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UNIVERSITY OF CALIFORNIA
Radiation Laboratory
Division of Medical Physics

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OPALESCEENCE OF SERUM AFTER TOTAL BODY RADIATION AS A PROGNOSTIC SIGN OF DEATH

Robert L. Rosenthal

January 14, 1949

Berkeley, California
Opalescence of Serum after Total Body Radiation as a Prognostic Sign of Death

Robert L. Rosenthal

Radiation Laboratory, Division of Medical Physics
University of California
Berkeley, California

During an investigation of the clotting reaction of blood after irradiation with 200 kilovolt X-rays, the author noted the appearance of a marked opalescence in the serum and plasma of rabbits which subsequently died a few days after exposure to a single lethal dose of total body irradiation. This opalescence appeared within 24 hours following the exposure to radiation. In all cases, it disappeared completely 72 hours after exposure. A review of the literature has failed to reveal any mention of this phenomenon.

Rabbits of the New Zealand white strain were given over the total body single doses of 200 kilovolt X-irradiation, calibrated in air by a Victoreen ionization chamber. Dosage ranged from 200 to 1000 Roentgens (r). Blood samples were obtained by cardiac puncture before radiation and at various intervals after radiation (up to 30 days). Serum was obtained from the clotted blood and plasma obtained by centrifugation of either citrated or oxalated blood. In all cases the opalescence, when present, was noted in both serum and plasma.

1 Portions of this study were aided by the Atomic Energy Commission and U.S. Navy Contract N60or1-111, Task Order III Project No. NR 171-138.

2 The author wishes to thank Dr. John H. Lawrence and Dr. Hardin Jones for their valuable advice and assistance.
The opalescence was noticeable as a pearly white tint homogeneously distributed throughout the sample. Various degrees of intensity have occurred and can be classified as marked, moderate and slight, as shown in Fig. 1. All animals which showed the marked opalescence died as a result of radiation within 5 days following exposure. Animals having no opalescence or opalescence to a lesser degree usually survived the radiation for at least 30 days, unless death occurred from other causes.

The opalescence, when present, was prominent at 24 hours after radiation, and completely disappeared 3 days after radiation in all cases. No relation was noted between the occurrence of opalescence and diet or fasting. Serum obtained either with or without fasting (20 hours) has always been clear except for the opalescence following radiation. On the other hand, the opalescence has been found in both fasting and non-fasting animals.

In the present series of rabbits, there is no relation between the opalescence and changes in weight, white cell count, lymphocyte or heterophile count 24 hours after radiation. The absence of any red pigmentation in the opalescent serum tends to rule out erythrocyte hemolysis as a causative factor. Also, there does not seem to be any direct relation between opalescence and radiation dose rate. Table 1 lists data pertinent to this report. Detailed coagulation and hematological studies on these animals will be reported subsequently.

Studies are now in progress with the collaboration of Dr. John Gofman to determine the chemical nature of the opalescence. The opalescence can be eliminated from serum by acetone and ether extraction according to the method described by Blix. In low-speed ultracentrifugation, material, responsible at least in part for the opalescence, rises to the top to leave a clear infranatant solution.

\[\text{Blix, G. J. Biol. Chem., 108, 64, (1946)}\]
At present, there is no clear explanation of the mechanism by which radiation produces this opalescence. In view of its apparent relation to death, this phenomenon may not only provide a valuable, early measurement of the effect of acute exposure to radiation, but may lead to further knowledge concerning the nature of radiation sickness and its lethal mechanisms.
TABLE 1
Dosage of Total Body Irradiation, Appearance of Serum Opalescence, Survival Time, Lymphocyte and Heterophile Counts in Rabbits.

<table>
<thead>
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<th>Time</th>
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</tr>
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<td>400</td>
<td>25.8</td>
<td>None</td>
</tr>
<tr>
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<td>None</td>
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<td>23.2</td>
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<tr>
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<td>800</td>
<td>47</td>
<td>None</td>
</tr>
<tr>
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<td>24</td>
<td>Marked</td>
</tr>
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<td>800</td>
<td>52</td>
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</tr>
<tr>
<td>10</td>
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<td>52</td>
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</tr>
<tr>
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<td>52</td>
<td>Slight</td>
</tr>
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</tr>
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</tr>
<tr>
<td>17</td>
<td>1000</td>
<td>44</td>
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* Not sacrificed, 400 r. given on 28th day after first radiation.
** Died 20 minutes after nembutal. Post mortem: small rt. hemothorax, otherwise negative on gross examination.
*** Died within 1 hour after nembutal and cardiac puncture. Post mortem: marked gastric dilatation with moderate pyloric hypertrophy, otherwise negative on gross examination.
+ Died 1/2 hour after cardiac puncture. Marked hemopericardium present. Post mortem otherwise negative (gross examination).
Fig. 1. Tube at left shows clear serum as found before irradiation of rabbit. Center tube shows moderately opalescent serum (rabbit #16, 24 hours after irradiation; animal sacrificed 34 days after irradiation). Tube at right shows markedly opalescent serum (rabbit #15, 24 hours after irradiation; died a few hours later).