

Newborn Use Only

Sodium bicarbonate

2016

Alert	<p>If sodium bicarbonate is used during prolonged resuscitation, it should be given only after adequate ventilation and circulation is established with CPR.</p> <p>Rapid infusion of sodium bicarbonate is associated with increased incidence of intraventricular haemorrhage in preterm infants.</p> <p>Conversion factor for sodium bicarbonate: 1 mmol = 1 mEq</p> <p>Avoid simultaneous administration of sodium bicarbonate and catecholamines through the same IV catheter or tubing as the sodium bicarbonate solution will inactive the catecholamine.</p>
Indication	<p>Metabolic acidosis</p> <p>Chronic renal failure</p> <p>Renal tubular acidosis</p> <p>Prolonged resuscitation</p>
Action	<p>Neutralises excess hydrogen ion and raises pH of the blood. Increases the excretion of free bicarbonate ions in urine, raising urinary pH.</p>
Drug Type	<p>Electrolyte, alkalinising agent</p>
Trade Name	<p>Sodium Bicarbonate Injection 8.4% w/v BP [Phebra]; Sodium Bicarbonate Infusion [Baxter]</p>
Presentation	<p>8.4% (1 mmol/mL) 10 mL injection</p>
Dosage/Interval	<p>Usual dose: 1–2 mmol/kg</p> <p>To calculate dosage required based on base deficit: Sodium bicarbonate dose (mEq) = 0.3 x weight (kg) x base deficit (mEq/L) (Administer half of the calculated dose, then assess need for remainder)</p> <p>Dilute to a maximum concentration of no greater than 0.5 mmol/mL (osmolality = 1000 mOsm/L).</p>
Route	<p>IV</p> <p>PO</p>
Preparation/Dilution	<p>IV: Draw up 10 mL (10 mmol) and add 10 mL of water for injection to make a final volume of 20 mL with a concentration of 0.5 mmol/mL. It can also be diluted with sodium chloride 0.9%, dextrose 5% or other standard electrolyte solutions.</p> <p>PO: IV ampoules may be used orally. Draw up 10 mL (10 mmol) and add 10 mL of water for injection to make a final volume of 20 mL with a concentration of 0.5 mmol/mL.</p>
Administration	<p>IV: Infuse over at least 30 minutes (via central IV line if possible).</p> <p>Maximum rate in a medical emergency is 10 mmol/minute.</p> <p>PO: Administer 1–3 hours after feeds.</p>
Monitoring	<p>Monitor acid-base balance.</p> <p>Monitor local infusion site for signs of extravasation.</p>
Contraindications	<p>Respiratory or metabolic alkalosis.</p>
Precautions	<p>Hypercarbia or hypernatraemia</p>
Drug Interactions	<p>Concurrent use of ketoconazole may decrease ketoconazole exposure.</p> <p>Avoid simultaneous administration of sodium bicarbonate and catecholamines (dopamine, dobutamine, adrenaline (epinephrine), noradrenaline (norepinephrine)) through the same IV catheter or tubing as the sodium bicarbonate solution will inactive the catecholamine.</p>
Adverse Reactions	<p>Hypernatraemia, hyperosmolality, hypocalcaemia, hypokalaemia.</p> <p>May increase intracellular acidosis.</p> <p>If administered during inadequate ventilation, PaCO₂ may rise — thereby exacerbating acidosis.</p> <p>Rapid correction may be associated with IVH.</p> <p>Local tissue necrosis — thrombosis at site of administration</p> <p>Metabolic alkalosis and tetany.</p> <p>Abdominal cramping, nausea, vomiting.</p>
Compatibility	<p>Fluids: Glucose 5%, glucose 10%, glucose in sodium chloride solutions, sodium chloride 0.9%, sodium chloride 0.45%.</p> <p>Y site: Aciclovir, amifostine, amikacin, atropine, aztreonam, bivalirudin, ceftaroline fosamil,</p>

