INTRAVENOUS FLUID THERAPY
Supporting information

This guideline has been prepared with reference to the following:

NICE. Intravenous fluid therapy in children and young people in hospital. 2020. London. NICE

https://www.nice.org.uk/guidance/ng29

What is the optimal timing for adding sodium?
A randomised controlled trial involving 20 infants (Shaffer, 1989) concluded that administration of sodium "is probably unnecessary during the first few postnatal days" and that hypernatraemia could result from inappropriate supplementation.
Similar conclusions were reached by a prospective randomised trial in 17 infants (Costarino, 1992).
A recent review (Modi, 2004) recommended that maintenance sodium should be deferred until weight loss of approximately 6% has occurred.
"There is no simple formula that will guarantee to prevent either hyponatraemia or hypernatraemia in all children" (Coulthard, 2008).

Costarino AT, Gruskay JA, Corcoran L, et al. Sodium restriction versus daily maintenance replacement in very low birth weight premature neonates: a randomized, blind therapeutic trial. J Pediatr 1992;120:99-106

Coulthard MG. Will changing maintenance intravenous fluid from 0.18% to 0.45% saline do more harm than good? Arch Dis Child 2008;93:335-40
http://adc.bmj.com/content/93/4/335.long

Modi N. Management of fluid balance in the very immature neonate. Arch Dis Child Fetal Neonatal Ed 2004;89:F108-11
http://fn.bmj.com/content/89/2/F108.long

Shaffer SG, Meade VM. Sodium balance and extracellular volume regulation in very low birth weight infants. J Pediatr 1989;115:285-90

Evidence Level: II

What is the evidence for appropriate volume replacement on day 1,2,3, etc?
A Cochrane review of 5 trials (Bell, 2014) shows what appear to be significant advantages to a restrictive strategy for managing the water intake of premature infants who were in the restricted groups were at lower risk of patent ductus arteriosus and necrotizing enterocolitis, with no significant increase in adverse effects. There were trends toward increased risk of dehydration and decreased risk of bronchopulmonary dysplasia, intracranial hemorrhage and death with restricted water intake but these trends were not significant.
This amount must be flexible, taking into account ambient humidity and gestational/postnatal age, but would be in the range of 30-60 ml/kg/day plus estimated insensible water loss (Armon, 2008; Modi, 2004). Given adequate hydration, stepwise increments on subsequent days following birth should not be necessary unless accompanied by "a clinically relevant increase in nutrition" (Modi, 2004).

Armon K, Riordan A, Playfor S, et al. Hyponatraemia and hypokalaemia during intravenous fluid administration. Arch Dis Child 2008;93:285-7
http://adc.bmj.com/content/93/4/285.long

Bell EF, Acarregui MJ. Restricted versus liberal water intake for preventing morbidity and mortality in preterm infants. Cochrane Database Syst Rev. 2014: CD000503
http://onlinelibrary.wiley.com/doi/10.1002/14651858.CD000503.pub3/full

Modi N. Management of fluid balance in the very immature neonate. Arch Dis Child Fetal Neonatal Ed 2004;89:F108-11
http://fn.bmj.com/content/89/2/F108.long

Evidence Level: I

Can chronic lung disease, necrotising enterocolitis or patent ductus arteriosus (PDA) be caused by fluid overload, rather than inappropriate sodium supplementation?

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There is evidence that a positive water and sodium balance with expansion of the extracellular space in preterm infants increases morbidity (Bell, 2014). In this Cochrane Review, restricted water intake significantly reduced the risk of PDA (RR 0.52, 95% CI 0.37 to 0.73) and necrotising enterocolitis (RR 0.43, 95% CI 0.21 to 0.87), although not of chronic lung disease (RR 0.85, 95% CI 0.63-1.14). A recent review (Lorenz, 2004) concluded that, based on a metaanalysis of 3 RCTs, higher fluid intakes did not significantly increase the risk of chronic lung disease. A further retrospective study in 204 extremely low birth weight infants (Stephens, 2008) confirmed the association of high fluid intake (>170 ml/kg(-1)/day(-1)) with increased risk of PDA on day 2 (OR 1.014; 95% CI 1.001 – 1.028) and day 3 (OR 1.022; 95% CI 1.004 – 1.040). Findings from 2 RCTs on sodium supplementation were contradictory.

Bell EF, Acarregui MJ. Restricted versus liberal water intake for preventing morbidity and mortality in preterm infants. Cochrane Database Syst Rev. 2014: CD000503
http://onlinelibrary.wiley.com/doi/10.1002/14651858.CD000503.pub3/full

Lorenz JM. Fluid and electrolyte therapy and chronic lung disease. Curr Opin Pediatr 2004;16:152-6

Stephens BE, Gargus RA, Walden RV, et al. Fluid regimens in the first week of life may increase risk of patent ductus arteriosus in extremely low birth weight infants. J Perinatol 2008;28:123-8

Evidence Level: I

Should infants receiving phototherapy be given extra fluids?

A 2017 systematic review of RCTs found that Infants who received additional fluid appeared to have shorter duration of phototherapy (on average 10.70 hours shorter, participants = 218, studies = three) (Lai, 2017).

Earlier studies of phototherapy (e.g. Wu, 1985) showed increased insensible water loss during the process. This led to recommendations for fluid supplementation in infants undergoing phototherapy, and a survey in 1996 (Hansen, 1996) recorded 74% of responding neonatal ICUs following this policy. Later studies have produced contradictory results, however, with some suggesting that the earlier findings may have been due to heat stress and that phototherapy in a thermally stable infant does not increase fluid loss (Kjartansson, 1992i &ii), and another recording a 20% increase in transepidermal water loss despite tight control of both skin temperature and relative humidity (Grunhagen, 2002). If these results are accepted, an increase in maintenance fluids of 0.35 mL/kg/h is indicated to correct the deficit.

Two further examples of the more recent studies (Maayan, 2001; Wananukul, 2001) agree with Grunhagen that fluid loss is increased, even in thermally stable infants.

Grunhagen DJ, de Boer MG, de Beaufort AJ, et al. Transepidermal water loss during halogen spotlight phototherapy in preterm infants. Pediatr Res 2002;51:402-5
http://www.nature.com/pr/journal/v51/n3/full/pr200264a.html

Hansen TW. Therapeutic approaches to neonatal jaundice: an international survey. Clin Pediatr 1996;35:309-16

Kjartansson S, Hammarlund K, Sedin G. Insensible water loss from the skin during phototherapy in term and preterm infants. Acta Paediatr 1992;81:764-8

Kjartansson S, Hammarlund K, Riesenfeld T, et al. Respiratory water loss and oxygen consumption in newborn infants during phototherapy. Acta Paediatr 1992;81:769-73

Lai NM, Ahmad Kamar A, Choo YM et al. Fluid supplementation for neonatal unconjugated hyperbilirubinaemia. Cochrane Database Syst Rev. 2017:CD011891
http://onlinelibrary.wiley.com/doi/10.1002/14651858.CD011891.pub2/full

Maayan MA, Yosipovitch G, Hadad E, et al. Transepidermal water loss and skin hydration in preterm infants during phototherapy. Am J Perinatol 2001;18:393-6

Wananukul S, Praisuwanna P. Transepidermal water loss during conventional phototherapy in nonhemolytic hyperbilirubinemia term infants. J Med Assoc Thai 2001;84(Suppl 1):S46-S50

Wu PY, Hodgman JE, Kirkpatrick BV, et al. Metabolic aspects of phototherapy. Pediatrics 1985;75:427-33
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2532565/

Evidence Level: I

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