two times than those based on a MUAC cut-off of 115 mm. Other studies have reported that MUAC and WHZ identify different populations of children with SAM [5,6]. Previous studies have recommended higher cut-off levels (135 or more, even 155 mm) [7,8]. In this study, the MUAC cut off at 115 mm had zero sensitivity in the 3-6 year age group though higher cut off levels (<130 mm) had better sensitivity (24.2%). Part of the explanation for our findings is that children with lower MUAC tend to be younger than those with lower weight-for-height scores. The results suggest that a single cut-off cannot be used to screen nutritional status for all children below six years but should be increased with increasing age of children, as stated in another study [9]. Generalizability might be an issue which necessitates large scale community studies.

MUAC alone does not appear to be appropriate for diagnosis of SAM. Keeping in view the findings of our study, MUAC may be used along with simple clinical indicators such as bipedal edema and weight-for-height cut-off measurements.

*Contributors*: JPT: data analysis, preparation of the first draft of the manuscript and editing of the draft. AS: collection of data, analysis of data and editing of the draft. SP: conceived the idea, supervised data collection and edited the manuscript.

*Funding*: National Rural Health Mission of the Government of Haryana. *Competing interests*: None stated.

**JP TRIPATHY, A SHARMA AND *S PRINJA**
*School of Public Health ,*
*PGIMER, Chandigarh*
**shankarprinja@gmail.com*

**REFERENCES**

1. WHO Child Growth Standards and the Identification of Severe Acute Malnutrition in Infants and Children. A Joint Statement by the World Health Organization and the United Nations Children's Fund. Geneva: World Health Organization, 2009
2. Shekhar S, Shah D. Validation of mid-upper arm circumference cut-offs to diagnose severe wasting in Indian children. Indian Pediatr. 2012;49:496-7.
3. CDC. National Health and Nutrition Examination Survey (NHANES): Anthropometry Procedures Manual. Atlanta: Centre for Disease Control; January 2007.
4. Shakir A. Arm circumference in the surveillance of protein-calorie malnutrition in Baghdad. Am J Clin Nutr. 1975;28:661-5.
5. Ali E, Zachariah R, Shams Z, Vernaeve L, Alders P, Salio F, *et al*. Is mid-upper arm circumference alone sufficient for deciding admission to a nutritional programme for childhood severe acute malnutrition in Bangladesh? Trans R Soc Trop Med Hyg. 2013; 107:319-23.
6. WHO child growth standards and the identification of severe acute malnutrition in infants and children. World Health Organization and UNICEF, 2009.
7. Dasgupta R, Sinha D, Jain SK, Prasad V. Screening for SAM in the community: Is MUAC a 'Simple Tool'? Indian Pediatr. 2013;50:154-5.
8. Kumar R, Aggarwal AK, Iyenger S. Nutritional status of children: validity of mid-upper arm circumference for screening undernutrition. Indian Pediatr. 1995;33: 189-96.
9. Hop le T, Gross R, Sastroamidjojo S, Giay T, Schultink W. Mid-upper-arm circumference development and its validity in assessment of undernutrition. Asia Pac J Clin Nutr. 1998;7: 65-9.

# Effect of Fortification and Additives on Breast Milk Osmolality

This study evaluated the effect of fortification and commonly used additives on the osmolality of human milk. Osmolality after fortification with milk powder and human milk fortifier increased from 303 mOsmol/kg to 397 and 373 mOsmol/kg, respectively. The maximal increase in osmolality was seen with the addition of calcium gluconate.

**Keywords:** *Breastfeeding, Human milk fortifier, Infant feeding*.

Fortification of human milk is commonly used to achieve adequate postnatal growth of preterm infants. This can be done using either commercially available human milk fortifiers (HMF) or infant milk powder [1]. Several studies have evaluated the effect of HMF on osmolality of milk, but effect of infant milk powder and other additives has not been adequately studied. Various additives like calcium, iron and multivitamins may increase the osmolality beyond the recommended levels (<450 mOsmol/kg) [2-4]. Increased osmolality of milk has been associated with feed intolerance, delayed gut emptying and necrotizing enterocolitis [3,5,6]. We evaluated the effect of different combinations of fortification and commonly used additives on the osmolality of preterm human milk.

The osmolality was measured with freezing point depression method, using an osmometer (Osmomat 030 Germany). A thermistor probe measured the difference in freezing point of the solution measured from the reference. The instrument was regularly calibrated and was checked with internal controls for each batch of analysis of milk samples. Freshly expressed breast milk (EBM) was



Copyright of Indian Pediatrics 2016
For personal use only. Not for bulk copying or unauthorized posting to listserv/websites

obtained from four mothers (24- 28yrs old, normal nutritional status, delivered at 32-34 weeks gestation) during their second week of lactation after informed consent. The EBM was fortified by adding 1g HMF or 1 g Infant milk powder to 25 mL of EBM. Osmolality was checked before and after fortification, and also after addition of several nutrients that are used commonly. This included coconut oil, multivitamin drops (containing 1000IU Vitamin A, vitamin B complex, 40 mg vitamin C and 200IU vitamin D in each ml), 3% NaCl, calcium gluconate (9.3 mg/mL elemental calcium), neutral phosphate (33 mg/mL elemental phosphate), and colloidal iron drops (25 mg elemental iron, vitamin $B_{12}$ 5 mcg, folic acid 200 mcg in each mL).

