

3. Title: Erythrocyte Composition in Normal Thai Children.

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**Background** Previous study of erythrocyte composition in the normal American infant showed that red blood cell potassium concentration and effective plasma osmolality were higher in infants under 1 month of age than those who were between 1 to 11 months. Red cell water content was also greater in 6 to 11 months old infants than in the younger age group. There was no difference in hemoglobin and hematocrit values between infants aged 1 to 5 and 6 to 11 months despite the difference in cell water content. The reason for these differences is not yet known. It is postulated that the changes may be physiological due to growth and/or nutritional status.

Since Thai infants are fed differently from American and live in a tropical climate, it would be desirable to study the plasma and erythrocyte composition in Thai infants and children.

**Objective** To describe the erythrocyte composition and its relation to plasma water and solute concentrations in normal Thai children from birth through 3 years of age. This information will serve as baseline information for a study of plasma and erythrocyte composition in various diseases.

**Description** Blood specimens were obtained from normal infants and children whose ages ranged from birth through 3 years. Cord blood and peripheral blood specimens from normal newborn infants was obtained in the delivery room and nurseries of Chulalongkorn Hospital. Prenatal records as well as the neonatal course were evaluated to insure exclusion of data from infants with hematologic abnormalities. The older infants and children selected to serve as normal subjects were among the children who attended well-baby clinics at Chulalongkorn Hospital and Din Dang health center. Histories, physical examinations and social histories were evaluated to insure selection of normal subjects.

7 ml of blood was obtained in heparinized-vacutainer tubes. The following determinations were carried out on each blood specimen:

a. On whole blood: Hemoglobin, hematocrit, red blood cell count and reticulocyte count were determined by standard method. Estimation of pH and  $PCO_2$  were done by using an Astrup Radiometer.

b. On plasma: Refractive index by AO refractometer, specific gravity by certified pipette and accurate weight, dry solids by heating at  $105^\circ C$  for 24 hours, total solute concentration by using the Fiske Osmometer.  $Na^+$ ,  $K^+$ ,  $Ca^{++}$ ,  $Cl^-$ , urea N and sugar by Automated Technic,  $Mg^{++}$  by Atomic absorption spectrophotometer,  $CO_2$  by Natelson microgasmeter, and radioactivity related to intercellular trapped plasma by  $I^{131}$  human serum albumin.

c. On packed red blood cells: The packed RBC was prepared by centrifuging for one hour at 3000 rpm and by cutting 1 mm below the buffy coat layer after freezing with ethanol  $CO_2$  mixture. The hemolysate was prepared by adding deionized water approximately 2 gm/gram of RBC and was analyzed for specific gravity, dry solids,  $Na^+$ ,  $K^+$ ,  $Ca^{++}$ ,  $Mg^{++}$ ,  $Cl^-$  and radioactivity.

**Progress** A total of 116 blood specimens were obtained and analyzed. The error of the methods are: 5% for  $Na^+$ ,  $K^+$ ,  $Cl^-$ ,  $CO_2$ , and  $Mg^{++}$ , 0.1 mg% for  $Ca^{++}$ , 2% for specific gravity, 1.2% for dry solids, 2% for intercellular trapped plasma and 2% for osmolality.

Hemogram of adults, cord blood, newborn infants, infants 1 month through 5 months, 6 months through 11 months, 1 year through 2 years, and 2 years through 3 years are presented in Table 1.

