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A NEW BLOOD SUBSTITUTE DEVELOPED IN THE USSR

M. Popovskiy

The therapeutically effective method of blood transfusion has been widely applied in Soviet medical practice. Several institutes, hundreds of blood transfusion stations, and thousands of special surgeries throughout the whole country are preparing and conserving blood to transfuse it into wounded and sick patients. In the public health system of our country, there is a special blood service, with many thousands of physicians serving it, as well as an array of donors who give their blood for this purpose. More than 250,000 transfusions per year are being carried out in the Soviet Union, which is many times more than in any other country in the world.

However, the use of donors' blood presents a series of substantial drawbacks. The donors' blood is expensive and comparatively unstable, and its transportation to distant places involves considerable difficulty. But the most important difficulty is the existence of four different groupings of human blood. Transfusion to a patient of blood of a different type may cause complications. Besides, it is very difficult, and sometimes even impossible, to determine a wounded man's blood grouping under battle conditions.

Therefore, the idea of devising a substitute for human blood arose long ago. For many years, however, all attempts of that sort proved to be unsuccessful. Various saline solutions, devised by the scientists, could not be substituted for blood. We know that blood is more than a liquid containing a certain quantity of salts. It feeds the tissues of the body and must, therefore, contain such nutritious substances as sugar and proteins. But the principal shortcoming of all projected substitutes in Europe and the US was the fact that they did not stimulate the formation of the patient's own blood, whereas in many cases, the possibility of forcing the sick organism to generate blood corpuscles would have ensured his recovery.

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Then, in 1942, N. G. Belen'kiy, Doctor of Biology and Professor at the Moscow Institute of Chemical Technology imeni D. I. Mendeleev, began his research to develop a blood substitute. Shortly before that time, the scientist and his colleagues had been engaged in the pursuit of a purely practical problem: they had been seeking a means of increasing the quantity of blood obtained during the slaughter of cattle. Once, 24 hours before the slaughter, they pumped out about half of the total blood from a cow. On slaughtering the cow, they found that the [original] quantity of this cow's blood had been entirely replenished. Belen'kiy was deeply interested in the process of rapid restoration of such large quantities of blood by animals. Evidently, he assumed, there occur in the bodies of experimental animals which had lost much blood some substances which stimulate the functions of blood-forming organs. These substances -- the scientist named them hemoactins, i.e., activators (intensifiers) of blood formation -- must be secreted by organs of animals that have been partially deprived of their blood. Would the hemoactins taken from one organism increase the activity of blood-forming organs in another? The answer could be found only by experiment.

An aide brought some rabbits into the laboratory; from these, part of the blood had been previously removed. Some of the rabbits were injected with a small quantity of hemoactivated cow's blood, or, more precisely, they received its liquid portion -- blood serum. Other animals received no injections. Results confirmed the scientist's assumption. The animals that had been given the serum restored their original quantity of blood twice as quickly as those that had not been submitted to that procedure. Every time these tests have been repeated, they have invariably given the same results: the serum increased the activity of blood-forming organs and considerably improved the state of the animal's health.

Professor Belen'kiy made his discovery during 1943. Thousands of wounded soldiers needed blood transfusions. The blood was conveyed to the fighting front from the distant rear, transported by special cars and airplanes. But the donors' blood merely replaced the blood lost by the sick and wounded men, without stimulating the blood-generating processes in their bodies. Meanwhile, many of these men were suffering precisely from the sluggish activity of their blood-forming organs.

Belen'kiy had a miraculous remedy in his hands. A few grams of his serum increased the blood-forming activity of rabbits and dogs. How good it would be to utilize this remedy to aid man! However, animal blood cannot be transfused into man; as a rule, it produces a devastating action in his organism. Why is human blood incompatible with animal blood?

