

OnabotulinumtoxinA (Botox®)

Selected References:

- Bodkin CL, et al. 2005. OnabotulinumtoxinA therapy during pregnancy. *Mov Disord* 20(8): 1081-1082.
- Briggs J, et al. 2005. *Drugs in pregnancy and lactation*, 7th Ed. 174-175. Lippincott Williams & Wilkins: Philadelphia.
- Brin MF, et al. 2016. Pregnancy outcomes following exposure to onabotulinumtoxinA. *Pharmacoepidemiology and Drug Safety*. 25: 179-187.
- Brin, MF, et al 2023. Pregnancy outcomes in patients exposed to onabotulinumtoxinA treatment. *Neurology*. 101: e103-e113.
- Cardon BR, Smith ME, Cerrati EW. 2021 May-June. Case Series of Botulinum Toxin Administered to Pregnant Patients and Review of the Literature. *Facial Plast Surg Aesthet Med*. 23(3):187-190. De Oliveira Monteiro E. 2006. Botulinum toxin and pregnancy. *Skinmed* 5(6): 308.
- Li Yim and Weir CR. 2010. Botulinum toxin and pregnancy – cautionary tale. *Strabismus* 18(2): 65-66.
- Morgan JC, et al. 2006. Botulinum toxin A during pregnancy: a survey of treating physicians. *J Neurol Neurosurg Psychiatry* 77 (1) 117-119.
- Newman W.J., et al 2004. OnabotulinumtoxinA therapy during pregnancy. *Mov Disord* 19(11): 1384-1385.
- Polo JM, et al. 1996. Botulism and pregnancy. *Lancet* 348: 195.
- Robinson AY, Grogan PM. OnabotulinumtoxinA successfully used as migraine prophylaxis during pregnancy: a case report. *Mil Med*. 2014 Jun;179(6):e703-4.
- St. Clair EH, et al. 1975. Observations of an infant born to a mother with botulism. *J Pediatr* 87: 658.
- Wataganara T, et al. 2009. Treatment of severe achalasia during pregnancy with esophagoscopy injection of botulinum toxin A: a case report. *J Perinatol* 29(9): 639.
- Wong HT, et al. 2020. OnabotulinumtoxinA for chronic migraine during pregnancy: a real-world experience on 45 patients. *J Headache Pain*. 21(1):129.
- Wong HT, et al. 2025. OnabotulinumtoxinA treatment for chronic migraine in pregnancy: An updated report of real-world headache and pregnancy outcomes over 14 years in Hull. *Cephalalgia* 45(5):3331024251327387.

Mga Tanong? Tumawag sa 866.626.6847 | Mag-text sa 855.999.3525 | Mag-email o Makipag-chat sa [MotherToBaby.org](https://www.MotherToBaby.org).

Disclaimer: MotherToBaby Fact Sheets are meant for general information purposes and should not replace the advice of your health care provider. MotherToBaby is a service of the non-profit Organization of Teratology Information Specialists (OTIS). Copyright by OTIS, January 1, 2026.

OnabotulinumtoxinA (Botox®)

Selected References:

- Alembic Pharmaceuticals Inc. 2017. Metoprolol tartrate product labeling. <https://dailymed.nlm.nih.gov/dailymed/drugInfo.cfm?setid=24837d82-0f3f-4482-9af0-31e5f675c30f>. Accessed 27 Jan 2026.
- Bateman BT, et al. 2016. Late pregnancy β blocker exposure and risks of neonatal hypoglycemia and bradycardia. *Pediatrics*; 138(3). pii:e20160731.
- Battarbee AN, et al. 2020. Chronic hypertension in pregnancy. *Am J Obstet Gynecol*; 222(6):532-541.
- Davis RL, et al. 2011. Risks of congenital malformations and perinatal events among infants exposed to calcium channel and beta-blockers during pregnancy. *Pharmacoepidemiol Drug Saf*. 20(2):138-145.
- Duan L, et al. 2017. β -Blocker exposure in pregnancy and risk of fetal cardiac anomalies. *JAMA Intern Med*. 177(6): 885-887.
- Duan L, et al. 2018. Beta-blocker subtypes and risk of low birth weight in newborns. *J Clin Hypertens* 20(11):1603-1609.
- Firoz T, et al. 2014. Community Level Interventions for Pre-Eclampsia (CLIP) Working Group. Oral antihypertensive therapy for severe hypertension in pregnancy and postpartum: a systematic review. *BJOG*. 121(10):1210-1218.
- Kulas J et al. 1984. Atenolol and metoprolol. A comparison of their excretion into human breast milk. *Acta Obstet Gynecol Scand Suppl*. 118: 65-69.
- Lindeberg S et al. 1984. Disposition of the adrenergic blocker metoprolol in the late-pregnant woman, the amniotic fluid, the cord blood and the neonate. *Acta Obstet Gynecol Scand Suppl*. 118: 61-64.
- Ruys TP, et al. 2014. Cardiac medication during pregnancy, data from the ROPAC. *Int J Cardiol*. 15. 177(1):124-8.
- Sandstrom B, Regardh CG. 1980. Metoprolol excretion in breast milk. *Br J Clin Pharmacol*. 9: 518-519.
- Tamirisa KP, et al. 2022. Arrhythmias in Pregnancy. *JACC Clin Electrophysiol*. 8(1):120-135.
- Tanaka K, 2016. Beta-blockers and fetal growth restriction in pregnant women with cardiovascular disease. *Circ J*. 80(10):2221-2226.
- Welzel T, et al. 2021. Intrauterine Growth Retardation in Pregnant Women with Long QT Syndrome Treated with Beta-Receptor Blockers. *Neonatology*. 118(4):406-415.
- Wichman K et al. 1984. A placebo controlled trial of metoprolol in the treatment of hypertension in pregnancy. *Scand J Clin Lab Invest Suppl*. 169: 90-95.
- Xie RH, et al. 2014. Beta-blockers increase the risk of being born small for gestational age or of being institutionalised during infancy. *BJOG*. 121(9):1090-1096.
- Yakoob MY, et al. 2013. The risk of congenital malformations associated with exposure to β -blockers in pregnancy: a meta-analysis. *Hypertension* 62(2):375-381.

Mga Tanong? Tumawag sa 866.626.6847 | Mag-text sa 855.999.3525 | Mag-email o Makipag-chat sa [MotherToBaby.org](https://www.MotherToBaby.org).

Disclaimer: MotherToBaby Fact Sheets are meant for general information purposes and should not replace the advice of your health care provider. MotherToBaby is a service of the non-profit Organization of Teratology Information Specialists (OTIS). Copyright by OTIS, January 1, 2026.

OnabotulinumtoxinA (Botox®)

Selected References:

- AlHarthi A, et al. 2023. Investigating behavioral and neuronal changes in adolescent mice following prenatal exposure to electronic cigarette (e-cigarette) vapor containing nicotine. *Brain Sci*, 13(10): 1417.
- Archie S, et al. 2023. Maternal e-cigarette use can disrupt postnatal blood-brain barrier (BBB) integrity and deteriorates motor, learning and memory function: influence of sex and age. *Fluids Barriers CNS*, 20.
- Baez-Loya S, et al. 2014. Perceptions about e-cigarette safety may lead to e-smoking during pregnancy. *Bull Menninger Clin*. 78(3):243-52.
- Bednarczyk N, et al. 2022. Nicotine replacement therapy and e-cigarettes in pregnancy and infant respiratory outcomes. *Early Hum Dev*, 164:105509.
- Bell L, et al. 2023. Use of e-cigarettes in pregnancy: a systematic review of evidence published from 2020-2022. *Journal of Public Health*, 33: 315-328
- Bolumen-Lopez A, et al. 2025. Neonatal nicotine withdrawal in a newborn exposed to maternal e-cigarette use. *J Neonatal Perinatal Med*. Published online October 9, 2025.
- Cardenas VM, et al. 2019. Use of Electronic Nicotine Delivery Systems (ENDS) by pregnant women I: Risk of small-for-gestational-age birth. *Tobacco induced diseases*, 17:44.
- Centers for Disease Control and Prevention (CDC). 2018. Electronic Cigarettes. https://www.cdc.gov/tobacco/e-cigarettes/?CDC_AAref_Val=https://www.cdc.gov/tobacco/basic_information/e-cigarettes/index.htm [Accessed 4/2025].
- Centers for Disease Control and Prevention (CDC). 2023: General Information About Secondhand Smoke. https://www.cdc.gov/tobacco/secondhand-smoke/?CDC_AAref_Val=https://www.cdc.gov/tobacco/secondhand-smoke/about.html [Accessed 4/2025].
- Çetin T & Durmaz Ö. 2024. An assessment of the impact of smoking and vaping during pregnancy on placental dysfunction using shear-wave elastography. *Arch Basic Clin Res*, 6(3): 188-194.
- Chen T, et al. 2023. Ovarian toxicity of e-cigarette liquids: effects of components and high and low nicotine concentration e-cigarette liquid in vitro. *Tobacco Induced Diseases*, 21:128.
- Deprato A, et al. 2025. Associations between vaping during pregnancy and perinatal outcomes: A systematic review and meta-analysis. *J Hazard Mater.*;486:137028.
- Froggatt S, et al. 2020. The effects of prenatal cigarette and e-cigarette exposure on infant neurobehavior: A comparison to a control group. *EClinicalMedicine*, 28:10062.
- Hahn J, et al. 2014. Electronic cigarettes: overview of chemical composition and exposure estimation. *Tob Induc Dis*, 12(1):23.
- Galanti F, et al. 2023. Impact of different typologies of smoking on ovarian reserve and oocyte quality in women performing ICSI cycles: an observational prospective study. *Eur Rev Med Pharmacol Sci*. 27(11):5190-5199.
- Holmboe SA, et al. 2020. Use of e-cigarettes associates with lower sperm counts in a cross-sectional study of young men from the general population. *Hum Reprod*, 35(7):1693-1701.

- Kahr MK, et al. 2015. A qualitative assessment of the perceived risks of electronic cigarette and hookah use in pregnancy. *BMC Public Health*. 15(1):1273.
- Kim S, Oancea SC. 2020. Electronic cigarettes may not be a “safer alternative” of conventional cigarettes during pregnancy: Evidence from the nationally representative PRAMS data. *BMC Pregnancy Childbirth*, 20(1):557.
- Kim HK, et al. 2025. Impact of conventional cigarette and electronic cigarette use on sperm quality and IVF/ICSI outcomes. *Sci Rep*. ;15(1):23714.
- Kopa-Stojak PN & Pawliczak R. 2024. Disposable electronic cigarettes – chemical composition and health effects of their use. A systematic review. *Toxicology Mechanisms and Methods*, 35(3): 250-261.
- Le AD, et al. 2025. A Preconception Cohort Study of Nicotine Vaping and Incidence of Spontaneous Abortion. *Nicotine Tob Res*. Published online July 3, 2025.
- Lin S, et al. 2023. E-cigarette use during pregnancy and its association with adverse birth outcomes in the US. *Prev Med*, 166:107375.
- McDonnell BP, et al. 2020. Electronic cigarettes and obstetric outcomes: A prospective observational study. *BJOG*, 127(6):750-756.
- Nanninga EK et al. 2023. Adverse maternal and infant outcomes of women who differ in smoking status: e-cigarette and tobacco cigarette users. *Int. J. Environ. Res. Public Health*, 20(3): 2632.
- Nguyen T, et al. 2018. Maternal e-cigarette exposure results in cognitive and epigenetic alterations in offspring in a mouse model. *Chemical research in toxicology*, 31(7): 601-611.
- Noël A, et al. 2020. In utero exposures to electronic-cigarette aerosols impair the *Wnt* signaling during mouse lung development. *American journal of physiology. Lung cellular and molecular physiology*, 318(4):L705-L722.
- O’Connell, A., et al. 2025. Vaping and Smoking in Pregnancy-A Meta-Analysis of Neurobehavioural Development in Prenatally Exposed Offspring. *Acta paediatrica (Oslo, Norway : 1992)*, 114(12), 3108-3121.
- Orzabal MR, et al. 2019. Chronic exposure to e-cig aerosols during early development causes vascular dysfunction and offspring growth deficits. *Translational research: the journal of laboratory and clinical medicine*, 207:70-82.
- Popham K & Kandasamy Y. 2023. The impact of smoking and nicotine exposure during pregnancy on fetal nephrogenesis: a systematic review. *Journal of Developmental Origins of Health and Disease*, 14(5): 559-569.
- Phillips L et al. 2023. Developing a taxonomy to describe offspring outcomes in studies involving pregnant mammals’ exposure to non-tobacco nicotine: a systematic scoping review. *Plos One*, 18(2).
- Sana M et al. 2023. Maternal cigarette and electronic cigarette use before pregnancy associated with the risk of hypertension and gestational hypertension. *Obstetrics & Gynecology*, 141(5S): 83S-83S.
- Sukhato K, et al. 2025. Comparative effects of electronic cigarettes and dual use of electronic and conventional cigarettes on adverse pregnancy outcomes: a systematic review and meta-analysis. *BMC Public Health*. Published online November 28, 2025.
- Suter MA, et al. 2015. Is there evidence for potential harm of electronic cigarette use in pregnancy? *Birth Defects Res A Clin Mol Teratol*, 103(3):186-95.
- Trapphoff T, et al. 2024. Consumption of hookahs, e-cigarettes, and classic cigarettes and the impact on medically assisted reproduction treatment. *Sci Rep*.;14(1):9597.
- Vallée A, et al. 2025. Maternal vaping and pregnancy adverse outcomes: A systematic review and meta-analysis. *Women Birth* ;38(5):101951.
- Walayat A et al. 2024. Maternal e-cigarette exposure alters DNA methylome, site-specific CpG and CH methylation, and transcriptomic signatures in the neonatal brain. *Sci Rep*, 14.
- Wang X, et al. 2020. Smoking and use of electronic cigarettes (vaping) in relation to preterm birth and small-for-gestational age in a 2016 U.S. national sample. *Preventative medicine*, 134:106041.