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	ceftazidime, dexamethasone, dexmedetomidine, digoxin, doripenem, fentanyl, filgrastim, fluconazole, furosemide, gentamicin, granisetron, heparin sodium, hydrocortisone sodium succinate, ibuprofen lysine, indometacin, insulin, lignocaine, linezolid, metronidazole, morphine, penicillin G, phenobarbitone, potassium chloride, ranitidine, remifentanyl, vancomycin.
Incompatibility	Amino acid solution, adrenaline (epinephrine) hydrochloride, amiodarone, amoxicillin, amphotericin B, ampicillin, anidulafungin, atracurium, azathioprine, buprenorphine, calcium folinate, calcium salts, caspofungin, cefotaxime, cefoxitin, clindamycin, chlorpromazine, clonazepam, diazoxide, dobutamine, dolasetron, dopamine, ganciclovir, glycopyrrolate, haloperidol lactate, hydromorphone, imipenem-cilastatin, ketamine, labetalol, lipid emulsion, magnesium salts, metoclopramide, midazolam, mycophenolate mofetil, noradrenaline (norepinephrine), ondansetron, pentamidine, pethidine, promethazine, streptomycin, suxamethonium, thiopentone, ticarcillin-clavulanate, vancomycin, verapamil.
Stability	
Storage	Store vials below 30°C. Diluted solutions may be stored for up to 24 hours at 2–8°C.
Special Comments	Rapid onset of action after IV administration.
Evidence summary	<p><u>During resuscitation</u></p> <p>If effective spontaneous cardiac output is not restored despite adequate ventilation and adequate chest compressions, reversing intracardiac acidosis may improve myocardial function and achieve a spontaneous circulation. There are insufficient data to recommend routine use of bicarbonate in resuscitation of the newly born. The hyperosmolarity and carbon dioxide-generating properties of sodium bicarbonate may impair myocardial and cerebral function. Use of sodium bicarbonate is not recommended during brief CPR. If it is used during prolonged arrests unresponsive to other therapy, it should be given only after adequate ventilation and circulation is established with CPR. A dose of 1–2 mmol/kg may be given by slow intravenous injection after adequate ventilation and perfusion have been established (ILCOR 2015 recommendations).^{1,2}</p> <p><u>Preterm neonates with metabolic acidosis</u></p> <p>Lawn et al, in their Cochrane review, found two small randomised controlled trials that fulfilled the eligibility criteria (Corbet 1977; Dixon 1999) and one unpublished pilot trial (Lawn 2005). Corbet 1977 compared treating infants with sodium bicarbonate infusion (N = 30) versus no treatment (N = 32) and did not find evidence of an effect on mortality [relative risk (RR) 1.39 (95% confidence interval 0.72 to 2.67)] or in the incidence of intra/periventricular haemorrhage [RR 1.24 (95% confidence interval 0.47 to 3.28)]. Addition of the unpublished data of Lawn 2005 does not change the overall estimate of effect on mortality [typical RR 1.45 (95%CI 0.82 to 2.56)]. Dixon 1999 compared treatment with sodium bicarbonate (N = 16) versus fluid bolus (N = 20). The primary outcome assessed was arterial blood pH/base excess two hours after the intervention. Other clinical outcomes were not reported. Neither trial assessed longer term neurodevelopmental outcomes. There is insufficient evidence from randomised controlled trials to determine whether infusion of base or fluid bolus reduces morbidity and mortality in preterm infants with metabolic acidosis.</p> <p><u>Rapid correction of metabolic acidemia in the first 24 hours of life in preterm neonates</u></p> <p>There is no evidence available from randomised controlled trials to support or refute the rapid correction of metabolic acidemia, in LBW infants in the first 24 hours of life, as compared with slow or no correction.⁴</p> <p><u>Correction of chronic metabolic acidosis in chronic kidney conditions</u></p> <p>Metabolic acidosis is a feature of chronic kidney disease (CKD) due to the reduced capacity of the kidney to synthesise ammonia and excrete hydrogen ions. It has adverse consequences on protein and muscle metabolism, bone turnover and the development of renal osteodystrophy. Metabolic acidosis may be corrected by oral bicarbonate supplementation or, in dialysis patients, by increasing the bicarbonate concentration in dialysate fluid. Roderick et al performed a Cochrane review to examine the benefits and harms of treating metabolic acidosis in patients with CKD, both prior to reaching end-stage renal disease (ESRD) and whilst on renal replacement therapy</p>

(RRT), with sodium bicarbonate or increasing the bicarbonate concentration of dialysate. They identified three trials in adult dialysis patients (n = 117). There were insufficient data for most outcomes for meta-analysis. In all three trials, acidosis improved in the intervention group though there was variation in achieved bicarbonate concentration. There was no evidence of effect on blood pressure or sodium concentrations. Some measures of nutritional status/protein metabolism (e.g. SGA, NP NA) were significantly improved by correction in the one trial that looked at these in detail. There was heterogeneity of the effect on serum albumin in two trials. Serum PTH fell significantly in the two trials that estimated this, with no significant effect on calcium or phosphate though both fell after correction. Complex bone markers were assessed in one study, with some evidence for a reduction in bone turnover in those with initial high bone turnover and an increase in low turnover patients. The studies were underpowered to assess clinical outcomes; in the one study that did there was some evidence for a reduction in hospitalisation after correction. In conclusion, the evidence for the benefits and risks of correcting metabolic acidosis is very limited with no RCTs in pre-ESRD patients, none in children and only three small trials in dialysis patients. These trials suggest there may be some beneficial effects on both protein and bone metabolism but the trials were underpowered to provide robust evidence.

