REPOSITORY DOE-FORRESTAL
COLLECTION MARKEY FILES
BOX No. 3 OF 6
FOLDER CRITICALITY, MACHINE, & SOURCE ACCIDENTS

~~Dr Shelling~~
B. Weichold

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# REPORT ON THE YUGOSLAVIAN RADIATION ACCIDENT VICTIMS

(The following report was prepared on the basis of information obtained in Paris between January 13th through the 16th, 1959. The information was supplied by Dr. Henri Jammet, Dr. Danica Kalić, Dr. Branislau Penditch, and Dr. Georges Mathé, as well as by other physicians concerned with the care of these patients. The present report is presented to a limited number of people in the United States who have specific need for it. It is understood that none of it is to be published. Most of the information was obtained in informal conversations, and I am responsible for any errors which have occurred. G. Andrews)

The accident occurred on October 15th, 1958, and involved six Yugoslavian workers in an exposure to neutron and gamma radiation. Specific information on dosimetry is not available but it is believed that the total doses ranged from something over 500 r to above 1,000 r. The patients were transported to Paris about 48 hours after the accident, and most of the studies were done at the Curie Foundation where they are being cared for.

## Clinical Manifestations

All the patients developed nausea and vomiting within an hour or so after the accident. This continued for about two days. Subsequently vague gastrointestinal symptoms were prominent and have persisted for many weeks, more than in the patients exposed in the Y-12 accident. Soreness of the abdomen has been an intermittent symptom. Fever was noted in the early hours after the accident. There was also some redness and soreness of the mucous membranes which has largely cleared up at the present time. A high urinary output occurred during the first week. Some degree of thickening of the



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skin of the feet, with scaliness, was noted. There is a tendency to profuse perspiration which still persists. Epilation started about the 15th day and in general was more extensive than occurred in the Y-12 accident victims. The epilation did not follow the pattern of the Y-12 victims; that is, it was not particularly localized to the back of the head. There was, however, a tendency to preserve a rim of hair around the scalp so that some of the patients looked like individuals with normal baldness. In two or three of the Yugoslavian patients the epilation was uneven, involving one side of the head more than the other. There was some loss of beard and of hair on the body and extremities. Regrowth began around the 9th week and is not yet complete. After the initial febrile period the patients were afebrile for various periods but some of them developed transient febrile episodes during the first three weeks after irradiation before maximal hematologic depression had occurred. The exact nature of these febrile episodes is not known.

During the period of greatest bone marrow depression, starting about three weeks after the accident, severe clinical illnesses developed, characterized by fever and presumably by infection. Antibiotics were given. One patient, with the highest irradiation dose, died. Another developed rather severe generalized purpura. Others developed minimal hemorrhagic tendencies with "pink toothbrush", etc.

Following the use of bone marrow transplantation in four of the five patients there was improvement. The fifth patient appears to be making spontaneous recovery. At the present time the patients appear to be in reasonably good general condition. They are up and about, but largely restricted to the hospital. They show some degree of pallor and ease of



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sweating. They note that they become fatigued quite easily. It is reported that they are somewhat moody with rather irregular patterns of emotional tone. Partial epilation is still obvious in some of them.

Hematologic Studies

Careful and detailed hematologic studies were done. The platelets were counted by the Feissly method. The patients showed a prompt fall in lymphocytes and a more gradual fall in neutrophils, platelets, and red cell values. Reticulocytes fell to below 0.1 per cent on the third day in the two highest dose patients. The pattern of hematologic response was very similar to that of the Y-12 accident victims. There was, however, a much more severe depression, particularly of the granulocytes. This depression also developed a little more rapidly. An initial leukocytosis was not clearly shown on the charts I saw; however, there was a secondary rise in the white cell count during the second week (not to high values, but higher than it had been a few days previously) presumably correlated with an outpouring of abnormal cells. Then the white count went down rather steeply in the third and fourth weeks and in some of the patients the total neutrophils were less than 50 per cubic millimeter. Platelets also fell to very low levels at about the same time that the leukopenia was most severe. The bone marrow was not examined as frequently in the Yugoslavian patients as it was in the Y-12 patients, and the studies on the bone marrow slides are not yet completed. There is evidence that a good cellular response is obtained in the marrow two weeks after marrow transplantation.

Bone marrow transplantation was undertaken first in the patient who subsequently died, and in the one with the second highest dose, then in all but one of the others. The hematologic changes were strikingly changed by the bone marrow administration.

37 days



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General Therapy

The patients were given very detailed care with attention to a great many different factors. During the period when infection was thought to be a hazard, the personnel wore masks and gowns and used a technique for dipping the hands in an antiseptic solution.

Diet was very carefully managed and diet supplements including amino acids were given. In general the patients maintained a good appetite during most of the illness.

The patients were given antibiotics early after the radiation, generally Penicillin and Streptomycin. These were stopped after a few days; various antibiotics were used when later fever developed. The patients were given vitamin supplements including Vitamin B Complex, Vitamin B-4, Nicotinic Acid, and Vitamin B-12. They were also given crude liver extract by mouth. Vitamin K was administered. DOCA was given in small doses and steroids were given in small doses at certain points in the clinical course, particularly when the marrow depression was very severe. Steroids have been just recently stopped. Additional medications included Cortisone and an antibiotic application put in the eyes for conjunctivitis, a sulfonamide preparation put in the nose, a mouth wash, and Cysteine for the hair.

The patients were given gamma globulin in an effort to help them combat infection. This is important in that it makes it impossible to evaluate the normal gamma globulin levels in the blood.

A small blood transfusion was given to each patient shortly after his arrival in Paris, about 48 hours after exposure, partly for psychological reasons. Subsequently a few additional transfusions were given but most patients did not receive more than one or two. To two or three patients a large number of platelets was administered on a single occasion.



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Experience with platelet transfusions in two of these patients showed that relatively little could be done to raise the platelet levels. This is important in interpreting platelet levels after marrow transplant. When 480 billion platelets were given to patient No. 1, the platelet count rose from 26,000 to 50,000, but three days later was down to 19,000. In another case 750 billion platelets from 12 or more donors were given and the platelet count rose only from 25,000 to 62,000. In still another case, with a massive platelet transfusion, they were able to raise the platelet count from 15,000 to 41,000. Thus it did not appear that the platelet counts seen after marrow infusion could be due to the number of platelets given with the marrow itself.

