

SOME HEMATOLOGICAL DIFFERENCES BETWEEN THE BLOOD OF MOTHERS AND THEIR NEWBORN INFANTS

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SYNOPSIS

The measurement of the Hb concentration, PCV, serum iron concentration, serum transferrin concentration, TIBC and percentage saturation of transferrin was carried out in 27 mothers during delivery and in the cord bloods of their infants. The Hb, PCV and serum iron levels were significantly higher in the cord bloods than in the maternal blood but there was no correlation between the individual values in mother and infant. Serum transferrin levels in cord blood are approximately half those in the mother. There was a significant positive correlation between these levels in the mother and infant.

Pregnancy imposes a strain on the iron reserves of the mother and iron deficiency anemia during pregnancy is still a common problem throughout the world. (World Health Organisation, 1968). To find out whether the mother's hematological status is reflected in that of her newborn infant we investigated the relationship between the hemoglobin concentration (Hb), packed cell volume (PCV), serum iron concentration, serum transferrin concentration, total iron-binding capacity (TIBC) and percentage saturation of transferrin in mothers during labour and the cord blood of their infants soon after delivery.

MATERIAL AND METHODS

Venous blood samples were obtained from 27 women during labour. Immediately after delivery of the baby, blood was collected from the placental end of the cut umbilical cord into iron-free containers. All the subjects in the study were Chinese women delivered in Thomson Road General Hospital. The pregnancies were apparently normal and the deliveries were without complications. All the infants were full-term as calculated from the mothers' menstrual history.

The Hb concentration was measured by the cyanmethemoglobin method. (Van Kampen and Zijlstra, 1961). PCV was determined using heparinised microhematocrit tubes (Strumia *et al*, 1954). Serum iron was measured by the method

described by Henry, Chiamori and Sobel (1958) using sulphonated bathophenanthroline. Serum transferrin was measured by radial immunodiffusion (Mancini *et al*, 1965) and the TIBC was calculated from it by multiplying with the factor 1.25. (Surgenor *et al*, 1949).

RESULTS

The results of the study are summarised in Table I. The Hb, PCV and serum iron levels are all significantly higher in the cord-blood compared to that in the mother. ($p < 0.001$). There was however, no correlation between individual levels of these in mother and child.

The serum transferrin level in the mother was 320.3 mg./100 ml. which corresponds to a TIBC of 400.2 μ g/100 ml. This is significantly higher than normal values of serum transferrin found in non-pregnant Chinese women of child-bearing age. This was found in a previous study (Chang *et al*, 1972) to be 256.4 mg./100 ml. (± 39.8) and corresponds to a TIBC of 311.7 μ g/100 ml. (± 80.7). The serum transferrin level in cord blood was 174.1 mg./100 ml., with a TIBC of 217.6 μ g/100 ml. This is significantly lower than the maternal values. ($p < 0.001$).

A significant positive correlation was found between the serum transferrin level in the mother and that of her newborn infant. ($r = 0.491$, $p < 0.01$). A slight positive correlation was also found between the percentage saturation of transferrin in the cord blood and in the maternal blood. ($r = 0.377$, $p < 0.1$).

Table II compares the results obtained by previous authors on the serum iron, TIBC and percentage saturation of transferrin in paired maternal and cord blood with the results of the present series.

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TABLE I

THE RELATIONSHIP BETWEEN HB, PCV, SERUM IRON, SERUM TRANSFERRIN, TIBC, % SATURATION OF TRANSFERRIN IN 27 MOTHERS AND THEIR NEWBORN INFANTS

Investigation	Mother	Infant	Significance Between Means	Correlation Coefficient
	Mean \pm 1 S. D. (Range)			
Hb conc. (g./100 ml.)	14.5 \pm 1.6 (10.4 - 17.0)	17.0 \pm 1.57 (12.8 - 19.6)	p < 0.001	r = 0.258 No correlation
PCV (%)	43.5 \pm 4.46 (33.0 - 52)	50.1 \pm 6.57 (33.5 - 62.0)	p < 0.001	r = 0.170 No correlation
Serum iron (μ g/100 ml.)	79.7 \pm 25.6 (42.2 - 141.3)	155.5 \pm 44.4 (64.7 - 250.0)	p < 0.001	r = 0.117 No correlation
Serum transferrin (mg./100 ml.)	320.3 \pm 96.8 (190.0 - 600.0)	174.1 \pm 38.2 (127.5 - 250.0)	p < 0.001	r = 0.491 significant p < 0.01
TIBC (μ g/100 ml.)	400.3 \pm 121.0 (237.5 - 750.0)	217.6 \pm 47.7 (159.4 - 312.5)	p < 0.001	r = 0.511 significant p < 0.01
% saturation of transferrin	21.0 \pm 10.1 (9.8 - 51.2)	69.1 \pm 18.9 (31.4 - 96.8)	p < 0.001	r = 0.377 significant p < 0.1

