CLINICAL AND BIOLOGICAL OBSERVATIONS
ON SEVEN ACCIDENTALLY IRRADIATED ALGERIAN PERSONS


On May 5th 1978 an Ir 192 source of 15 Curies for gamma-graphy set in a pencil-like holder fell from a truck on the road from Algiers to Setif. It was found 2 or 3 days later by two young boys 3 and 7 years old (AEK and RAB). They handled this bright metallic object for some hours. Later their Grandmother (Mrs ARA, 47 years old) took the source away from them, brought it into their house and hid it in the kitchen. The Iridium source remained for 6 weeks in this room where 5 persons were irradiated depending on various conditions of time, posture and dose rate.

Two young female patients DJA (22 years old) and FMA (20 years old and pregnant) regularly frequented the working area of the kitchen at a distance of between 0.80 and 1.50 meters from the source which delivered a dose rate in the range of 8 Roentgen/hour at one meter. The exposure was estimated to be 6 to 8 hours daily.

Two girls, FAH (17 years old) and NOU (19 years old) usually spent several hours in the kitchen doing their homework. After 4 weeks, the pregnant woman FMA suffered a malaise and decided to leave the house and go to another house. From this time on the two younger girls replaced FMA in the kitchen and were irradiated from 6 to 8 hours daily.

Moreover, Mrs ARA, the Grandmother, came frequently into the kitchen and often leaned against the shelf where the source had been hidden and was thus often very close to it.

The Algerian authorities looked actively for the missing and finally located it on June 12, 38 days after it had been lost.
On June 14th and 15th, the seven injured persons were evacuated from Algiers to Paris where they were taken to the Curie Foundation Hospital (Dr. Jammet).

EARLY CLINICAL FINDINGS.

At the outset of the observations, i.e. 4 to 5 weeks after the beginning of the irradiation, the seven patients presented several aspects of acute irradiation syndrome:

- not very severe for the two young boys, AEK and RAB.
- very severe for the four female patients, two of whom DJA and FMA showed mucous bleeding from the mouth and pharynx.
- especially severe for Mrs ARA, the Grandmother. Cutaneous radiolesions were also present:
- for the two young boys on the palms of their hands.
- for Mrs ARA, there were very large and deep lesions of radio dermitis with ecchymotic aspects of the anterior and posterior thoracic walls.

ACUTE EVOLUTION.

During the following weeks, three different types of evolution were observed:

1/ For the two boys a general state of clinical restoration and an apparent progressive repair of the radiolesions of the hands.

2/ For Mrs ARA: progressive deterioration of the general clinical state and aggravation of the cutaneous lesions with necrotic aspect. She died 15 days after the end of the irradiation period.

3/ For the four young female patients: the aspect they presented was typically a very severe acute irradiation syndrome, with mucous haemorrhage, fever, loss of weight and, for two of them, development of candida albicans mycosis in the mouth. They also presented episodic bacteriemia, with positive blood culture.

THERAPEUTIC CONDITIONS.

During the whole evolution, the irradiated patients were isolated in sterile vinyl cells and were given antibiotic and antimycotic drugs.
The haematological syndrome described in the next pages was monitored by daily administration of large quantities of fresh blood cells from the three types separately: RBC, WBC and platelets, dosed according to the daily haematological findings in order to maintain the peripheral blood cells at a level sufficient to insure the anti-infectious and anti-haemorrhagic functions of these cells. The whole survey of the haematological conditions was performed daily in the RadioPathology Laboratory of the French Atomic Energy Commission (C.E.A.) at the Fontenay-aux-Roses Center, where the Chromosome Analysis and Dosimetry also were performed.

**DOSIMETRY PROBLEMS.**

The dosimetry problems were difficult to solve. As a matter of fact, there was considerable uncertainty about each of the irradiation parameters:
- the exact day the source arrived in the house.
- the exact patient-source distances according to the different occupational activities: posture (standing or squatting) orientation (front, back or profile).
- the duration of presence in the kitchen throughout the day for the various patients.
- the shadowing of different persons by one another, etc..

