

**BLOOD PLATELETS DURING PREGNANCY, LABOR,
THE PUERPERIUM AND MENSTRUATION,
AND IN THE NEW BORN.***

BY

STEPHEN REBAUDI, M.D.,

Genoa, Italy.

NUMEROUS students have investigated the blood during pregnancy, labor, the puerperium and menstruation in relation to the changes in the physical and chemical properties of the plasma

(intercellular substance) and of its cellular bodies, and have devoted adequate attention to all questions which are connected with them. Density, alkalinity freezing point, the coagulative, the autotoxic and bactericidal powers, the hemolytic and hemoagglutinative properties, the auto- and iso-hemolytic qualities of the serum, the electrical resistance and conductivity, etc., have been thoroughly investigated, as well as the changes of red corpuscles which are connected with those of the amount of hemoglobin, and the numerical alterations of the white corpuscles, the so-called leukocytic formula.

No mention, however, is made of platelets, the third morphological element of blood, Bizzozzero's element, or at least only a word is said here and there about them. This negligence may be referred to the distrust in regard to the actual existence of platelets, as well differentiated elements, and to the confusion which prevails among careless students as to the nature, origin, and normal evolution of these cellular bodies. Italian students ought to consider themselves especially bound to the study of blood platelets by the names of Bizzozzero, who first discovered this normal morphological element of blood, and Vassale, by whose researches its origin and physiological rôle have been ascertained.

I will summarize in the following pages the results of numerous experiments during different periods of pregnancy, during parturition, menstruation, and the first twelve days after labor, and in the new born during the twelve days following birth.

The number of platelets is always greater than normal at any time of pregnancy, though it is subject to very noticeable variations. The platelets increase in number during the first month, and keep on increasing during the second and third until they reach a maximum average of 630,000 per c. mm. during the first fortnight of the fourth month. They diminish slowly and gradually during the fourth, the fifth, and the first half of the sixth month, when they reach the minimum average of 500,000 per c. mm. The number of platelets increases rapidly again during the seventh, eighth, and ninth months, when they reach, at term, the maximum average of 950,000 per c. mm. During the last moments of labor, immediately before the expulsion of the child, platelets are even more numerous, and they reach a maximum average of 1,500,000 per c. mm.

During the physiological crises of pregnancy (Bossi), corresponding exactly with the premenstrual time, an augmentation in

the number of platelets is evident, and this continues during the time which would correspond to the missing menstrual period. The increase is about 200,000 per c. mm., and is more or less conspicuous and rapid, and disappears more or less rapidly, according to the period of pregnancy. During the first months of pregnancy platelets are small or of medium size, round, or ovoid. They show a rather high agglutinative power and unite in groups of 12, 14, or 16; large and non-cohesive platelets are rare. As the term of pregnancy approaches, and platelets become more and more numerous, their bulk diminishes; they become round; large platelets disappear completely. Viscosity increases, and they group together into more and more numerous heaps, so that at term, during the last days, the last hours before labor, one finds groups of from thirty to forty small and very viscid platelets so conglutinated that it is impossible to separate them, even by long and energetic shaking of the fixing and staining solution in which they have been collected directly from the blood.

During the critical periods of pregnancy an increase in the number of platelets is noted, and their tendency to agglutination is constantly lessened. Those of large size are more numerous and some giant forms appear, whose characteristic property is a minimum amount of viscosity. This condition, which is clearly appreciable until the sixth and seventh months of pregnancy, is less evident during the last three months.

When parturition is over and the placenta is expelled the number of platelets diminishes rapidly, coming down to an average of 350,000 per c. mm. Sixteen, twenty, or twenty-two hours after delivery it is up again to 840,000 per c. mm. From the twenty-fourth hour all through the first and second days after delivery a new diminution is noticeable to a minimum of 560,000 per c. mm. On the third day, coincident with lactation, or even before its appearance, an increase of platelets is found, which continues during the fourth, and sometimes even the fifth day, and the maximum average which may be reached is 930,000 per c. mm. After this maximum has been attained, the number of blood platelets decreases more rapidly for two days, and afterwards more slowly for five or six days, until on the twelfth day of the puerperium it reaches an average of 670,000 per c. mm.

After parturition and delivery of the placenta the platelets diminish in number, and in the meantime their agglutinative power is evidently impaired. They are found to be still small and

round, but they agglutinate in groups of only ten to fifteen. A few hours after parturition their bulk increases gradually; they become of medium size, most of them ovoid; also large forms appear and sometimes giant forms. The last are more numerous during the second and third days of the puerperium; rarer on the fourth and fifth. During the following days of the puerperium upon which I carried on my examinations these forms are less numerous than before.

As platelets vary in their morphological characters they are found to change also in their grouping activity. Their power of cohesion, or conglutinative power, clearly diminishes because of a want of viscosity in each element. This fact is very clearly noticeable on the second and third days of the puerperium; it is less clear during the following nine days, when viscosity, however, does not reach the normal degree. In fact, even after the third day, the platelets, which are mostly of medium size and ovoid, unite in groups of four to six at most.

During the catamenial period the number of platelets increases; the fact is actually demonstrable all through the premenstrual time, and a maximum average of 470,000 per c. mm. is reached on the second to the third day of the menstrual flow. After the third day a gradual diminution is appreciable until, on the last day of the flow, a minimum average of 350,000 per c. mm. is attained. After the menstrual flow ceases a number of 450,000 is reached on the following three days, and then day by day platelets become less and less numerous until the normal number of about 300,000 per c. mm. is reached.