TABLE II

COMPARISON OF RESULTS OBTAINED BY DIFFERENT AUTHORS ON THE MEAN SERUM IRON, TIBC AND PERCENTAGE SATURATION OF TRANSFERRIN IN PAIRED MATERNAL AND CORD BLOOD

Author	Year	No. of Pairs	Mother			Cord Blood		
			Serum Iron (μ g/100 ml.)	TIBC	% Sat. of Transferrin	Serum Iron (μ g/100 ml.)	TIBC	% Sat. of Transferrin
Laurell	1947	17 (serum iron 25 (TIBC))	80	446	17.9	147	226	65
Hagberg	1953	21	98	470	20.8	173	259	58
Fletcher and Suter	1969	40	106	555	19.0	169	293	59
Present series	1972	27	79.7	400.3	21.0	155.5	217.6	69.1

DISCUSSION

The Hb concentration of cord blood obtained in this series is of the same order as Mollison and Cutbush's (1951) figure of 16.6 g./100 ml. and Marks, Gairdner and Roscoe's (1955) figure of 16.9 g./100 ml. These high values contrast with the lower values obtained from the mother during labour and they reflect the response of the foetus to its relatively anoxic intra-uterine environment. Only 1 out of the 27 mothers in the series had a Hb concentration <11.0 g./100 ml. which level is considered by the World Health Organisation (1968) to be the critical one below which anemia in pregnancy is considered to be present. The relatively high Hb levels in the Singapore mothers is, we feel, due to the use of prophylactic iron therapy throughout pregnancy and the greater awareness amongst the mothers of the need for constant antenatal supervision. We could not find a correlation between the Hb level in the mother and that of her newborn infant. This agrees with the findings of Woodruff and Bridgeforth (1953) and Rowland (1968). Sisson and Lund (1958) however considered that measurement of the red cell volume and hemoglobin mass would be more helpful in the study of pregnant women and their newborn infants because of the volumetric changes in the cardiovascular system at these times. Using these measurements they were able to show that maternal anemia does lead to a lower circulating hemoglobin mass in the newborn infants.

The PCV is significantly higher in cord blood than in maternal blood. This is due to an increased number and size of the red blood cells in cord blood.

The serum iron level in cord blood is approximately twice that found in maternal blood, whilst the TIBC is lower. The percentage saturation of transferrin is high in cord blood and low in maternal blood. These results are in keeping with those reported by other authors. (Table II). The low maternal serum iron and high cord blood serum iron shows that the passage of iron across the placenta is an active process, working against concentration gradients. That this transfer of iron is a very rapid process has been shown using radioactive iron. (Pommerenke *et al*, 1942; Fletcher and Suter, 1969). No correlation was found between the levels of serum iron in maternal blood and that of the newborn infant. This could mean that factors other than the actual concentration of serum iron in maternal blood play a more important part in deciding how the foetus gets iron from the mother. Placental mechanisms which act to release iron into the foetal side of the circulation is a possibility.

The concentration of transferrin in maternal and cord blood was directly measured in this study and levels in the mother exceed those in the cord blood by almost twice. Derrington and Soothill (1961) found the mean concentration of transferrin in maternal serum to be 223% of a standard "normal" serum and that in cord blood to be 90%; maternal values exceed cord blood values by approximately two and a half times. The greatly increased levels of transferrin during late pregnancy, coupled with the low serum iron and the reduced percentage saturation of transferrin is thought to improve transfer of iron to the foetus because it increases intestinal absorption of iron and the mobilisation of iron from maternal storage sites. (Laurell, 1947). On the foetal side of the circulation however, the converse is true. The high serum iron and low transferrin concentration, with the increased saturation of transferrin is conducive to iron storage and it has been shown that more than half of the radioactive iron given to the mother 1-2 weeks before delivery is found in the liver and not in the circulating hemoglobin of the foetus. (Fletcher and Suter, 1969).

The significant positive correlation found between maternal and foetal transferrin levels requires further elucidation. This has not previously been described. Maternal transferrin does not cross the placenta, (Gitlin *et al*, 1964) and foetal serum transferrin is probably synthesized by the foetus itself. (Rausen *et al*, 1961). It is possible that the production of transferrin on either side of the placenta could depend on a common factor. This may be an endocrine one. An increased capacity in the mother to produce transferrin appears to be reflected in a smaller extent by her foetus. The significance of this, if any, has yet to be sought.

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