Mga Tanong? Tumawag sa 866.626.6847 | Mag-text sa 855.999.3525 | Mag-email o Makipag-chat sa [MotherToBaby.org](https://www.MotherToBaby.org).

Disclaimer: MotherToBaby Fact Sheets are meant for general information purposes and should not replace the advice of your health care provider. MotherToBaby is a service of the non-profit Organization of Teratology Information Specialists (OTIS). Copyright by OTIS, January 1, 2026.

OnabotulinumtoxinA (Botox®)

Selected References:

- Bateman BT, et al. 2016. Late pregnancy β blocker exposure and risks of neonatal hypoglycemia and bradycardia. *Pediatrics* 138(3) pii:e20160731.
- Bauer et al. 1979. Propranolol in human plasma and breast milk. *Am J Cardiol* 43(4):860-862.
- Bratton S, et al. 2024. Does atenolol use during pregnancy cause small for gestational age neonates? A meta-analysis. *Journal of Perinatal Medicine*. 52.8: 858-862.
- Davis RL, et al. 2011. Risks of congenital malformations and perinatal events among infants exposed to calcium channel and beta-blockers during pregnancy. *Pharmacoepidemiol Drug Saf.* 20(2):138-45. Duan L, et al. 2017. β -Blocker exposure in pregnancy and risk of fetal cardiac anomalies. *JAMA Intern Med* 177(6):885-887.
- Duan L, et al. 2018. Beta-blocker subtypes and risk of low birth weight in newborns. *J Clin Hypertens* 20(11):1603-1609.
- Firoz T, et al. 2014. Oral antihypertensive therapy for severe hypertension in pregnancy and postpartum: a systematic review. *BJOG* 121(10):1210-1218.
- Fischer AJ, et al. 2021. Antiarrhythmic drugs – safety and efficacy during pregnancy. *Herzschrittmacherther Elektrophysiol* 32(2): 145-151.
- Freppel R, et al. 2024. Beta-blockers and breastfeeding: a real-life prospective study. *Eur J Clin Pharmacol.* 80(12):1937-1943.
- Halpern DG, et al. 2019. Use of medication for cardiovascular disease during pregnancy: JACC state-of-the-art review. *Journal of the American College of Cardiology.* 73.4: 457-476.
- Hutchinson S, et al. 2013. Use of common migraine treatments in breast-feeding women: A summary of recommendations. *Headache* 53(4):614-627.
- Joglar JA, et al. 2023. 2023 HRS expert consensus statement on the management of arrhythmias during pregnancy. *Heart Rhythm.* 20.10: e175-e264. Karlberg B, et al.
- 1974. Excretion of propranolol in human breast milk. *Aceta Pharmacol Toxicol* 34(3):222-224.
- Lennestall R, et al. 2009. Maternal use of antihypertensive drugs in early pregnancy and delivery outcome, notably the presence of congenital heart defects in the infants. *Eru J Clin Pharmacol* 65(6):615-625.
- Manolis TA, et al. 2020. Cardiac arrhythmias in pregnant women: need for mother and offspring protection. *Curr Med Res Opin* 36(7):1225-1243.
- Moss HB, Procci WRR. 1982. Sexual dysfunction associated with oral antihypertensive medication: a critical survey of the literature. *Gen Hosp Psych* 4(2):121-129.
- Riant P, et al. 1986. High plasma protein binding as a parameter in the selection of betablockers for lactating women. *Biochem Pharmacol* 35(24):4579-4581.
- Rosen RC, et al. 1988. Beta-blocker effects on sexual function in normal males. *Arch Sex Behav.*