Case Summary on the Patient who Died

This young man, who had the most severe radiation dose, developed pronounced epilation and was obviously suffering from very severe radiation damage. He was given, on the 15th day, some fetal liver and/or spleen cells. This caused some temporary febrile response but no particularly prominent difficulty nor any apparent therapeutic response. A few days later he developed what appeared to be an acute abdominal condition. He was given Streptomycin and Chloromycetin because at this time he had fever and an extremely severe leukopenia, granulocytes being almost absent from his blood. (He was known to be sensitive to Penicillin.) He was also given Cortisone. Because of the seriousness of his general condition it was felt that he could not tolerate an abdominal operation, even though the abdominal symptoms might represent a surgical condition. Although he did not have prolonged hypotension with the acute abdominal situation, he developed anuria and a blood urea nitrogen of 400 mg./100 ml. He was given an exchange transfusion and subsequently put on



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the artificial kidney. Slightly before this, about 27 days after the accident, he was given a human bone marrow infusion. There was a rather prompt rise in his white count to levels of 3,000 to 6,000, and a prompt rise in the platelet count; this laboratory work was done in a different hospital where he had been taken for treatment with the artificial kidney. Reticulocyte counts were not done. At this time he had continuous fever but blood cultures were negative. In order to utilize the artificial kidney it was necessary to give him a small amount of Heparin. A hemorrhagic tendency, which had been slight before the use of the artificial kidney, became pronounced afterward and he had massive pulmonary hemorrhages. A tracheotomy was done in order to facilitate the aspiration of the bloody fluid, but in spite of all these measures the patient died on the 31st day. The mechanism of the hemorrhagic syndrome seemed rather complicated. There was the previous thrombocytopenia and the possibility that the recent rise in platelets represented an abnormal type of platelet following transplantation. It was also possible that the platelet counts were not entirely comparable since they were not done in the same laboratory as those in the rest of these studies. There is also the possibility that the small amount of Heparin that had been given contributed to the bleeding.

An autopsy was done and they found no evidence of a ruptured viscus or massive abdominal infection. However, there was intussusception (located in the ileocecal region, I believe) which presumably accounted for the abdominal syndrome. The adrenals were somewhat soft. The kidney, liver, and spleen were all somewhat enlarged. There were petechiae throughout the gastrointestinal tract except in the esophagus. There was massive hemorrhage in the lungs. The marrow was said to appear grossly normal.

In this patient the bone marrow infusion was given only about four days before death. There was some apparent response in the platelets and white cells,



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but the results are difficult to interpret in view of the desperate illness of the patient and the multiple therapeutic procedures undertaken.

Marrow Therapy

The use of bone marrow was the most interesting part of the whole study and treatment of these patients. The marrow was administered much later than we in the United States had thought would be practical. Dr. Mathé and the other French physicians did not feel that there was any particular advantage in delaying the marrow, but neither did they feel very strongly that it must necessarily be given in the first three or four days after irradiation. Their reason for delaying it was chiefly that they considered the procedure rather difficult and hazardous and they felt that there might be some criticism if untoward results developed from the procedure. Therefore, they waited until it seemed clear from the clinical situation that the patients had a very poor prognosis without the marrow treatment. They now wish very much that they had given the bone marrow earlier to the first patient, who died.

They believe that a single donor should be selected for each patient. They believe that there may be some interference with the multiple subtypes involved when more than one donor is used. They also believe that the procedure is so technically difficult and complicated that it would be rather impractical to apply it to several donors, particularly since it is difficult to locate donors who fit their criteria.

In contrast to some of the opinions held by us and by others in the United States, they do not believe that there is any special advantage in seeking donors who are related to the patients. On the other hand, they do emphasize the blood type of the donors, not only the major groups but the sub-groups.



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They try to have the donor as near to the recipient as possible but they like to have one clearly defined difference in a minor sub-group that can be used for agglutination studies to demonstrate transplantation. When there are differences between the donor and recipient in blood groups, they prefer to select a donor who is antigenically more negative than the recipient; that is, they try to avoid differences in subtypes that might lead to the production of antibodies in the recipient against the donor's cells. They recognize that in making this choice they may be encouraging the opposite result; that is, the production of antibodies in the transplanted marrow to the host, but they prefer to take this latter risk, if one must be taken.

They select donors of the same sex as the recipient. They believe that there might be some incompatibility based upon opposite sex selection, although they would like very much to have the sex tagged as a means of following the graft.

The donors selected for the Yugoslavian victims were French people, some of them part of the regular donor list of the blood bank, and one of them a physician on Dr. Mathé's staff.

The procedure for drawing marrow involves giving the donor a general anesthetic. Marrow is aspirated from multiple sites in the sternum, along the iliac crest, and in the posterior ilium. In a typical case there might be four aspirations from the sternum and seven from each ilium, making a total of 18. They would also use on some occasions the ribs and the scapula. The needle used is not exactly like any of the ones with which I am familiar, but it is a perfectly simple needle with a fairly strong hilt having two lateral projections for handling. It is about 18 gauge. It does not have the special lateral opening as does the Bierman needle, nor any cutting features as in the Turkel needle. They



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have had considerable trouble with breakage of needles during this marrow aspiration procedure. Marrow is aspirated into a syringe moistened with dilute Heparin solution. After 10 cc. of marrow has been obtained, (involving moving the needle two or three times) a small sample of the marrow is squirted out onto a slide from which smears and counts can be made. Then the syringe is immediately transferred to a needle which has been placed in the vein of the patient. This needle may be a little smaller, perhaps 20 gauge, and the marrow is forced into the patient's vein. There is thus practically no delay. This is repeated until the patient has received 10 to 15 billion nucleated cells. It requires the work of two or three technicians to keep doing the counts on the multiple small samples of marrow and to keep totaling up the sum of nucleated cells. From the sternum they often get 20,000 or 30,000 nucleated cells per cubic millimeter. From along the sides of the iliac crest they often get up to 60,000. From the ribs they get a small amount of highly cellular marrow. The total volume of aspirated material may be 200 to 300 milliliters.