It had long ago been established that plasma, which composes the principal mass of blood, is different for each kind of animal. These differences are even observed among representatives of the same species. The plasma of one animal becomes poisonous when injected in a certain quantity into another animal. But this is only one reason against the use of animal blood for transfusions. The other reason is the fact that when blood of different groups is mixed, the blood corpuscles agglutinate, precipitate, and being no longer able to serve the organism do not supply the tissues with oxygen. How can one eliminate the results of plasma heterogeneity when injecting animal blood into man? The scientist was deeply concerned with this question. He was firmly convinced of the possibility of discovering a miraculous substance that would substitute for human blood and at the same time would serve as an intensifier of the blood-forming process.

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The Soviet scientists faced an extremely difficult problem: it was necessary to treat the serum in such a way that, while being removed of all properties dangerous to man, it should not at the same time be deprived of its capacity of increasing blood-forming activity in a patient's body. All this demanded a great deal of effort, energy, and devotion. Only after innumerable tests did the indefatigable researcher and his assistants finally achieve the desired result.

The day came when a routine control test with dogs showed that no harmful consequences were observed on the animals after injection of especially prepared cow's serum. Further numerous control tests confirmed the fact that the obtained serum was harmless to any kind of animal. Now, it was necessary to test its action on man. Belen'kiy decided to conduct this test on himself. In the presence of his colleagues, he injected intravenously 400 cubic centimeters of the prepared serum into himself. The same quantity of raw cow's blood injected into a man would have inevitably killed him. The new preparation produced no harmful effect on the scientist.

To put this discovery fully into the hands of Soviet medical men, it was necessary first to determine the curative properties which the serum would demonstrate when administered to a patient. Professor D. A. Arapov, chief of the Surgical Clinic of the Institute imeni Sklifosovskiy, took on himself the task of carrying out this serious test. His tests were no less daring than those conducted by the discoverer himself. Arapov had gained full confidence in this preparation and transfused it to men of widely varying blood groupings. In cases of necessity, the serum was transfused in huge quantities -- up to 3 or even 4 liters at once.

The most beneficial action of the serum was demonstrated in cases of burns. Once, an electrician was brought to the clinic; almost half his skin surface had been burned. The physicians were seriously concerned about this patient's life. First of all, it was necessary to combat shock, as well as to alleviate the thickening of blood which always takes place after a burn. Formerly, a saline solution, or the so-called physiological solution, was usually applied in such cases. But this solution does not contain any protein, which is so necessary for an organism struggling for his life. Belen'kiy's serum contains protein, however, and Professor Arapov, therefore, courageously applied it. The patient received 4 liters of the new preparation. The state of shock ended, and the blood was restored to its normal thickness. It was then possible to begin treatment. After the first flaps of skin had been transplanted to the burnt surface, the patient received another injection of Belen'kiy's preparation. The flaps began to heal and to be assimilated quickly. In 3 months the patient left the clinic an absolutely healthy man.

A great number of such masterly and daring trials with the serum have been conducted by Professor Arapov and his colleagues. In addition to being investigated at the Institute imeni Sklifosovskiy, this species nonspecific serum has been tested in the Central Traumatological and Orthopedic Institute, at the Hospital imeni S. P. Botkin, and in many other medical institutions of Leningrad, Bryansk, and Minsk. More than 10,000 transfusions of the animal serum have been administered by doctors to patients suffering from various disturbances. The ability of the serum to raise blood pressure in the vessels and to increase the activity of blood-forming organs made it an indispensable therapeutic agent at the bedside of every wounded man in need of blood. Belen'kiy's preparation quickly healed such a serious illness of children as dyspepsia. Also, to men who could not take any food because of esophagus affection, it completely replaced a protein diet for the duration of a few weeks. In short, the species nonspecific serum discovered by Belen'kiy proved to be a perfect substitute for the liquid part of the blood, a medical preparation for which the surgeons of all countries in the world have been waiting. Cheap, and at the same time possessing extremely valuable qualities, this preparation is now receiving ever-growing application in the therapeutic practice of our medical institutions. It is a remedy destined for mass use.

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The discovery of species nonspecific serum is a remarkable victory of Soviet biology, which follows the path carved by I. V. Michurin and I. P. Pavlov. For the discovery and clinical tests of this serum, the scientist-innovators have been honored with a Stalin Prize.

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