

AUTOPSY REPORT

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A-92-095
 BOX No Box 1
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NAME: Kelley, Cecil

AGE: 38 years

OCCUPATION: Chemical Operator

AUTOPSY NO: A-318

INSTITUTION: Los Alamos Medical Center - Unit No. 7220

ATTENDING PHYSICIAN: John Benson, M.D., and R. S. Grier, M.D.

DATE AND HOUR OF DEATH: January 1, 1959, at 3:15 a.m.

AUTOPSY BY: C. C. Lushbaugh, M.D.

DATE AND HOUR: January 1, 1959, at 6:00 a.m.

CLINICAL IMPRESSION: Acute radiation syndrome

ANATOMICAL DIAGNOSIS: Acute radiation syndrome (estimated exposure
 in excess of 10,000 rads, neutron and gamma
 rays, to the anterior surface of the torso
 and head)

Acute myocarditis, right atrium and ventricle; severe intracellular
 myocardial edema.

Acute dilatation, right atrium and ventricle (clinical right
 heart failure).

Acute pericardial, fibrinous effusion, inflammation and edema.

Thrombosis of the right auricular appendage.

Acute hepatic central congestion.

Marked cerebral edema; slight cerebellar pressure conus;
 diffuse radioarteritis.

Acute radioatrophy of spleen, lymph nodes, thymus and bone
 marrow; lymphorrhesis in lymph nodes and thymus.

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FILE BARCODE



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Peripheral leukocytosis and lymphopenia.

Acute radiohemachromatosis of macrophages of bone marrow and lung.

Petechial hemorrhage (and radiovasculitis) of epigastrium, pericardium, left lobe of liver, jejunal and antral peritoneum, antral mucosa, pericardium, right atrial, ventricular and inter-ventricular septal myocardium.

Acute, moderate gastric distention.

Radionecrosis of gastric parietal cells of anterior gastric wall.

Acute upper jejunal distention.

Acute generalized mitotic radiosuppression seen in gastrointestinal tract, skin, esophagus, bone marrow, lymph nodes and testis.

Acute jejunal and ileal radioenteritis.

Moderate distention of gallbladder.

Early benign prostate hyperplasia, median bar type.

Fibrocalcareous complex of Ghon.

Minimal pulmonary anthracosis and anthracosis of peribronchial and hilar nodes.

Dermal tatoos.

EXTERNAL APPEARANCE:

The body is that of a middle aged, male adult weighing 172 pounds and measuring 71 inches in length. The only external evidences of disease are numerous needle puncture marks in both anticubical fossae and the large veins of the forearms and lower legs; and two recently sutured, 2 cm. long, surgical incisions over the manubrium sterni. Both forearms bear blue tatoosed designs. There is no erythema of the anterior abdominal wall. The conjunctivae are no longer blood-shot.

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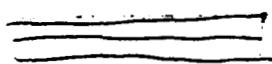


INTERNAL ORGANS:

Abdominal Cavity: The subcutaneous tissues and muscles are quite wet. There is about 250 cc of clear, thin fluid in the abdominal cavity. The peritoneal surfaces are smooth and glistening except those of the first loop of the jejunum, the gastric pyloric bulb, and the surfaces of the left lobe of the liver. These areas are dusky-rose in color and contain minute, petechial hemorrhages. Such hemorrhages are also present in the epigastrium in the parietal peritoneum. The domes of the diaphragms are at the fourth rib on each side. There is no excessive gaseous distention of the bowel. The majority of the intestines are small in diameter except for the hyperemic first portion of the jejunum. The stomach is moderately dilated, containing about 800 cc of gray, mucinous, gastric contents devoid of food or other recognizable debris.

Pleural Cavity: The lungs collapse as the chest is opened. The pleural spaces contain less than 10 cc of fluid. The anterior portions of both lungs are well-aerated while the posterior areas are atelectatic. There are no pleural adhesions.