A typical pattern for selection of the donor and recipient might be as follows:

Patient $\quad 0 - MN - \frac{C\ D\ e}{C\ D\ e} - Kell\ \ominus$

Donor $\quad 0 - M - \frac{C\ D\ e}{c\ d\ e} - Kell\ \ominus$

In two cases the only differences were in d and e subfactors.

The methods of evaluating the marrow transplantation involved changes in the general clinical and hematologic status of the patient, plus specific tags for the red cells produced by the infused marrow. Quantitative agglutination studies are done on the blood of the recipient. Corrections are made for any previous transfusion and for the amount of red cells given along with the marrow.



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It has been possible to do counts in red cell counting chambers in which all of the non-agglutinated cells are counted and this is expressed as a percentage of the total number of red cells known to be present. (Based on other counts.) I mentioned to Dr. Mathé that we had had difficulty in that with some of our sera for testing we did not get 100 per cent agglutination, even in cases of known positive cells. He said that they had had this difficulty but had been able to establish satisfactory concentrations of red cells, perhaps lower levels than usual in relation to the amount of serum, and had been able to make the agglutination 100 per cent for those cells that are positive. In some cases they had used more than one serum preparation for testing for the same subfactor, and they get quite good agreement in the results. They have tended to lean over backward in correcting for transfused blood, and have sometimes made a correction larger than was reasonable.

The bone marrow given to the Yugoslavian patients was first given on November 11th. This was given to the man who subsequently died, and to one other heavily irradiated patient. The individual who died got a rise in white count and platelets, as previously discussed. The other patient had a striking rise in platelets, reaching a maximum within something under two weeks. It is very interesting that the platelets reached a peak, then fell back, and then made a secondary rise. This is quite different from what we see in spontaneous recovery from radiation injury. Reticulocytes reached a peak on the 13th day after irradiation. A marrow infusion was given to each of the three remaining patients. Two were treated on the 17th of November and the remaining one on the 20th. All showed distinct reticulocyte response with a peak from 11 to 20 days of 8 to 13 per cent. Platelet response was maximal within one or two weeks. In the 4th patient the platelet response was less striking than in the others,



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and the early peak was not clearly seen. In the 5th patient there was some evidence of improvement in the platelets before the bone marrow was given, and response in the white count was not clear cut. Platelets rose gradually and reached a peak in about a month. All of these patients also showed a rise in the white count beginning fairly promptly after the marrow infusion; however, there was not a distinct secondary fall as seen in the platelets in three cases.

The increased number of white cells following marrow transplantation was comprised chiefly of neutrophils. There was also a definite rise in monocytes but not in lymphocytes. One patient developed eosinophilia of above 20 per cent during the two to three weeks after marrow was given and in one other there was a less pronounced eosinophilia.

Red cell subtyping studies showed that transplantation had occurred in all four cases who survived after the marrow was given. The peak of transplanted red cells was not reached until three weeks after the infusion, amounting to perhaps 30 to 50 per cent of the red cell population. The definitely rising number of transplanted cells was clearly demonstrated in the absence of any further blood administration during the three weeks after the bone marrow infusion. After the peak of foreign red cells was reached there tended to be a diminution, perhaps partly due to regeneration of red cells from the patients' normal marrow precursors. Then there was in some cases a secondary rise of the transplanted cells. The patients now have a mixed population of red cells, with the majority being from their own precursors. What long-range outcome in the red cell population will be is not known.

It is interesting that the response as demonstrated by the platelet values and reticulocytes could be better correlated with the date of administration of the marrow than it could with the duration of time after the radiation injury.



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The patient who received the lowest radiation dose and did not get any bone marrow reached his peak of platelets 45 days after irradiation, while patient No. 2, for example, the highest dose of those surviving, who was given the bone marrow, reached his peak of platelets on the 35th day.

At the present time the hematologic status of the patients given the bone marrow is not very reassuring. They have poorer blood values than the man who made a spontaneous recovery. There is some possibility that the patients may show rejection of the graft, or a late immune response that is unfavorable.

Discussion

It is very interesting to compare these Yugoslavian patients with the group of Y-12 accident victims in Oak Ridge. On clinical grounds it appears to me that the lowest dose among the Yugoslavians is comparable to or slightly higher than the highest dose among the Y-12 accident victims. There is good agreement on the general pattern of clinical and hematologic response to total body irradiation. Some types of information are available in each series of cases that can not be obtained from the other series.

The experience with the Yugoslavian patients suggests that the reticulocyte level may be of value as an early means of determining dose: there were very low levels by the third day. We are attempting a further evaluation on our patients by counting larger numbers of cells to more exactly establish the reticulocyte values during the first four or five days.

One of the important problems to be considered is the evidence for marrow transplantation in these patients. The evidence is really of two types. First, there is general clinical and hematologic evidence which suggests that a recovery phase occurred, which was either greater in degree or more prompt in onset than



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could be explained by anything other than transplantation. This is the type of evidence that applies to the white cell, platelet, and reticulocyte values. There was no specific tag applicable to white cells and platelets. Another type of evidence involves the red cells which were identified specifically according to subtype, and here there is proof of increasing numbers of donor-type red cells.

In considering whether or not bone marrow transplantation occurred, one must give consideration to two possibilities which might cause an erroneous interpretation. One of these is that administered blood elements might be mistakenly taken for transplanted ones. A second possible source of error would be the misinterpretation of spontaneous recovery as evidence of transplantation.

The information available is rather convincing evidence that true marrow transplantation occurred. Among the points of evidence are the following:

(1) The specific pattern of the platelet response was rather remarkable. There was, in at least two or three of the patients, a striking rise with a peak reached within the first two weeks followed by a rather quick fall. Then there was a second very gradual rise. This type of double curve with a sharp peak developing in less than two weeks is not seen in spontaneous recovery.

