doi:10.1016/j.earlhumdev.2007.01.013
- Jones HE, Kaltenbach K, Heil SH, et al. Neonatal abstinence syndrome after methadone or buprenorphine exposure. *Obstet Gynecol Surv.* 2011;66(4):191-193. doi:10.1097/OGX.0b013e318225c419
- Jones HE, Seashore C, Johnson E, et al. Psychometric Assessment of the Neonatal Abstinence Scoring System and the MOTHER NAS Scale. *Am J Addict.* 2016;25(5):370-373. doi:doi:10.1111/ajad.12388
- Kraft WK, Dysart K, Greenspan JS, Gibson E, Kaltenbach K, Ehrlich ME. Revised Dose Schema of Sublingual Buprenorphine in the Treatment of Neonatal Opioid Abstinence Syndrome. *Addiction.* 2011;106(3):574-580. doi:10.1038/nature08365.Reconstructing
- Lee SJ, Bora S, Austin NC, Westerman A, Henderson JMT. Neurodevelopmental Outcomes of Children Born to Opioid-Dependent Mothers: A Systematic Review and Meta-Analysis. *Acad Pediatr.* 2020;20(3):308-318. doi:10.1016/j.acap.2019.11.005
- Lemon LS, Caritis SN, Venkataramanan R, Platt RW, Bodnar LM. Methadone Versus Buprenorphine for Opioid Use Dependence and Risk of Neonatal Abstinence Syndrome. *Epidemiology.* 2018;29(2):261-268. doi:10.1097/EDE.0000000000000780
- Levine TA, Davie-Gray A, Kim HM, Lee SJ, Woodward LJ. Prenatal methadone exposure and child developmental outcomes in 2-year-old children. *Dev Med Child Neurol.* 2021;63(9):1114-1122. doi:10.1111/dmcn.14808
- Limjoco J, Zawadzki L, Belden M, Eickhoff J, Ikonomidou C. Amplitude-integrated EEG use in neonatal abstinence syndrome: a pilot study. *J Matern Neonatal Med.* 2020;33(21):3565-3570. doi:10.1080/14767058.2019.1579190
- Lu R, Liu X, Long H, Ma L. Effects of prenatal cocaine and heroin exposure on neuronal dendrite morphogenesis and spatial recognition memory in mice. *Neurosci Lett.* 2012;522(2):128-133. doi:10.1016/j.neulet.2012.06.023
- Mangat AK, Schmölder GM, Kraft WK. Pharmacological and non-pharmacological treatments for the Neonatal Abstinence Syndrome (NAS). *Semin Fetal Neonatal Med.* 2019;24(2):133-141. doi:10.1016/j.siny.2019.01.009
- McCarthy JJ, Terplan M. Detoxification from opiates during pregnancy: stressing the fetal brain. *Am J Obstet Gynecol.* 2016;215(5):670.e1-670.e2. doi:10.1016/j.ajog.2016.05.041
- McCarthy JJ. Intrauterine abstinence syndrome (IAS) during buprenorphine inductions and methadone tapers: Can we assure the safety of the fetus? *J Matern Neonatal Med.* 2012;25(2):109-112. doi:10.3109/14767058.2011.600371
- McLaren J, Holmes GL, Berg MT. Functional Connectivity in Term Neonates With Hypoxic-Ischemic Encephalopathy Undergoing Therapeutic Hypothermia. *Pediatr Neurol.* 2019;94:74-79. doi:10.1016/j.pediatrneurol.2019.01.006
- McQueen K, Taylor C, Murphy-Oikonen J. Systematic Review of Newborn Feeding Method and Outcomes Related to Neonatal Abstinence Syndrome. *JOGNN - J Obstet Gynecol Neonatal Nurs.* 2019;48(4):398-407. doi:10.1016/j.jogn.2019.03.004
- Meijer EJ, Hermans KHM, Zwanenburg A, et al. Functional connectivity in preterm infants derived from EEG coherence analysis. *Eur J Paediatr Neurol.* 2014;18(6):780-789. doi:10.1016/j.ejpn.2014.08.003

- Miller PA, Willier T. Baby STRENGTH: Eat, Sleep, Console for Infants with Neonatal Abstinence Syndrome. *Adv Neonatal Care*. 2021;21(2):99-106. doi:10.1097/ANC.0000000000000840
- Mirmiran M, Maas YGH, Ariagno RL. Development of fetal and neonatal sleep and circadian rhythms. *Sleep Med Rev*. 2003;7(4):321-334. doi:10.1053/smr.2002.0243
- Moe V. Foster-placed and adopted children exposed in utero to opiates and other substances: Prediction and outcome at four and a half years. *J Dev Behav Pediatr*. 2002;23(5):330-339. doi:10.1097/00004703-200210000-00006
- Nygaard E, Slinning K, Moe V, Walhovd KB. Behavior and attention problems in eight-year-old children with prenatal opiate and poly-substance exposure: A longitudinal study. *PLoS One*. 2016;11(6):1-21. doi:10.1371/journal.pone.0158054
- O'Brien CM, Jeffery HE. Sleep deprivation, disorganization and fragmentation during opiate withdrawal in newborns. *J Paediatr Child Health*. 2002;38(1):66-71. doi:10.1046/j.1440-1754.2002.00724.x
- Patrick SW, Davis MM, Lehmann CU, Cooper WO, Lehman CU, Cooper WO. Increasing incidence and geographic distribution of neonatal abstinence syndrome: United States 2009 to 2012. *J Perinatol*. 2015;35(8):650-655. doi:10.1038/jp.2015.36