Pericardial Cavity: The pericardial cavity contains about 75 cc of cloudy yellow fluid which contains fibrin that clots on standing. The right side of the heart is dilated and filled with blood. The left heart is in systole. The pericardium and epicardial fat over the right ventricle which lies in the midline, just above the xiphoid process, contains numerous petechial and small ecchymotic hemorrhages. These hemorrhages are also present in the right auricle and that portion of the right atrium which is most anterior. The distended right auricle appears to contain thrombosed blood.



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contains thrombosed blood between the pectinate muscles and there are numerous pericardial and intramuscular linear petechial hemorrhages in the right atrium and right ventricle. The left ventricle does not have these hemorrhages except in its muscles, in the inter-ventricular septum where these hemorrhages are most prominent just below the aortic valves. The coronary blood vessels show minimal atherosclerosis and no thrombosis. The aorta contains only a moderate amount of atherosclerosis in its lower third. The great veins are normal.

Liver: The liver weighs 1950 grams. It is acutely congested as evidenced by its dark color and by extremely prominent central areas which give its cut surfaces a typically nutmeg pattern. The peritoneum over the left lobe of the liver is slightly opaque and contains small areas of hemorrhages under it. On section, these areas of hemorrhage appear to be continuous with the vascular spaces of the liver.

The gallbladder is distended with about 50% more bile than is normal. The bile, however, is easily expressed through the papilla of Vater and is green, thin and mucinous. There are no gall stones.

Pancreas: The pancreas appears normal throughout its length.

Spleen: The spleen weighs 116 grams. Its capsule is wrinkled. The organ is exceptionally flabby. On the cut surfaces, the connective tissue trabeculae are unusually prominent and the pulp, while bloody, appears to be much more fluid than usual. No lymphoid aggregates can be discerned.

Gastrointestinal Tract: The stomach is distended with a little less than one liter of thin, mucinous, gray fluid with a typical gastric odor. The peritoneum under the anterior aspect of the antrum is dusky-rose and contains many hemorrhages. Under this area, the mucosa

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anteriorly and posteriorly contains numerous petechial hemorrhages. These hemorrhages are seen only within an area 5 cm distant from the pylorus. The mucosa of the duodenum and jejunum appears pale and edematous except in the region of the first 10 cm of the jejunum, which is moderately dilated and has a hyperemic mucosa. There are, however, no grossly discernable ulcerations in this or any other portion of the intestinal tract. The jejunum becomes progressively smaller in diameter caudally, so that the ileum and colon are quite contracted and free of fecal material and intestinal chyme other than mucus. The appendix appears to be atrophic. The mesenteric lymph nodes are small and difficult to discern from the surrounding fat since both are pinkish-yellow.

Adrenal Glands: Both adrenals are normal in size and shape. They weigh (with a small amount of fat) 7 grams each. Surfaces made by cutting failed to reveal any abnormality. The cortices appear normally lipid-rich.

Kidneys: The right kidney weighs 130 grams; the left weighs 140 grams. The capsules strip with ease. The parenchymal blood vessels are hyperemic. The surfaces made by cutting bulge slightly so that the edges cannot be completely approximated. The markings of the cut surfaces are those of grossly normal kidneys.

Gastro-Urinary Tract: The renal pelves, ureters, and urinary bladder are normal in appearance. The urinary bladder is contracted and contains only about 3 cc of yellow, cloudy urine. The lining of the bladder is thrown up into folds and contains no hemorrhages.

Generative Organs: The prostate is normal in size. There is, however, a hypertrophic median bar. The median bar is knobby and has a mulberry-like appearance.

The testes are normal in size but small. The testicular tubules can be teased apart easily.



Skeletal and Muscular System: There are no gross abnormalities of the bones other than the recent surgical biopsy of manubrium sterni.

The bone marrow appears to be hemorrhagic and devoid of its normal, fleshy appearance. The muscles are dark red and much more moist than normal.