(2) The reticulocyte response was rather pronounced, occurred somewhat earlier than could be expected with spontaneous recovery, and correlated in time with the administration of the marrow.

(3) The rise in the white count also corresponded with the bone marrow administration.

(4) Finally, the subtyping studies on the red cells, which have been carefully evaluated in terms of possible errors due to transfused blood, present convincing evidence that cells of the donor type were formed in the recipient.



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If we conclude that marrow transplantation has been achieved in these Yugoslavian patients, it is of interest to inquire why previous attempts in the United States to transplant bone marrow have not apparently succeeded. Several possible explanations must be considered:

(1) The Yugoslavian patients to whom the bone marrow was given were essentially normal individuals subjected to massive irradiation. Most if not all previous attempts to transplant marrow in human beings have been in patients with serious diseases such as widespread carcinoma, acute leukemia, or aplastic anemia.

(2) The dose of radiation may have been higher in the Yugoslavian accident than the maximum ever tried in other transplantation studies. In our group we have reached as high as 800 r without success, but this was only in one case. However, I think 800 r is not out of line with the lowest dose allowing transplantation in the Yugoslavian cases.

(3) The nature of the radiation, that is, neutron mixed with gamma, was different in the Yugoslavian patients than with pure gamma used in most clinical studies.

(4) The timing of the bone marrow was different in the Yugoslavians, several weeks having elapsed after irradiation.

(5) The selection of donors involved the matching of blood groups rather than the family relationship. Single donors were used for each patient.

(6) The technique of obtaining bone marrow was somewhat different from that used in the United States, although it did not vary greatly from that we had utilized. The marrow cells spent minimal time outside the body and were not suspended in any solution. The number of cells obtained for the Yugoslavians was somewhat larger than we have obtained from a single donor, although not as large as we have obtained from four donors. The donors were selected for the



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same sex in the Yugoslavian cases while we have not done this.

Dr. Mathé is pursuing actively the problem of treating acute leukemia with irradiation and bone marrow transplantation, and it is to be hoped that close cooperation will be maintained between the American and European efforts in this direction.



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PRIVILEGED COMMUNICATION
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Mathé data on Jugoslavs

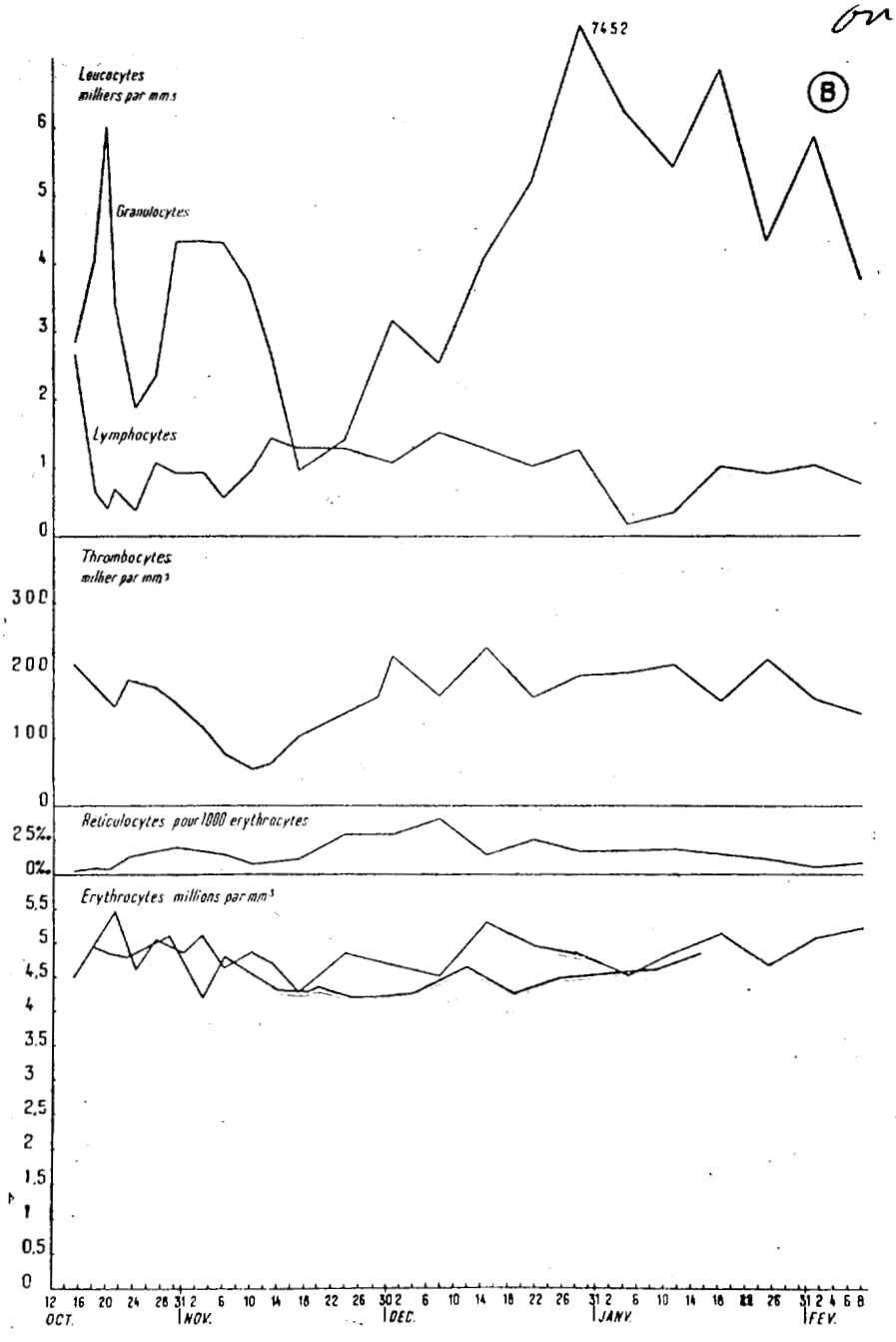


FIG. 1.

