Magnesium
Newborn use only

Alert	1 mmol of elemental magnesium (Mg) = 24.3 mg of elemental Mg. 1000 mg Mg **sulfate** = 98 mg elemental Mg = 4.1 mmol (8 mEq) of elemental Mg. 500 mg Mg **aspartate** = 37.4 mg elemental Mg = 1.5 mmol (3 mEq) of elemental Mg. Intravenous doses should be diluted to a concentration of Mg 20% or less. Calcium chloride/calcium gluconate should be available to reverse adverse effects.
Indication	Hypomagnesaemia (acute and chronic). Pulmonary hypertension when inhaled nitric oxide is not available. Perinatal asphyxia. Resuscitation of torsades de pointes. Neonatal tetany. Daily maintenance in parenteral nutrition (beyond scope of this guideline).
Action	An intracellular cation. Calcium and NMDA receptor antagonist. Mg is necessary for several steps in glycolysis, Krebs cycle and in protein and nucleic acid synthesis. Mg plays an important role in neurochemical transmission and functioning. Mg has an anticonvulsant effect.
Drug Type	Mineral
Trade Name	DBL Magnesium Sulfate Concentrated Injection (Pfizer) MagMin Tablets (Blackmores) Mag-Sup Tablets (Petrus) Bio-Logical Magnesium Complex oral liquid
Presentation	<u>**IV/IM:**</u> IV: 4.93 g magnesium **sulfate** /10 mL ampoule (49.3% solution) OR 2.465 g magnesium sulfate /5 mL. Both preparations provide 10 mmol magnesium/5 mL <u>**PO:**</u> • MagMin 500 mg and Mag-sup 500 mg magnesium **aspartate** tablets. Contains 37.4 mg (1.5 mmol) of elemental Mg. • Bio-Logical Magnesium **Complex** - oral liquid contains 50 mg/mL (2.06 mmol/mL) of elemental Mg.
Dosage	**Hypomagnesaemia** **IV:** 25–50 mg/kg of Mg sulfate (0.1-0.2 mmol/kg of elemental Mg). Repeat if necessary. **Chronic hypomagnesaemia** **PO:** 187 mg (7.7 mmol) of elemental Mg/m^2/day in divided doses (=2500 mg Mg aspartate/m^2/day or 3.7 mL of Bio-Logical Mg complex/m2/day). (ANMF Endocrine team consensus) **Body Surface Area (BSA) calculation:** $BSA\ (m^2) = \sqrt{\frac{height\ (cm) \times weight\ (kg)}{3600}}$ **Pulmonary hypertension:** **IV:** Loading dose of 200 mg/kg of Mg sulfate (0.8 mmol/kg of elemental Mg) over 60 minutes followed by continuous infusion 20–50 mg/kg/hour of Mg sulfate (0.08-0.2 mmol/kg/hour of elemental Mg) (target serum magnesium between 3.5 and 5.5 mmol/L) **Perinatal asphyxia** **IV:** 250 mg/kg/dose of Mg sulfate (1 mmol/kg/dose of elemental Mg) over 60 minutes. To be commenced within 6 hours of birth. Total 3 doses at 24 hour intervals. **Torsades de pointes with pulse** **IV:** 25-50 mg/kg of Mg sulfate (0.1-0.2 mmol/kg of elemental Mg) over 15–20 minutes. **Pulseless torsades de pointes** **IV/Intraosseous:** 25–50 mg/kg of Mg sulfate (0.1-0.2 mmol/kg of elemental Mg) over several minutes. **Intramuscular Route (Emergency management of Neonatal tetany/convulsions/Hypocalcaemic convulsion when no IV access)**