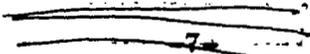
Rigor mortis is exceptionally strong and the muscles more contracted than usual. The muscles and subcutaneous tissues of the arms and thorax show extensive rigor mortis and swelling, while those of the lower portion of the body and extremities do not (5 hours postmortem).

Cranial Cavity: The brain stretches the dura mater tightly. It weighs (including the dura) 1600 grams. The gyri are flattened and the sulci obscured. The blood vessels are prominent. There is a small cerebellar pressure conus. The pituitary gland is quite hyperemic, fleshy, and soft in appearance.

from neuropathology

HISTOLOGY:

Bone Marrow: Sections were obtained from marrow in the proximal femur, vertebral bodies, and sternum. The marrow from these areas were histologically quite similar but the staining of the femoral marrow was best since no decalcification was used. A search for mitoses failed to reveal any in any of the sections. Similarly, there were no cells of either the myelocytic or erythropoietic series which showed any destruction in situ. Bone marrow islands contained more red cells than nucleated cells, and there was a pronounced decrease in polymorphonuclear leukocytes and primitive cells in particular. Eosinophilic myelocytes were prominent along with the very primitive reticulo-endothelial cells. The cytoplasm of the latter stained brownish-yellow and often contained irregular sized blobs of gold pigment and many pyknotic cell remnants. The



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Prussian Blue stain for iron made these cells stand out prominently, since the gold pigment and the diffuse brown cytoplasm of these cells now stained positively blue. Occasional megakaryocytes were found to have degenerate, pyknotic nuclei but nuclear debris was never found freely in any of the sections. When present, such debris was always inside the reticular histiocytes. The vertebral marrow showed an apparently slightly more severe depletion than the femoral marrow, as many of the spaces formerly filled by cells were found here to contain protein-rich edema fluid. The majority of the nucleated cells here were erythro- and normoblasts. As in the femoral marrow, no mitotic activity was present, and the primitive hemocytoblasts in all series were conspicuously difficult to find.

Lungs: There are occasional foci of alveoli containing thin, protein-containing fluid. The lungs are poorly expanded and there are many areas of focal atelectasis interspersed with areas where the alveoli are ballooned by emphysema and the walls ruptured. Many areas are found where there are relatively huge atrial cavities. In the alveoli near the periphery of the lung and in the atelectatic alveoli adjacent to the bronchi and interlobular septa, there are many macrophages collected in masses containing yellowish-green granular debris (some of which still has the form and appearance of erythrocytes). No true hemorrhages are found. These macrophages stain positively for diffuse and particulate iron. These are occasionally found associated with macrophages containing coal pigment in the interstitial tissue. In addition, the alveolar septa contain an abnormal number of polymorphonuclear leukocytes. There is so much iron present in macrophages that it is difficult to believe that this picture resulted from the radiation. The fact that this man has had pneumonitis in the past is evidenced by many of the peripheral alveoli being epithelialized and many of the macrophages are associated with this epithelium. On the other hand, however, it is in these areas that one sees degenerating polys and

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lymphocytes and extravasated red cells being ingested by the macrophages. Also many of the iron laden macrophages are in the bronchioles and bronchi apparently in the process of being coughed up. Sections containing pleura show damaged (pyknotic and crenated) serosal nuclei. Many pyknotic and degenerating lymphocytes and polys are found in the subpleural connective tissue.

Tracheo-Bronchial Lymph Nodes: Mucus in the bronchi contains desquamated columnar epithelial cells, macrophages laden with iron, and a few exudated polys. Whether blood was also present in it ante mortem cannot be determined. Peribronchial lymph nodes contain coal dust in macrophages in areas of increased collagenous connective tissue. The iron stain reveals foci of iron containing macrophages. These foci are usually in or around the areas of anthracosis. The cortical sinuses contain macrophages but very little stainable iron, although some dark-blue blobs are present. In another lymph node from the hilus, iron laden macrophages are found most prominently in the peripheral sinus and the perifollicular sinuses.