Slow infusion versus rapid IV bolus

van Alfen-van der Velden et al performed an RCT to study the effects of NaHCO₃ administration on cerebral haemodynamics and oxygenation in preterm neonates. Twenty-nine preterm infants with metabolic acidosis were randomised into two groups (values are mean ± SD): In group A (GA 30.5 ± 1.7 weeks, b.w. 1,254 ± 425 g) NaHCO₃ 4.2% was injected as a bolus. In group B (GA 30.3 ± 1.8 weeks, b.w. 1,179 ± 318 g) NaHCO₃ 4.2% was administered over a 30-min period. Concentration changes of oxyhemoglobin (cO₂Hb) and deoxyhemoglobin (cHHb) were assessed using near-infrared spectrophotometry. Changes in HbD (= cO₂Hb – cHHb) represent changes in cerebral blood oxygenation and changes in ctHb (= cO₂Hb + cHHb) reflect changes in cerebral blood volume. Cerebral blood flow velocity was intermittently measured using Doppler ultrasound. Longitudinal data analysis was performed using linear mixed models, to account for the fact that the repeated observations in each individual were correlated. Administration of NaHCO₃ resulted in an increase of cerebral blood volume which was more evident if NaHCO₃ was injected rapidly than when infused slowly. HbD and cerebral blood flow velocity did not show significant changes in either group. Conclusion: To minimise fluctuations in cerebral hemodynamics, slow infusion of sodium bicarbonate is preferable to rapid injection.

References

1. Wyllie J, Perlman JM, Kattwinkel J, et al. Part 7: Neonatal resuscitation: 2015 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science with treatment recommendations. *Resuscitation* 2015;95:e171–203.2.
2. Beveridge CJE, Wilkinson AR. Sodium bicarbonate infusion during resuscitation of infants at birth. *Cochrane Database of Systematic Reviews* 2006, Issue 1. Art. No.: CD004864. DOI: 10.1002/14651858.CD004864.pub2.
3. Lawn CJ, Weir FJ, McGuire W. Base administration or fluid bolus for preventing morbidity and mortality in preterm infants with metabolic acidosis. *Cochrane Database of Systematic Reviews* 2005, Issue 2. Art. No.: CD003215. DOI: 10.1002/14651858.CD003215.pub2.
4. Kecskes Z, Davies MW. Rapid correction of early metabolic acidaemia in comparison with placebo, no intervention or slow correction in LBW infants. *Cochrane Database of Systematic Reviews* 2002, Issue 1. Art. No.: CD002976. DOI: 10.1002/14651858.CD002976.
5. Roderick PJ, Willis NS, Blakeley S, Jones C, Tomson C. Correction of chronic metabolic acidosis for chronic kidney disease patients. *Cochrane Database of Systematic Reviews* 2007, Issue 1. Art. No.: CD001890. DOI: 10.1002/14651858.CD001890.pub3.
6. Berg CS, Barnette AR, Myers BJ, Shimony MK, Barton AW, Inder TE. Sodium bicarbonate administration and outcome in preterm infants. *J Pediatr* 2010;157(4):684-7.
7. Barnette AR, Myers BJ, Berg CS, Inder TE. Sodium intake and intraventricular hemorrhage in the preterm infant. *Ann Neurol* 2010;67(6):817-23.
8. van Alfen-van der Velden AA, Hopman JC, Klaessens JH, Feuth T, Sengers RC, Liem KD. Effects of rapid versus slow infusion of sodium bicarbonate on cerebral hemodynamics and oxygenation in preterm infants. *Biol Neonate* 2006;90(2):122-7.

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9. Aschner, Judy L. and Poland, Ronald L. Sodium Bicarbonate: Basically Useless Therapy. Pediatrics 2008;122;831-835.
10. Wyckoff, Myra H. and Perlman, Jeffrey M. Use of High-Dose Epinephrine and Sodium Bicarbonate During Neonatal Resuscitation: Is There Proven Benefit? Clin Perinatol 33 (2006) 141– 151.
11. Ammari, Amer N. and Schulze, Karl F. Uses and abuses of sodium bicarbonate in the neonatal intensive care unit. Current Opinion in Pediatrics 2002, 14:151–156.
12. Gehlbach BK, Schmidt GA: Bench to bedside review: Treating acid-base abnormalities in the intensive care unit. Crit Care 2004; 8:259.
13. Fanconi S, Burger R, Ghelfi D, Uehlinger J, Arbenz U. Hemodynamic effects of sodium bicarbonate in critically ill neonates. Intensive Care Med. 1993;19(2):65-9.
14. Micromedex online. Accessed on 10 August 2016.

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