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Pain and Stress in the NICU

Anand KJ. Pharmacological approaches to the management of pain in the neonatal intensive care unit. *J Perinatol.* 2007;27 Suppl 1:S4-S11. Review. PubMed PMID: 17453028.

Anand KJ, Hall RW, Desai N, et al. Effects of morphine analgesia in ventilated preterm neonates: primary outcomes from the NEOPAIN randomised trial. *Lancet.* 2004;363(9422): 1673-1682. PubMed PMID: 15158628.

Anand KJS. Defining pain in newborns: need for a uniform taxonomy? *Acta Paediatr.* 2017 Sep;106(9):1438-1444. doi: 10.1111/apa.13936. Epub 2017 Jul 18. Review. PubMed PMID: 28556311; PubMed Central PMCID: PMC5601230.

Anand KJS, Eriksson M, Boyle EM, et al. Assessment of continuous pain in newborns admitted to NICUs in 18 European countries. *Acta Paediatr.* 2017;106(8):1248-1259. doi: 10.1111/apa.13810. Epub 2017 Apr 17. PubMed PMID: 28257153.

Ancora G, Lago P, Garetti E, Pirelli A, Merazzi D, et al. Efficacy and safety of continuous infusion of fentanyl for pain control in preterm newborns on mechanical ventilation. *J Pediatr.* 2013 Sep;163(3):645-51.e1. doi: 10.1016/j.jpeds.2013.02.039. Epub 2013 Apr 10. PubMed PMID: 23582138.

Ancora G, Lago P, Garetti E, et al. Follow-up at the corrected age of 24 months of preterm newborns receiving continuous infusion of fentanyl for pain control during mechanical ventilation. *Pain.* 2017;158(5):840-845. doi: 10.1097/j.pain.0000000000000839. PubMed PMID: 28240994.

Bellu R, de Waal KA, Zanini R. Opioids for neonates receiving mechanical ventilation. *Cochrane Database Syst Rev.* 2008(1):CD004212. doi: 10.1002/14651858.CD004212.pub3. Review. PubMed PMID: 18254040.

Carbajal R, Eriksson M, Courtois E, et al. Sedation and analgesia practices in neonatal intensive care units (EUROPAIN): results from a prospective cohort study. *Lancet Respir Med.* 2015;3(10):796-812. doi: 10.1016/S2213-2600(15)00331-8. Epub 2015 Sep 24. Erratum in: *Lancet Respir Med.* 2015 Dec;3(12):e44. PubMed PMID: 26420017.

Committee On F, Newborn, Section On A, Pain M. Prevention and Management of Procedural Pain in the Neonate: An Update. *Pediatrics.* 2016;137(2):e20154271. doi: 10.1542/peds.2015-4271. Epub 2016 Jan 25. PubMed PMID: 26810788.

Cong X, Wu J, Vittner D, et al. The impact of cumulative pain/stress on neurobehavioral development of preterm infants in the NICU. *Early Hum Dev.* 2017;108:9-16. doi: 10.1016/j.earlhumdev.2017.03.003. Epub 2017 Mar 23. PubMed PMID: 28343092; PubMed Central PMCID: PMC5444300.

Courtois E, Droutman S, Magny JF, et al. Epidemiology and neonatal pain management of heelsticks in intensive care units: EPIPPAIN 2, a prospective observational study. *Int J Nurs Stud.* 2016;59:79-88. doi: 10.1016/j.ijnurstu.2016.03.014. Epub 2016 Mar 30. PubMed PMID: 27222453.



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de Graaf J, van Lingen RA, Simons SH, et al. Long-term effects of routine morphine infusion in mechanically ventilated neonates on children's functioning: five-year follow-up of a randomized controlled trial. *Pain*. 2011;152(6):1391-1397. doi: 10.1016/j.pain.2011.02.017. Epub 2011 Mar 12. PubMed PMID: 21402444.

de Graaf J, van Lingen RA, Valkenburg AJ, et al. Does neonatal morphine use affect neuropsychological outcomes at 8 to 9 years of age? *Pain*. 2013;154(3):449-458. doi: 10.1016/j.pain.2012.12.006. Epub 2012 Dec 20. PubMed PMID: 23352760.

Deindl P, Giordano V, Fuiko R, et al. The implementation of systematic pain and sedation management has no impact on outcome in extremely preterm infants. *Acta Paediatr*. 2016;105(7):798-805. doi: 10.1111/apa.13334. Epub 2016 Feb 10. PubMed PMID: 26792117.

Duerden EG, Guo T, Dodbiba L, et al. Midazolam dose correlates with abnormal hippocampal growth and neurodevelopmental outcome in preterm infants. *Ann Neurol*. 2016;79(4):548-559. doi: 10.1002/ana.24601. Epub 2016 Feb 15. PubMed PMID: 26754148.