- 17(3):241-255. Ruys TP, et al. 2014. Cardiac medication during pregnancy, data from the ROPAC. *Int J Cardiol.* 177(1):124-128.
- Salman M, et al. 2016. Erectile dysfunction: prevalence, risk factors, and involvement of antihypertensive drugs intervention. *Trop J Pharm Res* 15(4):869-876.
 - Smith MT et al. 1983. Propranolol, propranolol glucuronide, and naphthoxylactic acid in breast milk and plasma. *Ther Drug Monit.* 5(1):87-93.
 - Tanaka K, et al. 2016. Beta-blockers and fetal growth restriction in pregnant women with cardiovascular disease. *Circ J* 80(10):2221-2226. Taylor EA, Turner P. 1981. Anti-hypertensive therapy with propranolol during pregnancy and lactation. *Postgrad Med J* 57(669):427-430.
 - Thorley KJ, McAinish J. 1983. Levels of the beta-blockers atenolol and propranolol in the breast milk of women treated for hypertension in pregnancy. *Biopharm Drug Dispos.* 4(3):299-301.
 - Turnstall ME. 1969. The effect of propranolol on the onset of breathing at birth. *Br J Anaesth* 41(9):792.
 - Welzel T, et al. 2021. Intrauterine growth retardation in pregnant women with Long QT syndrome treated with beta-receptor blockers. *Neonatology* 118(4):406-415.
 - Xie RH, et al. 2014. Association between labetalol use for hypertension in pregnancy and adverse infant outcomes. *Eur J Obstet Gynecol Reprod Biol* 175:124-128.
 - Xie RH, et al. 2014. Beta-blockers increase the risk of being born small for gestational age or of being institutionalized during infancy. *BJOG.* 121(9):1090-1096.
 - Yakoob MY, et al. 2013. The risk of congenital malformations associated with exposure to β -blockers in pregnancy: a meta-analysis. *Hypertension* 62(2):375-381.

Mga Tanong? Tumawag sa 866.626.6847 | Mag-text sa 855.999.3525 | Mag-email o Makipag-chat sa [MotherToBaby.org](https://www.MotherToBaby.org)..

Disclaimer: MotherToBaby Fact Sheets are meant for general information purposes and should not replace the advice of your health care provider. MotherToBaby is a service of the non-profit Organization of Teratology Information Specialists (OTIS). Copyright by OTIS, January 1, 2026.