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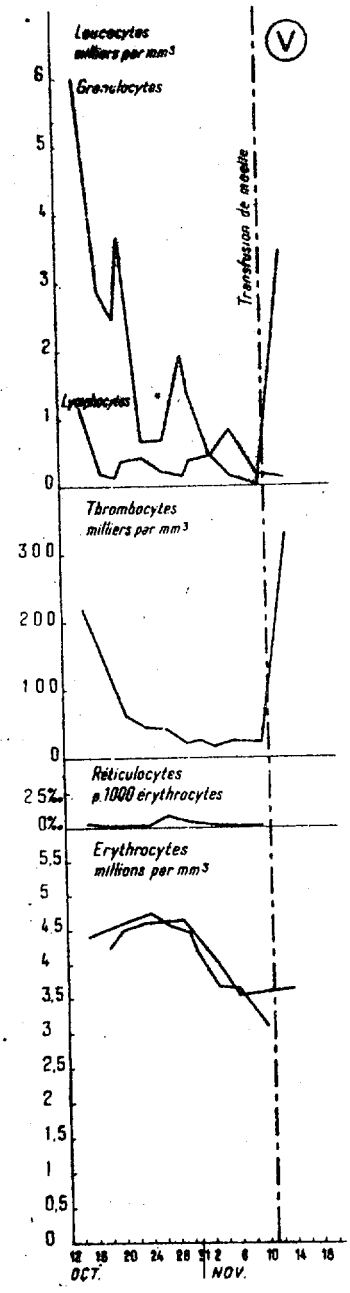


FIG. 2.

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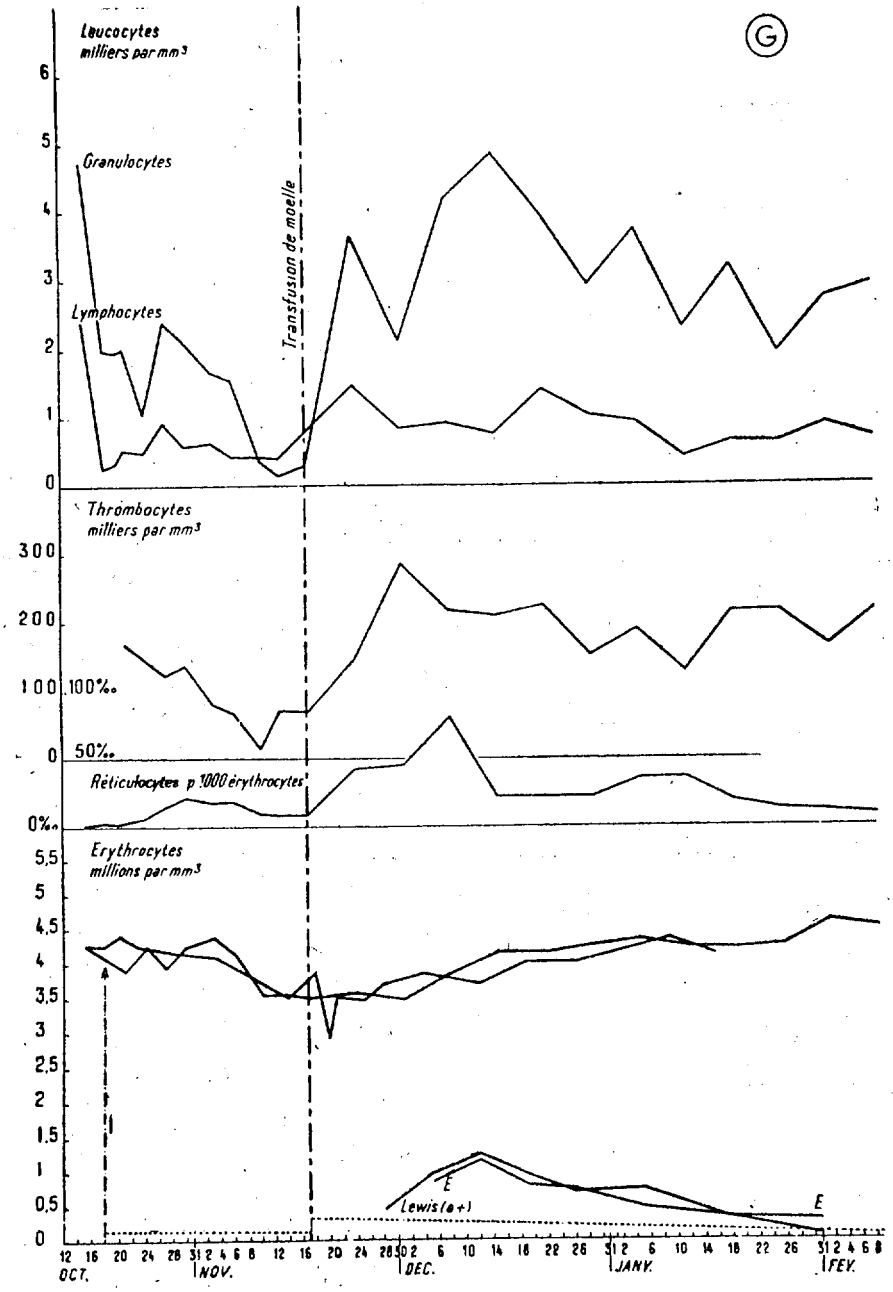


FIG. 3.