The average hemoglobin level in the newborn infant was 18 gm% which was higher than the same age group reported by Hellerstein et., al., (Table 2). This was likely due to the fact that the newborn infant

TABLE 1. HEMOGRAM

Subjects		Hemoglobin Gm%	Hematocrit %	RBC x10 <sup>6</sup>	Retic %	Venous Blood	
						pH	PCO <sub>2</sub> mmHg
ADULTS	Mean	13.3	41	5.17	0.57	—	—
	SD	1.3	4	.93	.28		
	No.	20	20	20	20		
CORD BLOOD	Mean	14.8	47	4.17	3.1	—	—
	SD	1.6	5	0.48	1.2		
	No.	17	17	17	17		
NEWBORN INFANTS	Mean	18.0	54	4.9	2.6	7.33	—
	SD	2.7	9	0.8	.9		
	No.	22	22	22	22		
1 through 5 Mo. Infants	Mean	10.4	34	4.21	.7	7.35	40.2
	SD	1.1	3	.6	.6		
	No.	21	21	21	21		
6 through 11 Mo. Infants	Mean	10.9	35	4.81	.6	7.38	37.6
	SD	.1	3	.5	.5		
	No.	17	17	17	17		
1 through 2 yr. Infants	Mean	11.9	36	4.75	.7	7.36	40.3
	SD	1.0	3	.69	.5		
	No.	13	13	13	13		
2 through 3 yrs. Children	Mean	11.5	35	4.14	1.5	7.37	37
	SD	1.0	3	.52	1.0		
	No.	6	6	6	6		

TABLE 2. PLASMA AND RED BLOOD CELLS WATER AND SOLUTE IN INFANTS AND CHILDREN BY HELLERSTEIN, VARAVITHYA AND GRADY

Subjects	Plasma Na <sup>+</sup> mEq/L	(mOsm) EFF mOsm/Kg	RBC		K <sup>+</sup>			Cl <sup>-</sup>			Hb gm%	Hct %
			Solids %	H <sub>2</sub> O/100 Gm Solids	Kg RBC	100 Gm Solids	Kg RBC H <sub>2</sub> O	Kg RBC	100 Gm Solids	Kg RBC H <sub>2</sub> O		
Less than one month	Mean	278	33.3	201	92.4	27.7	139	49.2	14.8	74	15.1	46
	SD	5.2	—	8.9	3.7	1.2	6	2.9	1.2	4	2.0	8
	No	19	18	18	18	18	18	18	18	18	18	18
1 through 5 Mo. Infants	Mean	273	30	203	87.6	26.4	131	49.8	15.1	75	11.0	33
	SD	6	—	15	32	1.7	.5	3.8	1.6	5	1.1	4
	No	42	17	18	41	40	40	39	38	38	42	39
6 through 11 Mo. Infants	Mean	272	31.2	222	90.4	29.1	131	52.3	16.9	76	10.8	35
	SD	5	—	14	3.8	2.0	5	2.8	1.5	4	1.6	4
	No	35	30	30	33	30	30	25	22	22	34	31

In the present study was younger than the previous report. However, there was no difference in the hemoglobin level in the older age group between the two studies.

Venous blood pH and  $PCO_2$  were within normal range in all groups.

Plasma solute presented in Table 3 and the pertinent findings are as follows:

1. Plasma effective osmolality (EFF) was lower in cord blood and in the group of infants one month through 2 years of age than newborn infants, adults and older children.
2. Plasma magnesium levels were lower in cord blood and newborn infants than the other groups.

Red blood cells water and solute are presented in Table 4. Samples from cord blood and from subjects (6–12 months, 1 to 2 years and 2 to 3 years) show that the mean red blood cell water contents were  $210 \pm 5$ ,  $215 \pm 18$ ,  $211 \pm 17$  and  $214 \pm 11$  gm/100 gm RBC solids respectively. Red blood cell water contents were  $205 \pm 15$ ,  $201 \pm 10$ ,  $203 \pm 10$  gm/100 gm solids in adults, newborn infants and infants one month through 5 months respectively. The adults and newborn who had high hemoglobin and hematocrit also showed low water content. Since hemoglobin normally accounts for about 90% of red cell solids, an erythrocyte with high hemoglobin content should have diminished water content. However, this does not explain the low water content level in infants one month through 5 months when they have about the same hemoglobin level as those of older children. The decreased water content in this group was associated with decreased red blood cell potassium content. As a result, the concentration of potassium in the red cell of one to 5 month old infants was nearly identical with the older children.