OnabotulinumtoxinA (Botox®)

Selected References:

- Abdellatif M, et al. 2019. Association between exposure to macrolides and the development of infantile hypertrophic pyloric stenosis: a systematic review and meta-analysis. *Eur J Pediatr* 178(3):301-314.
- Adair CD, Gunter M, Stovall TG et al. 1998. Chlamydia in pregnancy: A randomized trial of azithromycin and erythromycin. *Obstet Gynecol* 91:165-168.
- Andersson NW, Olsen RH, Andersen JT. 2021. Association between use of macrolides in pregnancy and risk of major birth defects: nationwide, register based cohort study. *BMJ*. 372:n107.
- Bahat Dinur A, et al. 2013. Fetal safety of macrolides. *Antimicrob Agents Chemother* 57(7):3307-11.
- Berard A, et al. 2015. Use of macrolides during pregnancy and the risk of birth defects: a population-based study. *Pharmacoepidemiol Drug Saf* 24(12):1241-1248.
- Cohen I, et al. 1990. Improved pregnancy outcome following successful treatment of chlamydial infection. *JAMA* 263:3160-3163.
- Committee on Drugs, American Academy of Pediatrics. 2001. The transfer of drugs and other chemicals into human breast milk. *Pediatrics* 108:776-89.
- Damkier P, et al. 2019. In utero exposure to antibiotics and risk of congenital malformations: A population-based study. *Am J Obstet Gynecol* 221:648.e1-15.
- Fan H, et al. 2020. Associations between macrolide antibiotics prescribing during pregnancy and adverse child outcomes in the UK: population based cohort study. *BMJ* 368:m331.
- Flenady V, et al. 2013. Prophylactic antibiotics for inhibiting preterm labour with intact membranes. *Cochrane Database Syst Rev* 5;12:CD000246.
- FitzSimmons J et al. 1990. Chlamydial infections in pregnancy. *J Reprod Med* 31:19-22, 1986.
- Goldstein LH, et al. 2009. The safety of macrolides during lactation. *Breastfed Med* 4:157-200
- Källén B, Danielsson BR, 2014. Fetal safety of erythromycin. An update of Swedish data. *Eur J Clin Pharmacol* 70(3):355-60.
- Keskin-Arslan E, et al. 2023. Pregnancy outcomes following maternal macrolide use: A systematic review and meta-analysis. *Reprod Toxicol*; 115:124-146.
- Lin KJ, et al. 2013. Safety of macrolides during pregnancy. *Am J Obstet Gynecol* 208(3):221.e1-8.
- Lund M, et al. 2014. Use of macrolides in mother and child and risk of infantile hypertrophic pyloric stenosis: nationwide cohort study. *BMJ* 11;348:g1908.
- Marlow N, et al. 2017. The ORACLE Children Study: educational outcomes at 11 years of age following antenatal prescription of erythromycin or co-amoxiclav. *Arch Dis Child Fetal Neonatal Ed* 102(2):F131-F135.
- McCormack WM et al. 1987. Effect on birth weight of erythromycin treatment of pregnant women. *Obstet Gynecol* 69:202-207.
- McGregor JA et al. 1986. Adjunctive erythromycin treatment for idiopathic preterm labor: Results of a randomized, double-blind, placebo-controlled trial. *Am J Obstet Gynecol* 154:98-103.
- Romøren M, et al. 2012. Pregnancy outcome after gestational exposure to erythromycin – a population-based register study from Norway. *Br J Clin Pharmacol* 74(6):1053-62.
- Ryan GM Jr, et al. 1990. Chlamydia trachomatis infection in pregnancy and effect of treatment on outcome. *Am J Obstet Gynecol* 162:34-39.
- Schachter J, et al. 1986. Experience with the routine use of erythromycin for chlamydial infections in pregnancy. *N Engl J Med* 314:276-9Sorensen, HT et al. 2003. Risk of infantile hypertrophic pyloric stenosis after maternal postnatal use of macrolides. *Scand J Infect Dis* 35:104-6
- Shen Q, et al. 2025. Associations between urinary antibiotic exposure and semen parameters among adult men: a biomonitoring-based cross-sectional study. *Environmental Pollution* 375: 126335

- WHO Working Group, Bennet PN (ed). 1988. Drugs and Human Lactation. Elsevier, Amsterdam, New York, Oxford, pp. 253-4.

Mga Tanong? Tumawag sa 866.626.6847 | Mag-text sa 855.999.3525 | Mag-email o Makipag-chat sa [MotherToBaby.org](https://www.MotherToBaby.org)..

Disclaimer: MotherToBaby Fact Sheets are meant for general information purposes and should not replace the advice of your health care provider. MotherToBaby is a service of the non-profit Organization of Teratology Information Specialists (OTIS). Copyright by OTIS, January 1, 2026.