

## Research article

**Plasma colloid osmotic pressure in healthy infants**

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(Print ISSN 1364-8535; Online ISSN 1466-609X)**Abstract**

**Background** The plasma colloid osmotic pressure (COP) plays a major role in transcapillary fluid balance. There is no information on plasma COP of healthy infants beyond the first post-natal week. The normal COP in healthy adult subjects (25 mmHg) is currently also applied as a reference value for healthy infants. This study was designed to test whether plasma COP values in healthy infants are the same as those in normal adults.

**Methods** Plasma COP was measured in 37 male and female healthy infants from 1 to 11 months old. For this purpose, 1 ml blood was collected during the patient's regularly scheduled visit if the patient required any type of blood test for routine laboratory analyses.

**Results** Plasma COP levels correlated slightly with increasing age from 1 to 9 months old (linear regression analysis;  $r^2 = 0.1$ ,  $P < 0.049$ ). We found no correlation between plasma COP and body weight at the same age ( $r^2 = 0.05$ ,  $P = 0.155$ ). The mean and standard deviation of COP in all infants was  $25.1 \pm 2.6$  mmHg, which is almost identical to an average COP of 25 mmHg in healthy adult subjects. Arbitrary division of the infants into three different age groups (1–3 months [ $n = 11$ ], 5–8 months [ $n = 13$ ] and 9–11 months [ $n = 13$ ]) showed an average increase of approximately 2 mmHg in COP of 9-month-old to 11-month-old infants, compared with 1-month-old to 3-month-old infants (one-way analysis of variance;  $P = 0.26$ ). There was no gender difference in the COP level (unpaired *t*-test), with an average of  $25.1 \pm 2.4$  mmHg in 19 male infants compared with  $25.2 \pm 2.9$  in 18 female infants. The 95% confidence interval for COP in both male and female infants ( $n = 37$ ) was between 24.3 to 26.0 mmHg, ranging from 19.5 to 30.3 mmHg, with a median value of 25.2 mmHg.

**Conclusions** The data accept the null hypothesis that the COP range in infants younger than 1 year old is similar to those observed in adult subjects. Our observations, compared with previously reported neonatal COP values, suggest that there is a sharp increase in COP within the first months after birth.

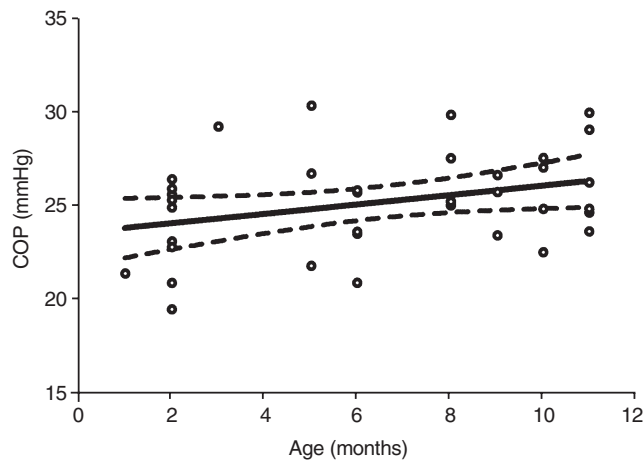
**Keywords** colloid osmotic pressure, colloid therapy, fluid balance, infant patients, neonate patients

**Introduction**

Plasma COP is generated by the plasma proteins, particularly albumin, and is known to vary during various neonatal diseases [1-4]. Lower plasma COP favors a fluid shift from intravascular space into interstitial space, with subsequent formation of peripheral and pulmonary edema [3-8]. To stabilize the intravascular volume and prevent or reverse the events leading to peripheral and pulmonary edema, albumin or other colloid solutions are frequently administered, to maintain the