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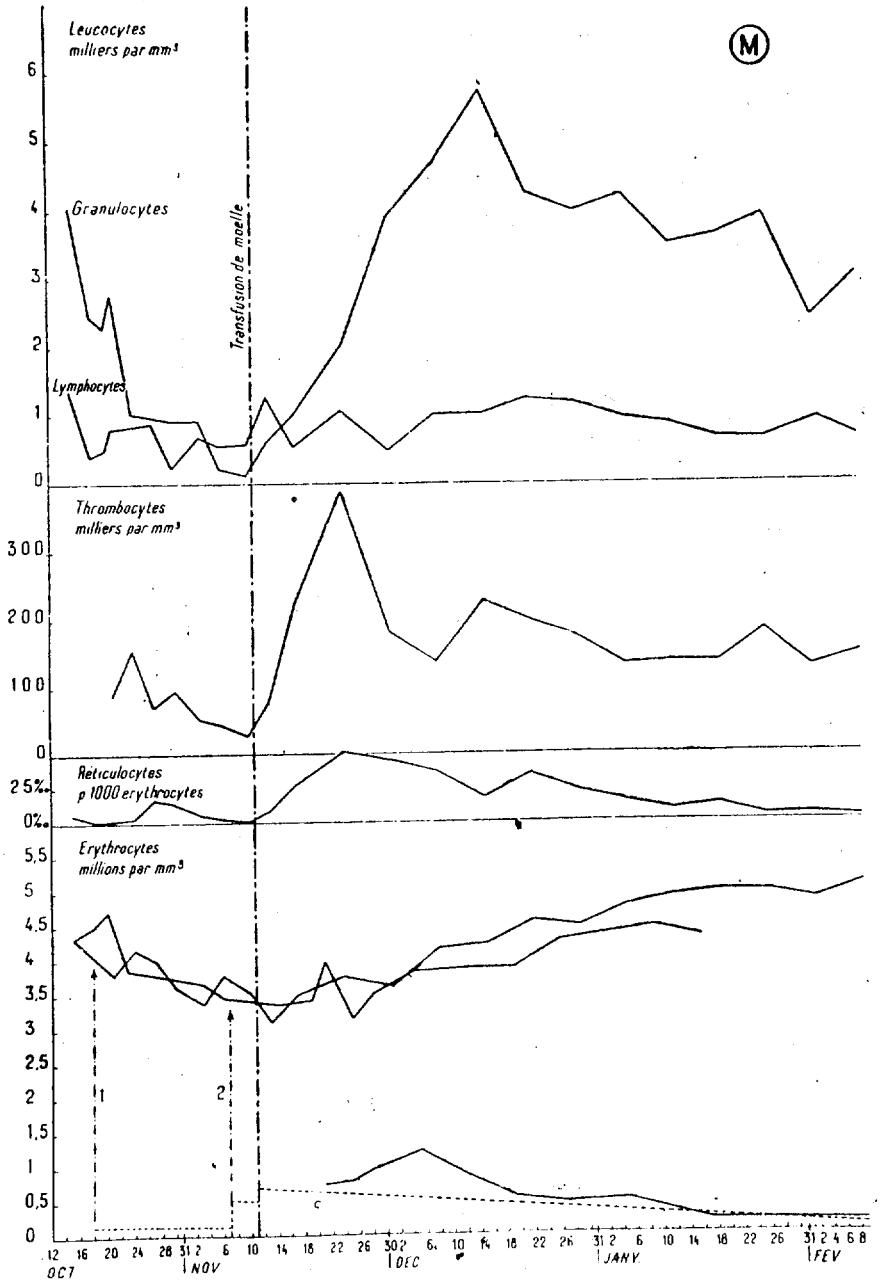
Leucocytes
milliers par mm³
Granulocytes
Lymphocytes
Transfusion de moelle
Thrombocytes
milliers par mm³
Reticulocytes
p 1000 erythrocytes
Erythrocytes
millions par mm³
OCT
NOV
DEC
JANV.
FEV

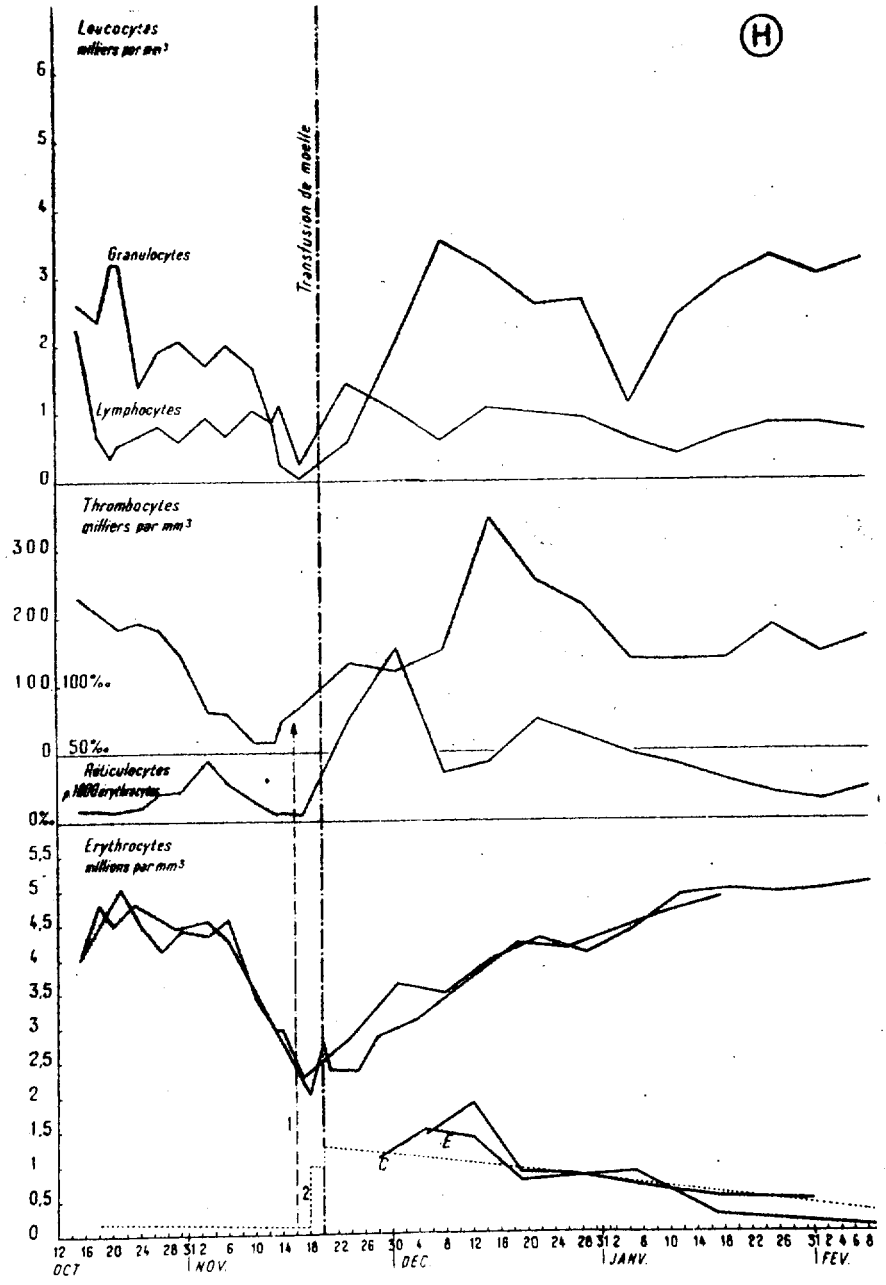


FIG. 5.