Ferguson SA, Ward WL, Paule MG, Hall RW, Anand KJ. A pilot study of preemptive morphine analgesia in preterm neonates: effects on head circumference, social behavior, and response latencies in early childhood. *Neurotoxicol Teratol*. 2012;34(1):47-55. doi: 10.1016/j.ntt.2011.10.008. Epub 2011 Nov 7. PubMed PMID: 22094261.

Fitzgerald M, Walker SM. Infant pain management: a developmental neurobiological approach. *Nat Clin Pract Neurol*. 2009;5(1):35-50. doi: 10.1038/ncpnuro0984. Review. PubMed PMID: 19129789.

Lago P, Frigo AC, Baraldi E, et al. Sedation and analgesia practices at Italian neonatal intensive care units: results from the EUROPAIN study. *Ital J Pediatr*. 2017;43(1):26. doi: 10.1186/s13052-017-0343-2. PubMed PMID: 28270167; PubMed Central PMCID: PMC5341165.

Levene M. Morphine sedation in ventilated newborns: who are we treating? *Pediatrics*. 2005;116(2):492-493. PubMed PMID: 16061608.

Ng E, Taddio A, Ohlsson A. Intravenous midazolam infusion for sedation of infants in the neonatal intensive care unit. *Cochrane Database Syst Rev*. 2017;1:CD002052. doi: 10.1002/14651858.CD002052.pub3. Review. PubMed PMID: 28141899; PubMed Central PMCID: PMC6464963.

Porter FL, Grunau RE, Anand KJ. Long-term effects of pain in infants. *J Dev Behav Pediatr*. 1999;20(4):253-261. Review. PubMed PMID: 10475600.

Roze JC, Denizot S, Carbajal R, et al. Prolonged sedation and/or analgesia and 5-year neurodevelopment outcome in very preterm infants: results from the EPIPAG cohort. *Arch Pediatr Adolesc Med*. 2008;162(8):728-733. doi: 10.1001/archpedi.162.8.728. PubMed PMID: 18678804.

Simons SH, van Dijk M, van Lingen RA, et al. Routine morphine infusion in preterm newborns who received ventilatory support: a randomized controlled trial. *JAMA*. 2003;290(18):2419-2427. PubMed PMID: 14612478.

Steinhorn R, McPherson C, Anderson PJ, Neil J, Doyle LW, Inder T. Neonatal morphine exposure in very preterm infants-cerebral development and outcomes. *J Pediatr*. 2015;166(5):1200-1207 e1204. doi: 10.1016/j.jpeds.2015.02.012. Erratum in: *J Pediatr*. 2015 Jul;167(1):215. PubMed PMID: 25919729; PubMed Central PMCID: PMC4928575.



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Valkenburg AJ, van den Bosch GE, de Graaf J, et al. Long-Term Effects of Neonatal Morphine Infusion on Pain Sensitivity: Follow-Up of a Randomized Controlled Trial. *J Pain.* 2015;16(9):926-933. doi: 10.1016/j.jpain.2015.06.007. Epub 2015 Jun 25. PubMed PMID: 26120056.

van den Bosch GE, White T, El Marroun H, et al. Prematurity, Opioid Exposure and Neonatal Pain: Do They Affect the Developing Brain? *Neonatology.* 2015;108(1):8-15. doi: 10.1159/000376566. Epub 2015 Apr 11. PubMed PMID: 25871803.

van Ganzewinkel CJ, Anand KJ, Kramer BW, Andriessen P. Chronic pain in the newborn: toward a definition. *Clin J Pain.* 2014;30(11):970-977. doi: 10.1097/AJP.0000000000000056. PubMed PMID: 24296909.

Zwicker JG, Miller SP, Grunau RE, et al. Smaller Cerebellar Growth and Poorer Neurodevelopmental Outcomes in Very Preterm Infants Exposed to Neonatal Morphine. *J Pediatr.* 2016;172:81-87 e82. doi: 10.1016/j.jpeds.2015.12.024. Epub 2016 Jan 4. PubMed PMID: 26763312; PubMed Central PMCID: PMC5462546.

Duerden EG, Grunau RE, Guo T, et al. Early Procedural Pain Is Associated with Regionally-Specific Alterations in Thalamic Development in Preterm Neonates. *J Neurosci.* 2018;38(4):878-886. doi: 10.1523/JNEUROSCI.0867-17.2017. Epub 2017 Dec 18. PubMed PMID: 29255007; PubMed Central PMCID: PMC5783966.

Vinall J, Miller SP, Bjornson BH, et al. Invasive procedures in preterm children: brain and cognitive development at school age. *Pediatrics.* 2014;133(3):412-421. doi: 10.1542/peds.2013-1863. Epub 2014 Feb 17. PubMed PMID: 24534406; PubMed Central PMCID: PMC3934331.