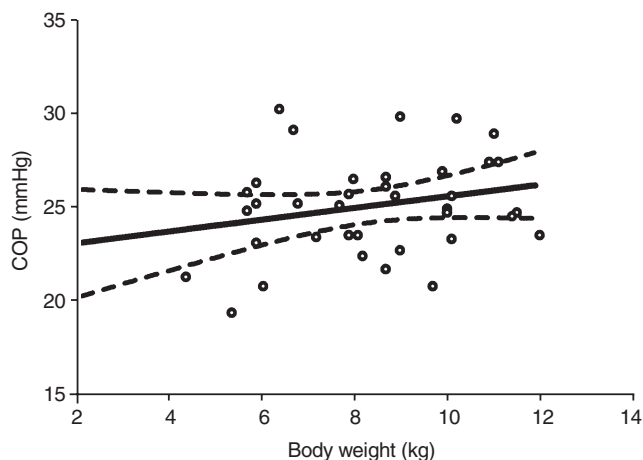
COP in the 'normal' range [7-12]. Albumin administration for various conditions, however, is controversial [13-15]. Plasma COP in healthy neonates, sick neonates, and prematurely born infants are reported to be much lower than in adults [16-18]. The normal range of COP for healthy adults is reported to be between 22 and 28 mmHg, with a mean of 25 mmHg [19,20]. There is, however, no information in the literature on normal COP range beyond the early neonatal age. The adult COP values in our intensive care unit are also considered to be

**Figure 1**



A weak association was found between colloid osmotic pressure (COP) levels and age in healthy infants within the first post-natal year ( $r^2 = 0.10$ ,  $n = 37$ ,  $P < 0.049$ ).

**Figure 2**



There is no significant correlation between colloid osmotic pressure (COP) levels and body weight in healthy infants within the first post-natal year ( $r^2 = 0.05$ ,  $n = 37$ ,  $P = 0.15$ ).

normal for infants. The excessive use of albumin and its potential complications [15,21,22] may be avoided if the normal range of COP in infants is significantly less than in adults. The present study was therefore designed to determine the normal range of COP in infants younger than 1 year of age and to establish whether there is any correlation between post-natal age, gender, or weight and COP. The null hypothesis is that the COP range in the first months of life is in fact similar to those observed in adult subjects.

### Patients and methods

The protocol for this study was approved by the Miami Children's Hospital Institutional Review Board and conducted in the Continuing Care Center of Miami Children's Hospital. The COP was determined in infants from birth to 12 months of age. Blood samples were taken during the patient's regularly scheduled clinic visit for 'well baby visits'. An additional 1 ml blood was collected for our research if the patient required any type of blood test for routine laboratory analyses. The COP was measured using the Model 4400 Colloid Osmometer (Wescor Inc., Logan, UT, USA) on serum that was separated from the sample after centrifugation.

The study was designed as a non-blinded, sequential, descriptive study. Patients were included in the study, after informed consent was obtained from the parent or guardian. Patients older than 1 year, those with an underlying illness, such as nephropathy, liver disease, cardiac anomalies, malnutrition, viral illness with resulting gastrointestinal disturbances or acute febrile illness, or history of any disease state that may interfere with protein metabolism were excluded.

### Statistical analysis

A simple linear regression test was used to determine whether there is any correlation between age and COP, or body weight and COP. An unpaired *t*-test was used to evaluate gender differences in COP. We also used one-way analysis of variance (ANOVA) to evaluate whether the average COP levels were different among infants that were categorized into three different age groups of 1–3, 5–8, and 9–11 months old. All values are presented as mean  $\pm$  standard deviation (SD), and  $P < 5\%$  were considered significant.

### Results

The study was concluded after completion of a single COP measurement in 19 male infants and 18 female infants from 1 to 11 months old. The study population consisted of 32 infants out of 37 infants with Hispanic origin. A relatively weak but significant correlation ( $r^2 = 0.10$ ,  $P < 0.049$ ) was found between the COP values and age within the first year of life in healthy infants (Fig. 1). There was, however, no correlation between COP and body weight (Fig. 2). No gender differences were found between the male and female infants in this age group (Table 1). An arbitrary division of the all infants into three different age categories (1–3 months old [ $n = 11$ ], 5–8 months old [ $n = 13$ ] and 9–11 months old [ $n = 13$ ]) showed an average increase of approximately 2 mmHg in COP in 9-month-old to 11-month-old infants, compared with 1-month-old to 3-month-old infants (one-way ANOVA). This increase from 24 to 25.8 mmHg was not statistically significant (one-way ANOVA;  $P = 0.26$ ). The median value of COP for either male or female infants separately, or combined, was 25.1–25.2 mmHg, with a