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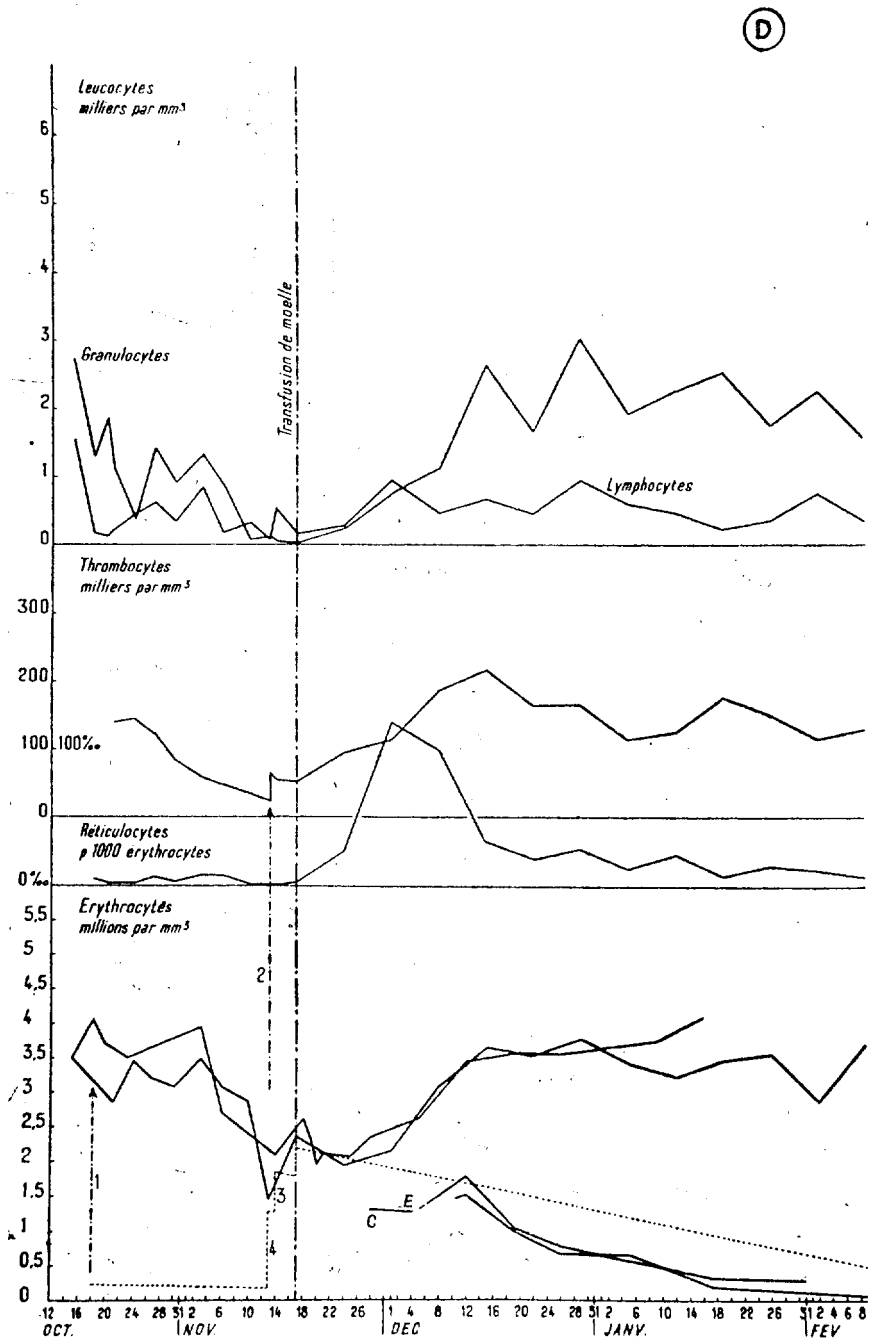


FIG. 6.

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| Sérum utilisé. | Milieu de suspension des hématies. | Concentration d'hématies par mm³. | | |
|---|---|---|---|---|
| Anti-C | Tampon phosphate pH 7,2 | 800 000 | 37° | 60′ |
| Anti-E | Tampon phosphate pH 7,2 | 600 000 | 37° | 60′ |
| Anti-c | Sérum humain AB | 600 000 | 37° | 60′ |
| Anti-Le$^a$ | Tampon phosphate pH 7,2 | 600 000 | 25° | 60′ |

le nombre relatif d'hématies agglutinées et permet d'obtenir le pourcentage des hématies portant l'antigène en cause.

## RÉSULTATS

### 1° *Malade M*

Groupes sanguins : O Ms Ns CC D ee kk Fy($a^+$) Jk($a^+$) Le($a^-b^-$)
Groupes du donneur : O M S Cc D ee kk Fy($a^+$) Jk($a^-$) Le($a^-b^+$)

Le pourcentage des cellules du donneur a été déterminé à l'aide d'un sérum anti c, la transfusion de moelle ayant eu lieu le 11 novembre 1958.