	IM: 100 mg/kg of Mg sulfate (0.2 mL/kg of 49.3% Mg sulfate, equivalent to 0.4 mmol/kg of elemental Mg). Can be repeated 12 hourly.
Route	IV, IM, oral, Intraosseous.
Preparation	**Hypomagnesaemia/Torsades de pointes** Draw up 0.4 mL (200 mg of magnesium sulfate) of 49.3% solution and add 7.6 mL sodium chloride 0.9% or glucose 5% to make a final volume of 8 mL with a concentration of 25 mg/mL. (rounded off dilution) **Pulmonary hypertension IV infusion** Loading dose: Draw up 2 mL (1000 mg of magnesium sulfate) of the 49.3% solution and add 8mL of sodium chloride 0.9% or glucose 5% to give a final volume of 10mL with a concentration of 100mg/mL. (rounded off dilution) Maintenance infusion: Draw up 2 mL/kg (1000 mg/kg of magnesium sulfate) of 49.3% solution and add glucose 5% or sodium chloride 0.9% to make a final volume of 50 mL. (rounded off dilution) Infusing at a rate of 1 mL/hour = 20 mg/kg/hour. **Perinatal asphyxia** Draw up 2 mL (1000 mg of magnesium sulfate) of the 49.3% solution and add 8 mL of sodium chloride 0.9% or glucose 5% to give a final volume of 10mL with a concentration of 100mg/mL. (rounded off dilution)
Administration	IV for hypomagnesaemia: Infuse over 30–60 minutes. IV loading dose for pulmonary hypertension: Administer over 60 minutes. IV dose for perinatal asphyxia: Administer over 60 minutes. Torsades de pointes: Administer the preparation over several minutes to 20 minutes.
Monitoring	ECG and continuous or frequent blood pressure. Monitor magnesium concentrations.
Contraindications	Heart block, myocardial damage.
Precautions	Use with caution in renal impairment.
Drug Interactions	Concurrent use with paralysing agents may enhance neuromuscular blockade (e.g. succinylcholine, vecuronium, rocuronium, etc). Concomitant use with aminoglycosides may cause neuromuscular weakness (respiratory arrest). Concurrent use with nifedipine may result in exaggerated hypotensive response.
Adverse Reactions	Hypotension, bradycardia and circulatory collapse with rapid infusion. ECG changes (prolonged AV conduction time, sino-atrial block, AV block). Calcium chloride/calcium gluconate should be available to reverse adverse effects. Flushing, sweating, respiratory depression (particularly with higher plasma concentrations), abdominal distension, diarrhoea, urinary retention, CNS depression, muscle relaxation, hyporeflexia.
Compatibility	**Fluids:** Sodium chloride 0.9%, sodium chloride 0.45%/glucose 4%, glucose 5%, parenteral nutrition glucose amino acid solution. **Y site:** Aciclovir, amifostine, amikacin, ampicillin, aztreonam, bivalirudin, caspofungin, cefotaxime, cefoxitin, cefazolin, chloramphenicol, cisatracurium, dexmedetomidine, dobutamine, doripenem, esmolol, gentamicin, granisetron, heparin sodium, labetalol, linezolid, metronidazole, milrinone, morphine sulfate, piperacillin-tazobactam (EDTA-free), potassium chloride, remifentanil, sodium nitroprusside, trimethoprim-sulfamethoxazole, vancomycin.
Incompatibility	**Fluids:** Fat emulsion. Incompatible with soluble phosphates and with alkaline carbonates and bicarbonates. **Y site:** Aminophylline, amiodarone, anidulafungin, azathioprine, calcium chloride, calcium salts, cefepime, ceftriaxone, ciprofloxacin, clindamycin, cyclosporin, dexamethasone, ganciclovir, haloperidol lactate, hydrocortisone sodium succinate, indometacin, methylprednisolone sodium succinate, pentamidine, phosphate salts, sodium bicarbonate.
Stability	Change the IV preparation every 24 hours.
Storage	Store at room temperature and protect from light.
Excipients	DBL Magnesium Sulfate Concentrated Injection (Pfizer): water for injection only. MagMin Tablets (Blackmores): Carnauba Wax, colloidal anhydrous silica, croscarmellose sodium, hypromellose, macrogol 8000, magnesium stearate, microcrystalline cellulose, purified talc, sodium starch glycollate, titanium dioxide.