- Patrick SW, Slaughter JC, Harrell FE, et al. Development and Validation of a Model to Predict Neonatal Abstinence Syndrome. *J Pediatr*. 2021;229:154-160.e6. doi:10.1016/j.jpeds.2020.10.030
- Pinto F, Torrioli MG, Casella G, Tempesta E, Fundarò C. Sleep in babies born to chronically heroin addicted mothers. A follow up study. *Drug Alcohol Depend*. 1988;21(1):43-47. doi:10.1016/0376-8716(88)90009-9
- Rana D, Pollard L, Rowland J, Dhanireddy R, Pourcyrus M. Amplitude-integrated EEG in infants with neonatal abstinence syndrome. *J Neonatal Perinatal Med*. 2020;12(4):391-397. doi:10.3233/NPM-1834
- Rose-Jacobs R, Trevino-Talbot M, Lloyd-Travaglini C, et al. Could prenatal food insecurity influence neonatal abstinence syndrome severity? *Addiction*. 2019;114(2):337-343. doi:10.1111/add.14458
- Sarfi M, Smith L, Waal H, Sundet JM. Risks and realities: Dyadic interaction between 6-month-old infants and their mothers in opioid maintenance treatment. *Infant Behav Dev*. 2011;34(4):578-589. doi:10.1016/j.infbeh.2011.06.006
- Sargeant TJ, Miller JH, Day DJ. Opioidergic regulation of astroglial/neuronal proliferation: Where are we now? *J Neurochem*. 2008;107(4):883-897. doi:10.1111/j.1471-4159.2008.05671.x
- Scher MS, Stepe DA, Banks DL. Prediction of lower developmental performances of healthy neonates by neonatal EEG-sleep measures. *Pediatr Neurol*. 1996;14(2):137-144. doi:10.1016/0887-8994(96)00013-6
- Shellhaas RA, Chervin RD, Barks JDE, Hassan F, Carlson MD, Burns JW. Lateralized neonatal EEG coherence during sleep predicts language outcome. *Pediatr Res*. 2022;91(4):962-969. doi:10.1038/s41390-021-01554-y
- Smith K. As Opioid Use Climbs, Neonatal Abstinence Syndrome Rises in New Hampshire | Carsey School of Public Policy | UNH. 2017. <https://carsey.unh.edu/publication/opioid-nas-nh>.
- Suarez EA, Huybrechts KF, Straub L, et al. Buprenorphine versus Methadone for Opioid Use Disorder in Pregnancy. *N Engl J Med*. 2022;387(22):2033-2044. doi:10.1056/nejmoa2203318

- Sun L, Tang J, Liljenbäck H, et al. Seasonal variation in the brain mu-opioid receptor availability. *J Neurosci*. 2021;41(6):1265-1273. doi:10.1523/JNEUROSCI.2380-20.2020
- Terplan M, Laird HJ, Hand DJ, et al. Opioid Detoxification During Pregnancy: A Systematic Review. *Obs Gynecol*. 2018;131(5):803-814. doi:10.1097/AOG.0000000000002562. Opioid
- Tobon AL, Habecker E, Forray A. Opioid Use in Pregnancy. *Curr Psychiatry Rep*. 2019;21(118):12-14. doi:10.1007/s11920-019-1110-4
- Touchette E, Petit D, Séguin JR, Boivin M, Tremblay RE, Montplaisir JY. Associations between sleep duration patterns and behavioral/cognitive functioning at school entry. *Sleep*. 2007;30(9):1213-1219. doi:10.1093/sleep/30.9.1213
- Wachman EM, Grossman M, Schiff DM, et al. Quality improvement initiative to improve inpatient outcomes for Neonatal Abstinence Syndrome. *J Perinatol*. 2018;38:1114–1122. doi:10.1038/s41372-018-0109-8
- Walhovd K V, Moe V, Slinning K, et al. Volumetric cerebral characteristics of children exposed to opiates and other substances in utero. *Bone*. 2008;23(1):1-7. doi:10.1038/nature08365. Reconstructing
- Walhovd KB, Watts R, Amlien I, Woodward LJ. Neural tract development of infants born to methadone-maintained mothers. *Pediatr Neurol*. 2012;47(1):1-6. doi:10.1016/j.pediatrneurol.2012.04.008
- Winkelman TNA, Villapiano N, Kozhimannil KB, Davis MM, Patrick SW. Incidence and Costs of neonatal abstinence syndrome among infants with Medicaid: 2004-2014. *Pediatrics*. 2018;141(4):1-8. doi:10.1542/peds.2017-3520
- Wouldes TA, Woodward LJ. Neurobehavior of newborn infants exposed prenatally to methadone and identification of a neurobehavioral profile linked to poorer neurodevelopmental outcomes at age 24 months. *PLoS One*. 2020;15(10 October):1-18. doi:10.1371/journal.pone.0240905
- Young LW, Ounpraseuth S, Merhar SL, et al. Eating, Sleeping, Consoling for Neonatal Opioid Withdrawal (ESC-NOW): a Function-Based Assessment and Management Approach study protocol for a multi-center, stepped-wedge randomized controlled trial. *Trials*. 2022;23(1):1-35. doi:10.1186/s13063-022-06445-z
- Zedler BK, Mann AL, Kim MM, et al. Buprenorphine compared with methadone to treat pregnant women with opioid use disorder: a systematic review and meta-analysis of safety in the mother, fetus and child. *Addiction*. 2016;111:2115-2128. doi:10.1111/add.13462