**Table 1****Colloid osmotic pressure (COP) values in 1-month-old to 11-month-old healthy infants**

COP (mmHg)	Male and female (n = 37)	Males (n = 19)	Females (n = 18)
Mean ± SD	25.1 ± 2.6	25.1 ± 2.4	25.2 ± 2.9
Median	25.2	25.2	25.1
Range	19.5–30.3	20.9–29.8	19.5–30.3
95% Confidence interval	24.3–26.0	23.9–26.3	23.7–26.6

SD, standard deviation.

95% confidence interval of 24.3–26.0 mmHg for the combined male and female infants (Table 1).

## Discussion

Sepsis, acute respiratory distress syndrome, hemorrhage and renal failure cause a decrease in the total plasma proteins with consequent reduction in COP, either because of the loss of blood proteins or owing to capillary leakage [4–9]. There are no standards for volume resuscitation and COP restoration of intensive care patients [22]. Because of the controversial debate on colloid versus crystalloid solutions for volume resuscitation [9,12–15,21,22], definition of the normal range of COP in different age groups is crucial. The present study was therefore designed to test whether the normal COP in adults does indeed represent the normal COP values in infants that are younger than 1 year old. The results of the study confirm that plasma COP in humans can reach its peak level as early as 1–3 months after birth. The results, therefore, justify the use of the adult COP range as a reference point for either colloid or crystalloid therapy for restoration of COP during various post-natal diseases that occur within the first year of life.

The plasma COP in the pre-term and full-term healthy neonates and in pre-term and full-term sick neonates [16–18] is much lower than those reported in adults [19,20]. For example, the average COP ± SD in five healthy pre-term neonates was reported to be 15.4 ± 1.3 mmHg [16], compared with an average of 25 mmHg in adults [19,20]. The COP in 40 sick pre-term neonates was also significantly lower (12.4 ± 1.6 mmHg) compared with healthy pre-term neonates [16]. Solo and Gregory [17] have also reported a similar range of COP (12.5 ± 2.5 mmHg) in 362 sick pre-term infants. Healthy full-term neonates (n = 99), delivered vaginally, had a higher COP of 19.4 ± 2.2 mmHg, compared with 40 healthy full-term neonates who were delivered by Cesarean section [17]. Zimmermann *et al* [18] found a strong relationship between water homeostasis and neonatal respiratory distress. They showed a significantly lower COP of 15 ± 2.2 mmHg in 1-day-old neonates with respiratory distress, compared with 17.9 ± 2.5 mmHg in healthy neonates [18].

The lack of a significant gender difference in COP of our healthy infants allowed us to combine the COP of the male and female subjects in a larger group. The demographic cross-section of the population used in this study was mostly of Hispanic origin (32 of 37 infants). Although the Hispanic population in South Florida is not ethnically a homogeneous group, the question is whether our sample can truly represent infants from other ethnic groups. Our infant's population included only one 9-month-old black female with a COP of 23.4 mmHg. This value falls slightly below the 95% confidence interval, calculated for the entire female infants of our sample (Table 1). This COP level, however, was within the observed range, and was only one unit of SD away from the sample mean (equivalent to the 33rd percentile). The mean ± SD of four non-Hispanic white infants (three females and one male) in our sample was 25.5 ± 3.7 mmHg, compared with an average of 25.1 ± 2.5 mmHg in 32 Hispanic infants. This small sample suggests that the observed COP values in the larger Hispanic group are indeed representative of COP levels in healthy infants of non-Hispanic children. In conclusion, our data extend the age spectrum for the normal COP levels to also include the first post-natal year. Our results compared with those observed during the early neonatal period in healthy full-term and pre-term infants [15–18] suggest a sharp increase in COP within the first months after birth.

## Competing interests

None declared.

## Acknowledgement

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