	Mag-Sup Tablets (Petrus): Carnauba Wax, crospovidone, hypromellose, macrogol 8000, magnesium stearate, microcrystalline cellulose, purified talc, silicon dioxide, sodium starch glycollate, titanium dioxide. Bio-Logical Magnesium Complex oral liquid: hydrochloric acid, potable water.
Special Comments	Serum Mg concentrations do not reflect with whole body stores. Renally excreted.
Evidence	**Persistent pulmonary hypertension of the newborn (PPHN)** A single RCT enrolling infants with severe respiratory distress, an oxygen index ≥25 despite HFOV support, and echocardiographic evidence of PPHN assessed the effect of MgSO4 group 200 mg/kg infused over half an hour with maintenance 50-150 mg/kg/hour to attain a serum magnesium level of 5.0-7.0 mmol versus iNO group at initial concentration of 20 ppm with crossover if no response. There was no difference in the proportion of infants who responded primarily to either vasodilator ($MgSO_4$ 23.3% versus iNO 33.3%, p=1.0). Of the non-responders, 9 of 10 in the HFOV + IV $MgSO_4$ group versus 8 / 12 HFOV + iNO group responded. There was a significant difference in mortality, with 8 of 13 (62%) HFOV + IV $MgSO_4$ group versus 2 of 12 (17%) HFOV + iNO group alive at discharge (p=0.004). Infants who were administered iNO following failed $MgSO_4$ therapy were associated with a better outcome than those who were administered $MgSO_4$ following failed iNO therapy. Several small case series have reported that 37 of 42 infants with severe PPHN treated with $MgSO_4$ responded and survived to discharge.[1-4] Conclusion: The role of $MgSO_4$ in the management of PPHN is unclear. Further trials are required. (LOE II, GOR D) **Perinatal asphyxia** A systematic review [5] of RCTs that compared magnesium to control in newborns with HIE included 5 studies.[6-10] All used magnesium sulfate given within 24 hours of birth. The dose varied: 250mg/kg every 24 hours for three doses in two studies, 250mg/kg followed by two doses of 125mg/kg every 24 hours for two doses in another two studies and a single dose of 250mg/kg in one study. Magnesium was administered over 30 min in one study, over 1 hour in three studies. There was no difference in the death or moderate-to-severe neurodevelopmental disability at 18 months between the magnesium and the control groups (RR 0.81, 95% CI 0.36 to 1.84). There was significant reduction in the unfavourable short-term composite outcome (survival with abnormalities in any of the following: neurodevelopmental exam, neuroimaging or neurophysiologic studies), (RR 0.48, 95% CI 0.30 to 0.77) but no difference in mortality (RR 1.39, 95% CI 0.85 to 2.27), seizures (RR 0.84, 95% CI 0.59 to 1.19) or hypotension (RR 1.28, 95% CI 0.69 to 2.38) between the magnesium and the control groups. Conclusion: There is insufficient evidence to determine if magnesium therapy given shortly after birth to newborns with HIE reduces death or moderate-to-severe disability. The improvement in short-term outcomes without significant increase in adverse effects supports the need for further adequately powered trials to determine if there are long-term benefits of magnesium and to confirm its safety. (LOE I GOR D) The publication of 3 additional small trials is unlikely to change this conclusion. [11-14] **Refractory ventricular fibrillation (VF)/pulseless VF (pVF)/ polymorphic ventricular tachycardia (Torsade de pointes)** The ANZCOR Guideline on Medications and Fluids in Paediatric Advanced Life Support reported hypomagnesaemia may cause life-threatening ventricular tachyarrhythmia, particularly when associated with hypokalaemia. Magnesium is the preferred antiarrhythmic treatment for polymorphic ventricular tachycardia (Torsade de pointes – "Twisting of peaks") due to acquired or congenital prolonged QT interval syndromes [LOE IV]. Neither increased return of spontaneous circulation (ROSC) nor survival in adults has been demonstrated in treatment of VF with magnesium [LOE IV]. The intravenous or intraosseous bolus dose of magnesium sulphate is 0.1-0.2 mmol/kg followed by an infusion of 0.3mmol/kg over 4 hours. [15] **Neonatal tetany/convulsions** An RCT of oral calcium gluconate versus oral phenobarbitone versus $MgSO_4$ 0.2 mL/kg (100 mg/kg) of 50% magnesium sulfate IMI in infants with hypocalcaemic convulsions secondary to feeding with full-cream evaporated milk reported infants treated with magnesium sulphate had higher plasma-calcium concentrations after 48 hours' treatment and fewer convulsions during and after the treatment