Lymph Nodes, in General: The lymph nodes, in general, are quite atrophic due to a recent loss of lymphocytes. The architecture is quite recognizable and the reticulum and the sinusoidal macrophages are particularly prominent. There is a variable amount of lymphocytic debris present. A peri-aortic node from the coeliac axis shows the least amount of lymphocytic debris but the most amount of atrophy. The reticular centers of follicles are not prominent and there is no apparent increase in sinusoidal phagocytosis although some leukocytes are present. Many of the remaining lymphocytes are small and pyknotic but many normal appearing lymphocytes are present. Relatively more debris is found in the lower abdominal lymph nodes along with an occasional reticular center. Occasional nodes from this region contain large numbers of leukocytes in the sinuses. Lymph nodes from higher up in the mediastinum and lower down in the abdomen show follicles rich in chromatin dust.

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Thymus: The thymus consists of thin strands of reticular cells with occasional large Hassall's bodies. Either there were very few lymphocytes before the accident or, as is more likely the case, since macrophages can be seen containing vestiges of cellular debris, the lymphocytes that were present at the time of the accident were destroyed and removed. The lymphocytes that were present at the time of death are extremely pyknotic and many peculiar "explosion figures" can be seen which typify, for me, continuing rhexis.

Spleen: The lymphoid follicles are greatly depleted. The follicles are now composed of large reticular cells, a few scattered lymphocytes (the majority of which are normal in appearance), and numerous large macrophages containing "mineral oil" vacuoles. The red pulp is composed of islands of erythrocytes among which there are many pyknotic white cells. The sinusoids, however, are far from being completely distended and there are many areas in the pulp where there are no red cells other than a few apparently dead ones mixed amongst degenerating leukocytes. The reticulo-endothelial cells in these areas are large and often found filled with red and white cell debris. The iron stain shows such macrophages staining positively for iron but not to the same extent as in the bone marrow and lung. In addition, in the relatively bloodless areas of the pulp there is diffuse, fine reticular-like fibers which stain positively for iron.

Appendix: The appendiceal mucosa is hyperchromatic. The lamina propria is lymphoid-poor. The submucosal follicles contain large reticular centers in which a few of the reticular histiocytes still contain chromatin dust. These centers are surrounded by pyknotic crenated lymphocytic nuclei. The mucus of the lumen is free from fecal debris but contains masses of degenerating leukocytes. An occasional vein of the meso-appendix contains fibrinous leukocytic clots.

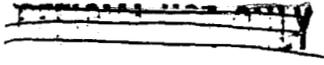
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Liver: The histologic appearance of the liver is quite different from what was imagined from its gross appearance. The central areas do not show much atrophy and the engorgement seen grossly was apparently lost during fixation. The iron stain shows relatively little iron deposition. There is a yellow-brown pigment in the central hepatic cells which fails to stain positively for iron. The hepatic cells do contain fine granules of iron but the most strongly positive areas are found in occasional macrophages located in the mid-central zones. There is a fine granular material in the blood which also stains positively. No macrophages, however, are found which stain as positively as those of the bone marrow and lungs. Aside from the early central atrophy, there is no evidence of primary hepatic cell injury.

Kidney: The convoluted tubules show a slight amount of cytoplasmic sloughing. Down in the medulla, occasional tubules are found filled with eosinophilic, cytoplasmic debris.

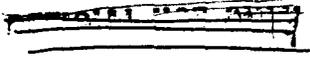
Gastrointestinal Tract - Esophagus: The esophageal epithelium is covered by a thin layer of poorly staining erythrocytes. There is a well defined basal, glomerular and squamous layer. A search along the basal layer shows that no mitoses are present. There is an occasional vacuole containing a lymphoid-like cell in the epithelium. The basal cells appear to be differentiating into squamous cells. The nuclei are swelling and becoming more vesicular than normal and even the most basal of these cells appears to have developed intercellular bridges which are accentuated by intercellular edema. In the subepithelial connective tissue, there is an increase in numbers of lymphoid and polymorphonuclear cells. An occasional lymphoid follicle is present which contains chromatin dust which is free and in macrophages. There is a reduced number of large and medium sized lymphocytes in these follicles, which appear to be normal. There is no true arteritis or phlebitis. The



smooth muscle coats are edematous. The blood in some of the smaller vessels of the peri-esophageal mediastinal connective tissue stains opaquely as though it were congealed. In these vessels there is seen an occasional leukocyte apparently undergoing rhexis.