Therefore the main methods for assessing the irradiation damage were:
- first, chromosome analysis
- second, the haematological evolution. It should be borne in mind that the essential aim of this analysis was to estimate the bone marrow damage so that the probable evolution during the few next days could be predicted leading to appropriate therapeutic options.

**CHROMOSOME ANALYSIS.**

The results of chromosome analysis performed at the Cytogenetic Laboratory of the C.E.A. (Mrs M.T. Doloy) were available within a four days period from first sample obtained upon the arrival of the patients in Paris. 4000 cells were scored during the survey period until the restoration of the general state occurred.

Roughly considering the Chromosome Analysis did give the following results, by comparing the scores with a reference curve of "Acute Homogeneous Single Dose" irradiation of normal blood in vitro.
These preliminary estimations could not be considered definitive, due to a number of causes:

- **first**: these estimations refer to an experimental curve established under different conditions (acute, homogeneous) from the accidental conditions;

  But in this situation the notion of "dose" in the sense of the Dosimetry was of poor value as regards to the notion of damage which is of prime importance for the physician involved in the therapeutic problems.

- **second**: the patients exhibited an evidence of the fact that the majority (50 to 100 per cent) of the lymphocytes had achieved, one or several mitosis at the time of the observation.

- **third**: the "normal" lymphocytes from the transfused blood could have been in competition with the heavily damaged patient lymphocytes in the blood culture thus eliminating those cells suffering from a heavier burden of aberrations (some of the lymphocytes in culture contained the Y-chromosome whose presence had been necessarily introduced by the transfusion).

For these reasons, the estimated dose levels could only be considered as a low level threshold of the real values of the doses to the patients.

**HAEMATOLOGICAL EVOLUTION.**

Early blood cell counts. Upon their arrival, the patients already showed the severity of the situation:

**LYMPHOCYTES** (normal: 2000/2500)  

<table>
<thead>
<tr>
<th>Patient</th>
<th>ARA</th>
<th>DJA</th>
<th>FMA</th>
<th>FAH</th>
<th>NOU</th>
<th>AEK</th>
<th>RAB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>47</td>
<td>22</td>
<td>20</td>
<td>17</td>
<td>19</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>Estimated dose from Dicentr.</td>
<td>150</td>
<td>420</td>
<td>200</td>
<td>160</td>
<td>160</td>
<td>150</td>
<td>250</td>
</tr>
<tr>
<td>Dic.+ Rings</td>
<td>150</td>
<td>420</td>
<td>210</td>
<td>160</td>
<td>150</td>
<td>160</td>
<td>240</td>
</tr>
<tr>
<td>Acentrics</td>
<td>160</td>
<td>360</td>
<td>220</td>
<td>210</td>
<td>120</td>
<td>120</td>
<td>230</td>
</tr>
</tbody>
</table>

Fig. 1

**POLYMORPHONUCLEAR** (normal: 3000/4500)  

<table>
<thead>
<tr>
<th>Patient</th>
<th>DJA, FMA, FAH</th>
<th>NOU</th>
<th>ARA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>100 to zero in few days</td>
<td>30</td>
<td>10/20</td>
</tr>
</tbody>
</table>

Fig. 2
**RETICULOCYTES** (normal : 100,000/150,000)  
FMA, NOU, ARA : 100/200  
DJIA, FAH : zero

**THROMBOCYTES** (normal : 250,000/300,000)  
DJIA, FMA, NOU : 20,000/30,000  
FAH : 7,000  
ARA : 12,000

These results showed haematological damage whose level was in the range of the damage observed in the most severe known accidents, such as NOL-1964, or even more severe.