Résultats :

| | Pourcentage de cellules c+ (donneur). |
|---|---|
| 21-11-58 | 18 p. 100. |
| 25-11-58 | 25 — |
| 28-11-58 | 27 — |
| 5-12-58 | 32 — |
| 12-12-58 | 22 — |
| 19-12-58 | 13 — |
| 26-12-58 | 10 — |
| 5- 1-59 | 10 — |
| 17- 1-59 | Présence. |
| 31- 1-59 | Présence. |

### 2° *Malade H*

Groupes sanguins : A2 MNS cc D E kk Fy($a^+$) Jk($a^+$) Le($a^-b^-$)
Groupes du donneur : A2 MsNs Cc D ee kk Fy($a^+$) Jk($a^+$) Le($a^+b^-$)

Le pourcentage des cellules du donneur a été déterminé par un sérum anti C, celui des cellules du receveur par un anti E, la transfusion de moelle ayant eu lieu le 20 novembre 1958.

Résultats :

| | Pourcentage de cellules C+ (donneur). | Pourcentage de cellules E+ (receveur). |
|---|---|---|
| 28-11-58 | 38 | Non testé. |
| 5-12-58 | 48 | 55 |
| 12-12-58 | 37 | 50 |
| 19-12-58 | 17 | 80 |
| 26-12-58 | 19 | 80 |
| 5- 1-59 | 19 | 85 |
| 17- 1-59 | 5 | 89 |
| 31- 1-59 | Présence. | 91 |

### 3° *Malade G*

Groupes sanguins : O MsNs CC D E kk Fy($a^+$) Jk($a^+$) Le($a^-b^+$)
Groupes du donneur : O MsNs CC D ee kk Fy($a^+$) Jk($a^+$) Le($a^+b^-$)

Le pourcentage des cellules du donneur a été déterminé par un anti Le$^a$, celui des cellules du receveur par un anti E, la transfusion de moelle ayant eu lieu le 17 novembre 1958.

Résultats :

| | Pourcentage de cellules Le($a^+$) (donneur). | Pourcentage de cellules E+ (receveur). |
|---|---|---|
| 28-11-58 | 12 | Non testé. |
| 5-12-58 | 25 | 80 |
| 12-12-58 | 33 | 69 |
| 19-12-58 | 23 | 83 |
| 26-12-58 | 14 | 82 |
| 5- 1-59 | 17 | 89 |
| 17- 1-59 | 8 | 92 |
| 31- 1-59 | Présence. | 92 |

### 4° *Malade D.*

Groupes sanguins : O MsNs cc D E kk Fy($a^+$) Jk($a^+$) Le($a^-b^-$)
Groupes du donneur : O MNS Cc D ee kk Fy($a^-$) Jk($a^-$) Le($a^-b^+$)

Le pourcentage des cellules du donneur a été déterminé par un sérum anti C, celui du receveur par un anti E, la transfusion de moelle ayant eu lieu le 17 novembre 1958.

Résultats :

| | Pourcentage de cellules C+ (donneur). | Pourcentage de cellules E+ (receveur). |
|---|---|---|
| 28-11-58 | 55 | Non testé. |
| 5-12-58 | 48 | 51 |
| 12-12-58 | 44 | 49 |
| 19-12-58 | 28 | 71 |
| 26-12-58 | 19 | 78 |
| 5- 1-59 | 19 | 83 |
| 17- 1-59 | 6 | 90 |
| 31- 1-59 | Présence. | 91 |

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TABLEAU I

Données Concernant l'Âge, le Sexe, l'Irradiation des Patients et les Transfusions de Moelle Osseuse de Donneurs Adultes

| | Sexe et âge | Doses estimées à partir des mesures physiques (rem) | Doses estimées à partir des circonstances de l'accident et des données cliniques et hématologiques (rem) | Date de la transfusion de moelle osseuse | Volume de liquide médullaire | Nombre de cellules nucléées injectées |
|---|---|---|---|---|---|---|
| V... | M. 24 ans. | 840 | 1,000-1,200 | 11 Nov. | 211 $cm^3$ | $8,5 \times 10^9$ |
| M... | M. 25 " | 856 | 700-1,000 | 11 Nov. | 183 $cm^3$ | $11 \times 10^9$ |
| G... | M. 27 " | 920 | 700-1,000 | 17 Nov. | 270 $cm^3$ | $12 \times 10^9$ |
| D... | F. 25 " | 1,024 | 700-1,000 | 17 Nov. | 300 $cm^3$ | $8,5 \times 10^9$ |
| H... | M. 25 " | 696 | 600- 800 | 20 Nov. | 300 $cm^3$ | $14 \times 10^9$ |
| B... | M. 35 " | 408 | 300- 500 | | | |

par G. Mathé, H. Jammet, B. Pendic, L. Schwarzenberg, J.-F. Duplan, B. Maupin, R. Latarjet, M.-J. Larrieu, D. Kalic et Z. Djukic

(Hôpital Hérold et Hôpital Curie, Paris)

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TABLEAU II

Comparaison des Phénotypes de Groupes Sanguins
des Quatre Couples Donneur-Receveur
qui font l'Objet Respectivement des Figures 2, 3, 4 et 5

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1. Malade: M... | | | | | | | |
| | O | MN | CC D ee | kk | Fy(a+) | Jk(a+) | Le(a- b-) |
| Donneur: P... | | | | | | | |
| | O | M | Cc D ee | kk | Fy(a+) | Jk(a-) | Le(a- b+) |
| 2. Malade: D... (femme) | | | | | | | |
| | O | MN | cc D E | kk | Fy(a+) | Jk(a+) | Le(a- b-) |
| Donneuse: D... (femme) | | | | | | | |
| | O | MN | Cc D ee | kk | Fy(a-) | Jk(a-) | Le(a- b+) |
| 3. Malade: G... | | | | | | | |
| | O | MN | CC D Ee | kk | Fy(a+) | Jk(a+) | Le(a- b+) |
| Donneur: B... | | | | | | | |
| | O | M | CC D ee | kk | Fy(a+) | Jk(a+) | Le(a+ b-) |
| 4. Malade: H... | | | | | | | |
| | A. 2 | MN | cc D E | kk | Fy(a+) | Jk(a+) | Le(a- b-) |
| Donneur: S... | | | | | | | |
| | A. 2 | M | Cc D ee | kk | Fy(a+) | Jk(a+) | Le(a+ b-) |

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