Stomach: The gastric mucosa is, in general, well preserved. The most superficial portions show foci of autolytic changes. In the most well preserved areas, many acid secreting eosinophilic chief cells can be found free in the lumen of the glands. These sloughed cells usually have crenated pyknotic nuclei. Occasionally, however, the nuclei are swollen and vesicular. (These changes were seen in the stomachs of the heavily irradiated monkeys as one of the earliest signs of heavy radiation exposure.) The zymogen cells appear to be unaffected. The subperitoneal connective tissue is extremely edematous. In this edematous fluid, there are occasional leukocyte-like cells rimmed by dark blue to purple, opaque material, irregular in outline which gives them a "fried egg" appearance. There is an increase in leukocytes in the connective tissue here and occasional veins are occluded by fibrin and leukocyte masses. The blood vessels themselves do not appear to be chemotactic. Sections from the posterior gastric wall do not show the necrosis of the parietal cells.

Duodenum: The most superficial portions of the duodenal mucosa are missing. Fragments of the epithelial strips are lying free in the lumen. Occasionally a well preserved villus with epithelium can be found. Such a villus shows loss of small lymphocytes from the connective tissue core. There is shrinkage of the core with condensation of the reticular cells and histiocytes. Scattered among these cells are occasional pyknotic remnants of lymphocytes and polys. Such remnants can also be seen in the overlying epithelium which contains occasional mucous vacuoles. These mucous



vacuoles are found also in the deepest cells of the crypts. No mitoses are present here. Outside of the pyknotic nuclear remnants, the only other change in the crypts consists of nuclear ballooning. Brunner's glands show cells which are occasionally without a nucleus or have a distorted pyknotic one. In general, they appear to be unaffected.

Jejunum: The section of jejunum was taken from the area of subperitoneal hemorrhage and edema. The extravasated red cells can be seen diffusely through the subperitoneal edematous connective tissue. There has been a slight leukocytic exudation. In addition, in and around some of the smaller blood vessels leukocytic nuclear debris can be found along with leukocytic nuclei elongated in the process of diapedesis. Some of these vessels are occluded by opaque masses of erythrocytes in which it is difficult to delineate individual red cells. The Meissner-Auerbach plexus and the sympathetic nerves are quite edematous. The mucosa is better preserved than in the duodenum. Villi can be seen which are still covered completely by epithelium. The epithelium is extremely hyperchromatic. No mitoses are present in the crypts. The nuclei show ballooning. A few examples of intraepithelial nuclear debris can be found, but the crypts filled with debris as found in heavily irradiated animals are not found here. Pyknotic leukocytic and lymphocytic remnants are present in the lamina propria which is relatively cell-poor and is shrunken. The epithelial cells of the extrusion zone of the tip of the villus are lower and broader than those along the side of the villus. True early squamous metaplasia is seen best in the necks of the crypts.

Lower Jejunum: Similar changes are seen.

Ileum: The omental fat shows no changes. The lymphoid tissue of the villi is markedly depleted. The villi are, in general,

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shortened and there is an apparent increase in mucous goblet cells. No mitoses are found. An occasional crypt contains cellular debris.

Pancreas: The pancreas shows normal appearing islets and acini. An occasional necrotic cell in the pancreas proves, on close examination, to be leukocytic in origin.

Prostate: Some of the prostatic glands are hyperplastic and show a squamoid metaplastic type of epithelium which, in some areas, is definitely transitional.

Pituitary: The pituitary blood vessels are quite hyperemic and in the region of the stalk there are areas of what appears to be extravasated red blood cells.

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