For the two childrens, the situation was less severe:

**LYMPHOCYTES** : 1000/1200  
**POLYMORPHONUCLEAR** : 2,500/3,000  
**RETICULOCYTES** : 150/200,000  
**THROMBOCYTES** : 250,000

These values were evocative of their entry into the restoration period. This was confirmed during the next days and weeks by the progressively ascending curves of the different cell lines which reached the normal levels after 15 days of observation, i.e. about 50 days after the source had been discovered on the road and which had been the only day the boys had been irradiated.

On the other hand, the haematological evolution was very severe for the five adults. The blood cells reached the levels of:

- 250/500 Polymorphs i.e. 4 to 10 per cent of normal  
- 1000/5000 Reticulocytes 0,1 to 5 per cent  
- 50/60,000 Thrombocytes 15 to 20 per cent  
- 600/800 Lymphocytes 30 per cent

Despite the fact that each of the patients was given several (1 to 3) bags of freshly isolated cells of each line (red, white, platelets) daily, this critical situation lasted for a period of between 30 and 60 days after the end of the irradiation period.

The patient ARA (47 y.) died 15 days after the end of irradiation with a very extended necrotic area of the skin on the thoracic and abdominal walls.

**THE RESTORATION PERIOD** started late and progressed very slowly spanning 4 to 5 weeks before reaching a stabilization level. Moreover these levels were not stabilized at the normal range, demonstrating a persisitnant hypocellularity of the haematopoietic stem cells.
DISCUSSION

These seven observations constitute an unusual contribution to radiopathological data and they raised a number of specific problems.

Problems in Physical Dosimetry.

A very precise simulation of the accident was set up on the spot in Algeria by the Dosimetry Laboratory of our Department. This simulation allowed us to get a map of the distribution of doses and to propose a number of hypotheses about the theoretical isodoses, according to the different positions, attitudes and length of presence in the proximity of the source.

The dosimetry study also allowed us to reconstruct with precision the distribution of the doses to which the boy's hands had been subjected.

Problems in Cytogenetic Assessment of damage.

The different problems of interpretation have already been mentioned:
- the main importance given to the estimation of a level of damage instead of a level of dose.
- level of occurrence of mitotic activity during the irradiation period and loss of a fraction of the lesional representation inside the remaining cells.
- "dilution" of damaged lymphocytes by some transfused normal lymphocytes and competition in culture.

Problems of Therapeutics.

Therapeutic problems were numerous and had to be managed daily according to the haematological results. The numerical compensation from separated blood cells of each line was at the upper limit of that possible from transfusion centers and the compensation reached its own limits of efficacy for a few days in any case at least for two patients (DJA and FAH). For these two patients the platelet level could not be maintained despite 3 bags of platelets a day. Indeed, these two patients reached the conditions for a bone marrow transplantation. Bone marrow donors were typed and kept on call. But the procedure was not carried out because of a very slight positive response of the haematological curves.
Other problems arose from FWA's pregnancy. Ultimately the death of the foetus occurred during the restoration phase and its spontaneous evacuation occurred two weeks later.

The last problems lie in the therapeutic management of the local lesions on the hands of the two young boys. Surgical amputation of the 5th finger was necessary for one of them because of the radionecrotic aspect of the lesion. A skin graft is presently in progress.
TITLES OF FIGURES.

Fig. 1  Evolution of the Lymphocyte curve during the post irradiation period, for the patient NG. (severe protracted irradiation).

Fig. 2  Evolution of the Polymorphonuclear curve during the post irradiation period, for the patient NG. (severe protracted irradiation).

Fig. 3  Evolution of the Reticulocyte curve during the post irradiation period, for the patient NG. (severe irradiation).

Fig. 4  Evolution of the Thrombocyte curve during the post irradiation period, for the patient NG. (severe protracted irradiation).

Fig. 5  Evolution of the Thrombocyte curve for one of the young boys (AB.) (Acute moderate global irradiation + severe local irradiation of the hands).
LYMPHOCYTES / µl

Er

Th

Le

Fig. 1
THROMBOCYTES \( x \times 10^{-2}/\mu l \)  

Fig. 5