Fortification using milk powder and HMF increased osmolality of EBM, from 303 mOsmol/kg to 397 and 373 mOsmol/kg, respectively. Addition of additives led to a further increase in the osmolality (***Fig*. 1**). The increase in osmolality was largest with addition of 10% calcium gluconate, and least with coconut oil (***Fig*. 1**). Though fortification or additives added alone to unfortified milk did not increase the osmolality beyond 450 mOsml/kg, addition of these additives to fortified milk increased the osmolality beyond this safe limit.

The increase in osmolality of milk by addition of HMF in our study was comparable to some earlier studies [7,8], but was less than that observed by Kreissl, *et al*. [9], who also observed marked increase in osmolality by addition of multivitamins, iron and calcium along with HMF.

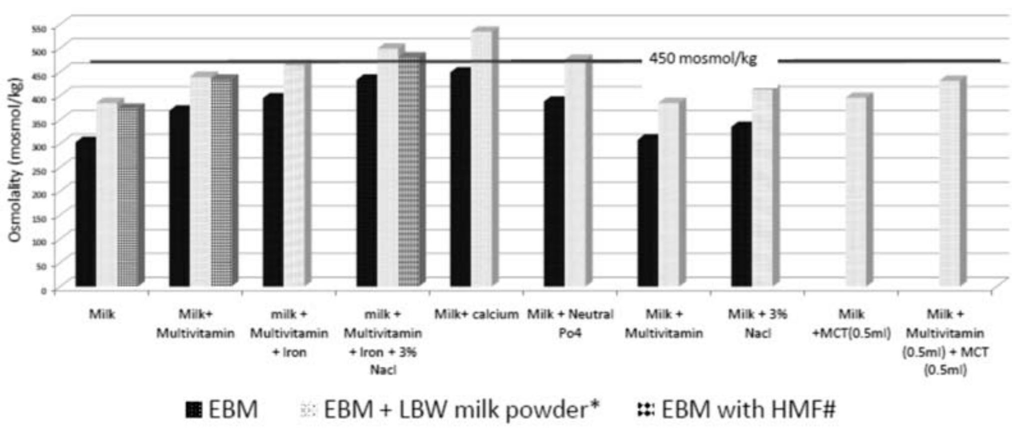
Addition of additives to fortified milk should be done with caution as this may increase the osmolality of feeds beyond the safe limit. It is important to make paediatricians aware that fortification and additives increase the osmolality of milk which could potentially lead to gut injury in preterm neonates.

*Contributors*: All authors were involved in the concept, design and analysis of the study. The first draft was prepared by VG and all authors were involved in the revision, and approval of the final version of the manuscript.
*Funding*: None; *Competing interests*: None stated.

**VIJAY GUPTA, VICTORIA JOB AND *NIRANJAN THOMAS**
*Department of Neonatology and Clinical Biochemistry,*
*Christian Medical College, Vellore, Tamil Nadu, India.*
**niranjan@cmcvellore.ac.in*

### REFERENCES

1. Kuschel CA, Harding JE. Multicomponent fortified human milk for promoting growthin preterm infants. Cochrane Database Syst Rev. 2004;1:CD000343.
2. De Curtis M, Candusso M, Pieltain C, Rigo J. Effect of fortification on the osmolalityof human milk. Arch Dis Child Fetal Neonatal Ed. 1999;81:F141-3.
3. Janjindamai W, Chotsampancharoen T. Effect of fortification on the osmolality ofhuman milk. J Med Assoc Thail Chotmaihet Thangphaet. 2006;89:1400-3.
4. Commentary on breast-feeding and infant formulas, including proposed standards forformulas. Pediatrics. 1976;57:278-85.
5. Pearson F, Johnson MJ, Leaf AA. Milk osmolality: Does it matter? Arch Dis Child Fetal Neonatal Ed. 2013;98:F166-9.
6. Willis DM, Chabot J, Radde IC, Chance GW. Unsuspected hyperosmolality of oralsolutions contributing to necrotizing enterocolitis in very-low-birth-weight infants.Pediatrics. 1977;60:535-8.
7. Agarwal R, Singal A, Aggarwal R, Deorari AK, Paul VK. Effect of fortification withhuman milk fortifier (HMF) and other fortifying agents on the osmolality of pretermbreast milk. Indian Pediatr. 2004;41:63-7.
8. Srinivasan L, Bokiniec R, King C, Weaver G, Edwards




*LBW : Simyl LBW (FDC LTD) low birth weight milk powder, #EBM : Expressed breast milk with Lactodex human Milk fortifiers, Raptakos Brett & Co. Ltd.
MCT: coconut oil used as Medium chain triglyceride

***Fig*. 1**. *Osmolality of breast milk with fortification and different combinations of additives.*



Copyright of Indian Pediatrics 2016
For personal use only. Not for bulk copying or unauthorized posting to listserv/websites

AD. Increased osmolality ofbreast milk with therapeutic additives. Arch Dis Child Fetal Neonatal Ed.2004;89:F514-7.
9. Kreissl A, Zwiauer V, Repa A, Binder C, Haninger N, Jilma B, *et al*. Effect of fortifiers and additional protein on the osmolarity of human milk: is it still safe for the premature infant? J Pediatr Gastroenterol Nutr. 2013;57:432-7.