The summation of  $Na^+$  and  $K^+$  in red cell water was greatest in the newborn infant. This is an evidence of increased solute concentration in the red cell water of this group.

This findings confirm the previous work reported by Hellerstein, Varavithya and Graddy\* (Table 2):

1. That the concentration of solute in red cell water and effective plasma osmolality are increased in infants less than one month compared with older infants.
2. That red cell water content is increased in the erythrocytes of infants older than 5 months.

Red blood cell magnesium (Table 5) was low in cord blood and newborn infants compared to other groups. This is consistent with observations reported by other workers.

**Conclusion** Data on plasma and red blood cell water and solute indicate that changes in erythrocyte composition relative to growth exist.

1. The concentration of solute in red cell water and effective plasma osmolality are increased in newborn infants.
2. Red blood cell water content is increased in the erythrocyte of cord blood and infants older than 5 months as compared to newborn infants and adults.
3. Plasma and red blood cells magnesium is low in cord blood and newborn infants.

A few more infants under one month of age and children 2 through 3 years are to be studied so that data will be completed and can be used as baseline data for further study of erythrocyte composition in various diseases.

\* American Journal of Diseases of Children: October 1966, Vol. 112, pp. 298–311.

TABLE 3. PLASMA SOLUTE

Subjects	Mean SD No	Plasma mEq/L				mg%		mg %		Osmolality mOsm/Kg		Plasma Mg <sup>++</sup> mEq/L
		Na <sup>+</sup>	K <sup>+</sup>	Cl <sup>-</sup>	CO <sub>2</sub> <sup>-</sup>	Ca <sup>++</sup>	P <sub>E</sub>	Sugar	PUN	FP	EFF	
ADULTS		143 2 21	4.0 .5 21	106 2 21	— — —	9.9 .4 19	3.4 .6 20	92 13 20	11.4 2.1 21	278 7 20	278 7 20	1.76 .2 11
CORD BLOOD		138 2.4 22	6.3 1.4 22	105 2 22	19.2 2.4 18	10.5 0.9 19	5.4 .9 21	79 25 22	8.5 2.7 22	283 8 22	276 7 22	1.5 .2 22
NEWBORN INFANTS		140 4 22	5.3 .8 22	105 3 22	20.3 2.7 19	9.8 .5 20	5.6 1 18	76 19 22	8.3 2.9 22	286 10 22	279 9 22	1.59 .18 22
1 through 5 Mo. Infants		138 2 21	4.9 .5 21	105 3 21	20.7 2.4 21	10.2 .3 19	5.8 .5 19	97 12 21	9.7 4.2 20	283 5 20	274 5 20	1.9 .3 12
6 through 11 Mo. Infants		139 2 17	4.5 .4 17	105 2 17	20.8 2.3 17	10.3 .4 15	5.6 .5 17	100 10 17	7.9 3.2 17	285 7 17	276 7 16	1.7 .24 16
1 through 2 yrs. Infants		140 5 13	4.8 .6 13	105 2 13	21.3 .9 13	10.0 .6 9	5.5 .5 8	98 11 10	8.7 2.4 13	284 4 12	275 4 12	1.96 .2 13
2 through 3 yrs. Children		142 2 6	4.2 .2 6	108 1 6	18.4 2.6 6	9.6 .5 5	4.4 .7 5	107 1.7 6	9.1 1.7 6	288 7 6	278 6 6	1.9 .3 6

