RADIUM AND SOME PRECAUTIONS IN CONNECTION WITH ITS USE.

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There are certain precautions in connection with the use of radium with which many nurses are familiar without always knowing the reason for them.

The precaution which is most obvious, because it entails the greatest amount of work for the nurse, is that taken to prevent loss of the radium. In hospitals where the substance is always in use, all ward refuse before destruction and all linen before being sent to the laundry must be examined by X-ray. In other institutions, where it is only occasionally used, the routine examination of all utensils and bed linen by the sister or staff nurse is the rule, before these are disposed of. Often even the sweepings of the floor must be retained until the radium has been safely removed and checked. The reason for this great care is not only that the radium-bearing areas of the world are few, but that in its raw state radium is combined with a very great quantity of other material. In addition, at least six months must elapse in the refining process. The chief known radium fields are at Joachimsthal in Austria, in the Belgian Congo, Colorado and a newly-discovered area in the far north of Canada. Reports of pitchblende come also from Dutch Guiana. Radium is always found in conjunction with another element, uranium, in the ratio of one part to 2,800,000 parts. The richest pitchblende ore may contain as much as 80 per cent. of uranium, but to obtain the necessary quantity of ore many tons of useless material must be handled at the mines. One ton of finest pitchblende contains much less than one gram of radium, and with some of the poorer ores, such as carnotite, 500 tons of ore are required to produce one gram. The refining process is also very long and costly. Sulphuric acid is added to the ore, and this precipitates the radium and barium in it. The separation of the radium from the barium sulphates is the next problem. This is done by a process known as fractional crystallization, a previously-heated, saturated solution being allowed to cool until crystals form in it. These radium-barium crystals contain a larger proportion of radium than the original sulphates. By repeating this process many times the pure radium salt is obtained. Radium sulphate is used for inclusion in radium tubes and needles; radium bromide in the production of radon.

The Nature of Radium.

The second precaution in connection with the use of radium is concerned with the storing, handling and "screening" of it. When not in use, radium is stored in very thick lead safes. It is transported to the ward or theatre in a long-handled carrier of lead. For protection, laboratory workers in radium stand behind screens which the "rays," given off from the substance, cannot penetrate. Surgeons and nurses handle the tubes and needles as little as possible, preferring to lift them with forceps in preference to even gloved hands. Frequent handling of radium can give rise to dermatitis and prolonged exposure to its rays to leukopœnia. Radium salt and radon are applied in containers of gold, platinum, or some other dense metal.

The reason for the care in handling and applying the substance can only be made clear by a brief explanation of the phenomenon of radioactivity, and to do this, some reference to the atomic theory of matter, now generally accepted, is necessary. An element is a substance which cannot be split up by chemical means into any other substances. An atom is the smallest part of an element which retains the properties of that element. Atoms are presumed to consist of an extremely small nucleus with an excess of positive electricity and a sufficient number of negative electrons distributed around it to balance the positive charge of the nucleus. The positive particles of an atom, which give the nucleus its positive charge, are called protons. The simplest atom is that of hydrogen with one proton and one electron. The atomic weight of hydrogen is said to be one. The helium atom is the next simplest in the series, with four protons and four electrons and an atomic weight of four. Uranium, the most complex atom, has an atomic weight of 238. All elements which have an atomic weight over 209 are radioactive.

Radioactivity has been defined as "the spontaneous disintegration of an element in the process of which the atomic nucleus ejects helium nuclei or single negative particles, or both together." Whether the complexity of the elements with a high atomic weight is the cause of this instability is not known. Rutherford named the products of radio-activity alpha, α, beta, β, and gamma, γ, rays. Radium is a member of the uranium series of radioactive elements, each of which in turn, by the process of disintegration, which is radioactivity, is being converted into the next element of the series. The parent of the series is uranium, atomic weight 238, and the end product is lead, atomic weight 206, a non-radioactive element. Radium occurs towards the middle of the series, being immediately preceded by ionium and followed by radon. When radium is extracted from its ore, that is to say, separated from its parent ionium, it gradually decreases in volume because no new radium atoms are being created. This, however, does not greatly matter, as a given quantity of radium loses only half its value in 1,690 years. The production of radon, the offspring of radium, continues in spite of the separation of that substance from its ore. The manner in which this takes place is as follows:—One atom of radium, atomic weight 226, expels a tiny particle of its constituent matter and what remains is radon, atomic weight 222. The ejected particle, which is the difference between the atomic weights 226 and 222, is the α particle, wrongly called the alpha ray, which gathers to itself two electrons and becomes a helium atom, atomic weight 4. Radon is a gas which is very heavy, but can be compressed into very small containers, known as radon seeds, which are much used in radium therapy. Radon atoms in their turn also undergo disintegration, and the resultant elements are, first, radium A and then radium B, with again helium in both cases. Unlike radium, radon atoms have a very short life; they lose half their value in 3.85 days. For this reason radon seeds have no monetary value beyond that of the container, which is usually of gold, and for the same reason they must be used directly they are made, as after five days a very large part of their radioactive value has disappeared. The atoms of radium A and B disintegrate very rapidly—a matter of minutes only—and the latter gives rise to radium C, but no helium; instead β particles and γ rays are emitted. β particles are electrons, travelling at very high speeds; γ rays are electro-magnetic waves of infinitely small wave-length, travelling at the speed of light, and similar in their action to X-rays, but with greater penetrating power. α and β particles cause necrosis of living tissues, healthy as well as neoplastic; γ rays appear to have a selective action upon the immature types of cells of which neoplastic tissue is formed.

A "screen" of 0.6 mm. of platinum or 0.3 mm. of gold eliminates practically all the harmful α and β rays, and stops the passage of only about 6 per cent. of the γ rays. The "screen" is the thickness of the wall of the radium or radon container, whether in tube, needle, seed, or any other form. Radium tubes for use in the cavitary method