# Papaverine for Ischemia Following Peripheral Arterial Catheterization in Neonates

11 Extremely low birth weight neonates who developed skin discoloration after peripheral arterial catheterization were given intra-arterial papaverine before the removal of arterial line. The skin color turned normal in all these neonates and none developed residual damage. In 3 neonates who could not receive papaverine, one developed gangrene of fingers. .

**Keywords**: *Arterial cannulation, complications, neonate, Vasospasm*.

Vascular spasm is a common complication of arterial catheterization, and is usually temporary and reversible [1]. Heparin and nitroglycerine (NTG) ointments have been used with varied success [2,3]. Papaverine is used in cardiac patients to relieve arterial spasm, and also to prolong the patency of arterial catheters in preterm neonates [4]. We retrospectively analyzed records of 14 extremely low birth weight (ELBW) neonates who developed skin discoloration following peripheral artery cannulation. Vasospasm was defined as complete perfusion recovery within 4 hours, thromboembolism as any discoloration of the skin not recovering within 4 hours, and residual damage as events leading to gangrene or loss of function of the extremity.

In the study period from January 2012 to December 2014, 47 ELBW neonates required 54 peripheral arterial line placements, 14 developed discoloration requiring arterial line removal. These infants were given intra-arterial papaverine before the removal of arterial line (6 posterior tibial and 5 radial) provided it was patent, and NTG patch was applied subsequently. The dose of papaverine used was 1 mg/kg [5, 6] diluted with 0.9% saline (1 mg: 1 mL), and infused over 5-10 minutes. Eleven neonates (gestational age 26-31 weeks; weight 0.56-0.98 kg) received intra-arterial papaverine. The skin color became normal in six neonates within 4 hours of removal of arterial lines, and in the remaining five, it normalized over next few days; none of these neonates developed residual damage. Three neonates could not receive papaverine because of line block; two of them achieved normal skin color and one developed gangrene of fingers. The limitation of present study include: retrospective analyses, no control group, use of another co-intervention (NTG) and a small sample size. Also, doppler studies were not performed to confirm ischemia/vasospasm.

Papaverine is an opium alkaloid with vasodilatory and spasmolytic action, due to its inhibition of oxidative phosphorylation and calcium flux, during muscle contraction. An earlier study demonstrated efficacy of papaverine in prolongation of patency of arterial catheters without an increase in hypotension and intraventricular hemorrhage, even in preterm neonates [4]. It seems that papaverine is also effective in preventing residual damage in arterial catheterization-induced ischemia in ELBW neonates. These preliminary findings need to be confirmed by well-designed controlled studies.

*Contributors*: DC, NP: conceived and designed the study; SRV, NP: collection of data; PPK: analysis of the data and drafting the paper. All authors approved the final version of manuscript.
*Funding*: None; *Competing interests*: None stated.

**NALINIKANT PANIGRAHY, *PODDUTOOR PREETHAM KUMAR, DINESH KUMAR CHIRLA AND SHIVANARAYAN REDDY VENNAPUSA**
*Department of Neonatology, Rainbow Children's Hospital and Perinatal Centre, Hyderabad, India.*
**drpreethamp@gmail.com*

**REFERENCES**

1. Ramasethu J. Complications of vascular catheters in the neonatal intensive care unit. Clin Perinatol. 2008;35:199-222.
2. Malloy MH, Cutter GR. The association of heparin exposure with intraventricular hemorrhage among very low birth weight infants. J Perinatol. 1995;15:185-91.
3. Baserga MC, Puri A, Sola A. The use of topical nitroglycerin ointment to treat peripheral tissue ischemia secondary to arterial line complications in neonates. J Perinatol. 2002;22:416-9.
4. Griffin MP, Siadaty MS. Papaverine prolongs patency of peripheral arterial catheters in neonates. J Pediatr. 2005;146:62-5.
5. Park SY, Kim DH, Ki JS, Kim KS, Hong YS, Hong YW. Resolution of peripheral artery catheter-induced ischemic injury in infants -Two case reports. Korean J Anesthesiol. 2010;59:127-9.
6. Boris JR, Harned RK, Logan LA, Wiggins JW. The use of papaverinein arterial sheath to prevent loss of femoral artery pulse in pediatric cardiac catheterization. Pediatr Cardiol. 1998;19:390-7.



Copyright of Indian Pediatrics 2016
For personal use only. Not for bulk copying or unauthorized posting to listserv/websites