TABLE 4. RED BLOOD CELLS ELECTROLYTES

Subjects	Plasma			RBC		Na <sup>+</sup> mEq/			K <sup>+</sup> mEq/			Cl <sup>-</sup> mEq/			
	Na <sup>+</sup> mEq/L	(mOsm) EFF	mOsm/Kg	Solids %	H <sub>2</sub> O/100 Gm Solid	Kg RBC	100 Gm Solids	Kg RBC	100 Gm Solids	Kg RBC	100 Gm Solids	Kg RBC	100 Gm Solids	Kg RBC	H <sub>2</sub> O
ADULTS	Mean	278		32.9	205	8.9	2.6	13.2	90.8	27.4	135	47.7	14.3	71	
	SD	7		1.6	15	1.4	5	2.0	2.8	1.7	5	3.3	1.0	5	
	No	20		21	21	18	18	18	18	18	18	18	18	18	18
CORD BLOOD	Mean	276		32.3	210	10.5	3.2	15.4	92	28.5	136	46.7	14.4	69	
	SD	7		1.7	5	2.0	0.6	2.9	5.5	1.9	9	3.0	1.2	5	
	No	22		22	22	22	22	22	22	22	22	22	22	22	22
NEWBORN INFANTS	Mean	279		33.3	201	11.1	3.3	16.5	95.5	28.6	143	45.9	13.8	68	
	SD	9		1.0	10	1.6	0.5	2.3	6.4	2.1	10	3.2	1.1	5	
	No	22		22	22	22	22	22	22	22	22	22	22	22	22
1 through 5 Mo. Infants	Mean	274		33.1	203	12.0	3.6	17.9	97.8	26.5	131	42.8	12.9	63	
	SD	5		1.1	10	2.6	.8	3.9	3.7	1.4	6.4	2.7	1.1	4	
	No	20		20	21	21	21	21	21	21	21	21	21	21	21
6 through 12 Mo. Infants	Mean	276		31.8	215	11.2	3.5	16.3	89.7	28.2	131	43.4	13.4	63	
	SD	7		1.8	18	3.5	1.3	4.9	5.5	2.1	9.7	5.7	1.8	9	
	No	16		16	16	17	16	16	17	16	16	17	16	16	16
1 through 2 yr. Infants	Mean	275		32.7	211	10.0	3.1	13.8	91.7	28.0	135	44.4	13.6	66	
	SD	4		2.2	17	1.5	.5	2.4	3.7	2.5	5.7	4.4	1.4	8	
	No	12		12	12	13	12	12	13	12	12	13	12	12	12
2 through 3 yr. Children	Mean	278		31.9	214	9.9	3.1	14.5	89.1	27.9	131	46.5	14.5	68	
	SD	6		1.1	11	2.3	.7	3.2	2.6	.6	4.8	8.6	2.6	15	
	No	6		6	6	6	6	6	6	6	6	6	6	6	6

TABLE 5. PLASMA AND BLOOD CELL MAGNESIUM

Subjects		Plasma mEq/L	RBC mEq/		
			Kg RBC	100 Gm SOLIDS	Kg RBC H <sub>2</sub> O
ADULTS THAI	Mean SD No.	1.76 .2 11	5.31 .98 11	1.61 .29 11	7.91 1.46 11
CAUCASIAN	Mean SD No.	1.59 .2 10	5.06 .6 10	1.53 .17 10	7.54 .89 10
CORD BLOOD	Mean SD No.	1.50 .2 22	3.81 .5 22	1.17 .15 22	5.62 .7 22
NEWBORN INFANTS	Mean SD No.	1.59 .18 22	3.88 .5 22	1.16 .15 22	5.8 .7 22
1 through 5 Mo. Infants	Mean SD No.	1.9 .3 21	5.35 .5 21	1.60 .17 21	7.98 .26 21
6 through 12 Mo. Infants	Mean SD No.	2.0 .2 17	5.40 .59 17	1.70 .24 16	7.96 .9 16
1 through 2 yrs. Infants	Mean SD No.	1.96 .2 13	5.36 .57 13	1.5 .2 12	7.50 1.1 12
2 through 3 yrs. Children	Mean SD No.	1.9 .3 6	5.30 7 6	1.64 .22 6	7.80 1.1 6