	period. (LOE II GOR C/D) Magnesium levels increased from 0.59 +/- 0.17 mmol/L pre-treatment to 0.87 +/- 0.2 mmol/L post treatment. [16]
Practice points	
References	1. Chandran S, Haqueb ME, Wickramasinghe HT, Wint Z. Use of magnesium sulphate in severe persistent pulmonary hypertension of the newborn. J Trop Pediatr. 2004;50:219-23. 2. Daffa SH, Milaat WA. Role of magnesium sulphate in treatment of severe persistent pulmonary hypertension of the neoborn. Saudi Medical Journal. 2002;23:1266-9. 3. Dehdashtian M, Tebatebae K. Magnesium sulphate as a safe treatment for persistent pulmonary hypertension of newborn resistant to mechanical hyperventilation. Pakistan Journal of Medical Sciences. 2007;23:693-7. 4. Tolsa JF, Cotting J, Sekarski N, Payot M, Micheli JL, Calame A. Magnesium sulphate as an alternative and safe treatment for severe persistent pulmonary hypertension of the newborn. Archives of Disease in Childhood. 1995;72:F184-F7. 5. Tagin M, Shah PS, Lee KS. Magnesium for newborns with hypoxic-ischemic encephalopathy: A systematic review and meta-analysis. Journal of Perinatology. 2013;33:663-9. 6. Bhat MA, Charoo BA, Bhat JI, Ahmad SM, Ali SW, Mufti MU. Magnesium sulfate in severe perinatal asphyxia: a randomized, placebo-controlled trial. Pediatrics. 2009;123:e764-9. 7. Gathwala G, Khera A, Singh J, Balhara B. Magnesium for neuroprotection in birth asphyxia. Journal of Pediatric Neurosciences. 2010;5:102-4. 8. Groenendaal F, Rademaker CM, Toet MC, de Vries LS. Effects of magnesium sulphate on amplitude-integrated continuous EEG in asphyxiated term neonates. Acta Paediatr. 2002;91:1073-7. 9. Ichiba H, Tamai H, Negishi H, Ueda T, Kim TJ, Sumida Y, Takahashi Y, Fujinaga H, Minami H. Randomized controlled trial of magnesium sulfate infusion for severe birth asphyxia. Pediatrics International. 2002;44:505-9. 10. Khashaba MT, Shouman BO, Shaltout AA, Al-Marsafawy HM, Abdel-Aziz MM, Patel K, Aly H. Excitatory amino acids and magnesium sulfate in neonatal asphyxia. Brain Dev. 2006;28:375-9. 11. Gulczynska E, Gadzinowski J, Walas W, Maczka A, Talar T, Kesiak M, Caputa J, Sobolewska B. Therapeutic hypothermia enhanced by MGSO4 for hypoxic-ischemic encephalopathy in the neonates and its influence on biomarkers of asphyxia and course of hospitalization. Journal of Maternal-Fetal and Neonatal Medicine. 2014;27:221. 12. Gulczynska EMA, Gadzinowski J, Talar T, Nowiczewski M, Cyranowicz B. Therapeutic hypothermia enhanced by magnesium sulphate for hypoxic-ischemic encephalopathy in the neonates - and their influence on protein S-100B and ceruloplasmin serum concentration. Journal of Maternal-Fetal and Neonatal Medicine. 2012;25:32. 13. Hossain MM, Mannan MA, Yeasmin F, Shaha CK, Rahman MH, Shahidullah M. Short-term outcome of magnesium sulfate infusion in perinatal asphyxia. Mymensingh medical journal : MMJ. 2013;22:727-35. 14. Rahman SU, Canpolat FE, Oncel MY, Evli A, Dilmen U, Parappil H, Anabrees J, Hassan K, Khashaba M, Noor IA, Lum LCS, Siham A, Akar M, Tuzun H, Rahmani A, Rahman M, Haboub L, Rijims M, Jaafar R, Key LY, Tagin M. Multicenter randomized controlled trial of therapeutic hypothermia plus magnesium sulfate versus therapeutic hypothermia plus placebo in the management of term and near-term infants with hypoxic ischemic encephalopathy (The Mag Cool study): A pilot study. Journal of Clinical Neonatology. 2015;4:158-63. 15. ANZCOR Guideline 12.4 – Medications and Fluids in Paediatric Advanced Life Support. https://resus.org.au/wpfb-file/anzcor-guideline-12-4-medications-and-fluids-aug16-pdf/; downloaded 19/04/2018. 2016. 16. Turner TL, Cockburn F, Forfar JO. Magnesium therapy in neonatal tetany. Lancet. 1977;1:283-4. 17. Micromedex online. Accessed on 22 March 2016.

VERSION	DATE
Original 1.0	24/08/2016
Version 1.2	19/04/2018
Current 2.0	4/11/2021
REVIEW	4/11/2026

Authors Contribution

Original author/s	Chris Wake, Srinivas Bolisetty
Evidence Review	David Osborn
Expert review	
Nursing Review	Eszter Jozsa, Priya Govindaswamy
Pharmacy Review	Jing Xiao, Cindy Chen, Mohammad Irfan Azeem, Joanne Malloy
ANMF group contribution	Nilkant Phad, Bhavesh Mehta, John Sinn, Thao Tran, Michelle Jenkins, Simarjit Kaur, Cindy Chen, Mohammad Irfan Azeem, Helen Huynh, Hannah Bell
Final editing of the original	Ian Whyte
Electronic version	Cindy Chen, Ian Callander
Facilitator	Srinivas Bolisetty