Platelets show in the meanwhile a lessened agglutinative power through lack of viscosity. This property is already diminished during the premenstrual time, and lessens still more as soon as the blood flow begins and as long as it lasts. After menstruation it gradually becomes normal again. In relation to these facts, we notice that the numerical increase of platelets is shown in the medium-sized ones which are ovoid; the small and round-shaped forms become less numerous; large platelets increase in number and giant ones appear. Groups formed through agglutination during this period consist of four to five elements.

Even in amenorrhoeal subjects platelets increase in number during the premenstrual time to a maximum which is reached in the first two days of the absent menstrual flow, and is followed by a gradual diminution day by day. The medium-sized platelets are

the most numerous, but large and some giant appear, and agglutinative power is diminished.

The blood crisis, its vital power, showed in the women examined an influence on the number and on the agglutinative property of platelets. It was evident that when blood crisis was weakened, the changes in the number, morphology, and agglutinative power of platelets were more conspicuous.

As a complement of these researches, and with the object of acquiring a still more complete knowledge of the nature, function, and morphology of platelets, I undertook a systematic examination of these elements during the first ten days of life of new-born children. Through the same technique I reached the following conclusions: There is a close relation between the number of platelets of the mother and those of the child. Soon after birth platelets are very numerous in the blood of the new-born (up to an average of 970,000 per c. mm.); they decrease during the first day of life (80,000 per c. mm.), and they then increase again on the second and third days, though they remain notably below their original number (300,000 per c. mm.). On the fourth day a new diminution takes place, 150,000 per c. mm., and subsequently an increase to 250,000 per c. mm. during the fifth, sixth, and seventh days. They gradually diminish on the three following days down to an average of 93,000 per c. mm.

Soon after birth platelets are numerous, small, round, and viscid, so that they unite in groups of fifteen to twenty. As their number decreases their bulk increases, so that medium-sized elements preponderate, and large and sometimes giant platelets can be found, especially from the fourth to the seventh day of life, inclusive. The viscosity of such elements is lessened as usual, and heaps of platelets are rare, small, and constituted of four to seven elements only.

The numerous observations and blood examinations which I have made have led me to elaborate some personal conclusions concerning certain ill-defined and not generally accepted views as to the nature, the function, and the importance of these mysterious blood elements, platelets.

There is no accord at the present time as to the number of platelets per c. mm. in the blood of adults under physiological conditions. Some fix the average at 250,000 per c. mm.; some believe it to be as large as 778,000. My own observations show that under normal conditions blood platelets number about 300,000 per c. mm.; in the child the number is 95,000.

Platelets originate from red blood corpuscles and represent a regressive physiological condition of those blood elements. Vassale was the first to give a brilliant experimental proof of that statement, and his work has been verified by my results. In fact, I have always observed that coincident with or soon after an increase in the number of platelets, a diminution of red corpuscles is evident. On the other hand, when hemopoietic organs, through increase of their activity, pour into the circulation a number of new-formed red corpuscles, platelets diminish in number for a time which varies in duration according to the causes which gave rise to the increase of red corpuscles.

The viscosity of platelets is an interesting property which appeared to vary inversely with their bulk and size in all my observations. It is conspicuous when platelets are very small and round; it lessens gradually as their size increases, and it attains a minimum under those conditions where there is a maximum number of large and giant platelets.

With this important quality, through which platelets agglutinate in greater or smaller masses according as they are more or less endowed with viscosity, is connected the question of blood coagulation. According to Bizzozzero's views and those of his school, coagulation of the blood under physiological conditions depends on platelets.

Now, the coagulative power of the blood, according to my observations, would appear to depend upon the size of the platelets much more than upon their increased number. It has been demonstrated by Raineri that throughout pregnancy the coagulative power of blood is increased. My researches show that during pregnancy the agglutinative qualities of platelets are heightened until they reach a maximum just a few moments before labor.

In physiological crises (Bossi), when the changes of ovulation take place in the ovary, the agglutinative property of platelets is lessened just as occurs in the non-pregnant woman at each menstrual period. Raineri, Birnbaum, and Osten have presented evidence of the lowered coagulative power of blood. The trustworthiness of my statement is heightened by the fact that the coagulative power is low in new-born children, while my researches show that their platelets possess but slight viscosity.

Platelets may be considered as a morphological index of the coagulative power of blood.

Carbone showed experimentally that the degree of coagu-

lative power of the blood corresponds to a greater or lesser resistance to infectious diseases, especially to diplococcic infection. Platelets, which are considered to be the fundamental origin of the coagulative property of blood on account of their viscosity, might also be taken into account as the representatives of the amount of energy which an organism may display in opposition to any bacterial infection or to a toxemia of any origin.

These views are in accordance with Raineri's experiments, by which it has been proved that the bactericidal and antitoxic powers of blood are increased during pregnancy, but are diminished during the puerperium and also in the premenstrual period and during the first day of the menstrual flow; also that it is lower in the new-born than in the adult.

Tschistovitch advanced the hypothesis that platelets may be active in the struggle of the organism against infection, being the carriers of certain defensive substances, namely antitoxins, agglutinins, stimulins, etc. Tschistovitch's hypothesis should be interpreted as follows if we consider the results of the researches, from which I conclude that the coagulative power of blood is dependent upon the agglutinative property of platelets, the degree of coagulative power of blood being an index of the resistance of the organisms to toxic agents. To my mind this hypothesis would be valuable if it were made to signify that platelets are active in the struggle of the organism against infection, because of their agglutinative property, which causes a greater or less degree of coagulative power in the blood.

Through their agglutinative power, platelets probably represent, to a certain degree, the energy by which the organism acts on endogenous and exogenous toxic substances which threaten its vital power.