

History of use and abuse of X-ray: the early 20th century Italian pediatrics school

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Summary. In our paper we report a brief history of the X-rays discovery and discuss the implications of their use and abuse in the Italian pediatric schools of the early 20th century. Indeed, history of the X-ray treatment in the Italian Pediatric School has not yet been well studied. Even if the scientific experience of many physicians is well known in literature, a summary was missing. In Italy, in 1900, exposure to Röntgen and ultraviolet radiation or to large amounts of solar rays was a widespread medical practice, especially in several pediatric schools. During those years, diagnosis and treatment of childhood pathologies underwent considerable changes, especially after the twenties, when scientists developed an unquestionable trust in the therapeutic properties of radiation, considered harmless at that time. We report the main steps of the scientific research of the early 20th century in Italy. (www.actabiomedica.it)

Key words: pediatry, X-ray, 20th century, Italy, history

Introduction

X-rays are a form of electromagnetic radiation with a wavelength ranging from 0.01 to 10 nm ($10^2 - 10^2 \text{ \AA}$), thus significantly shorter with respect to visible radiation. They have good “hardness”, which is the ability to penetrate deeply in opaque objects. The hardness depends on the wavelength of the X-rays and must be calibrated according to the thickness (t) and physical-chemical properties of the irradiated object. Radioscopy is an investigative technique, consisting of the impression of X-ray on platinum, zinc, cadmium or calcium-tungstate zone plates. Nowadays it is widely used during surgical interventions and in the guided fracture reduction, whereas it is not so common in

other fields. The final images obtained with those techniques are less clean than radiographic ones.

Röntgen rays, most commonly known as X-rays, were discovered 8 November 1895 in Würzburg, in Germany, during some experiments with the Hittorf-Crookes tubes for the production of cathode ray. The experiments were carried out by W. C. Röntgen, a professor of physics at the University. The first X-ray radiography obtained by him, depicting his wife's right hand with a large ring in the middle finger, attracted much attention on the subject. A few months later, in 1896, Henry Becquerel discovered radioactivity, while working with phosphorescent materials. In December 1896 Pierre and Marie Curie, who actually coined the term radioactivity, conducted further pioneering

studies on radium and polonium isotopes. Although in 1901 Röntgen won the Nobel Prize in Physics he never patented his discovery. For this reason, in 1928 his colleagues named “Röntgen (R)” the unit of measurement for the exposure of X-rays. It is interesting to point out that X-rays were used soon also for the study of the mummies in order to comprehend “hidden pathologies” (1), practice still used today in the human remains (2, 3)

Starting from 1896, several cases of visual system and skin diseases were reported. In the first years of the 20th century, the scientific community draw attention to the possible correlation between X-rays and leukemia. In order to enlighten the dangerous effects of X-rays exposure, the Anglo-American engineer Elihu Thompson irradiated his left pinkie for a week causing skin lesions.

Little was known on the phenomenon and there was the belief that the exposure to this kind of radiation could be helpful in the diagnosis and treatment of several diseases. Therefore, experiments were conducted on patients of all ages and suffering from various diseases. The use and abuse of radiation was frequent among the operators, some of whom, voluntarily or more often inadvertently, exposed themselves to the harmful effects of excessive doses of ionizing radiation (4). Operators used to work in over-exposed environments with rudimentary instrumentation, lacking in an adequate protection. Children, equipped with appropriate glasses could take advantage of the beneficial effects of ultraviolet radiation in specially prepared indoor environments. Exposure to sunlight was proposed in small degrees with the use of complex tables (5). Until 1939 there had been still the belief among physicians that the effects of unduly dosed sunlight and an outdoor life could cause *lucite*, a pathology directly connected with the onset of pellagra, erythema multiforme and lupus. The enthusiasm of the researchers for the newly discovered X-rays led them to underestimate the serious side effects that were outlined by physicians in the early years of the application of this innovative technology. Serious eye and skin damage, and even leukemia, were reported already in 1896. In Europe, one of the first hospital using extensively X-rays was the “Royal London Hospital” and in 1898 the British surgeon John Hall-Edwards (1858-1926),

a military doctor, politician and passionate photographer, had his left hand amputated (still preserved in the Birmingham Museum) due to severe dermatitis contracted during the first years of experimentation. In the 1920s, the harmful effects of X-rays on the genome were outlined.

Having raised awareness on the side effects of the use of ionizing radiation, there was the willingness to reduce as much as possible the exposure of the subjects: aluminum filters, collimators, darkest photographic plates and general good practices for insiders and patients were introduced in the first years of the 20th century, especially by the British Röntgen Society (1915) and the American Röntgen Ray Society (1922) (6).

In Italy, the first enthusiastic experiments on the use of X-rays were conducted in 1896 at the Military Hospital of the Trinity, in Naples, by the lieutenant colonel Giuseppe Alvaro, who made use of the new technique on injured soldiers from the war in Africa.

During the First World War special vehicles, called Radiological Ambulances, were born. These four-wheeled life-saving mobile X-ray units were supplied to military hospitals for the emergency care on the battlefield.

The use of radiology was also reported at the end of the 19th century in neuro surgical departments and in psychiatric hospitals (7). Colonel Alvaro extended the use of X-rays to military hospitals as an attempt to treat Tbc, Tifo, Colera (8). This practice became very common, and in the early 1900s, some authors reported the use of radiation therapy in several acute inflammatory conditions such as lymphadenitis, boils, *paterecci* and other inflammatory skin conditions. Radiation therapy gave good results in the treatment of *Tinea capitis*, a pathology that afflicted mostly pre-puberal children from deprived social environments. The Radioterapic Institute was established in 1914 under the direction of Prof. Francesco Radaelli and was attached to the Dermosifilopatic Clinic of Cagliari. In its first year of activity in Cagliari they carried out thousands of treatments, the most numerous with the radion emitted by radium and Röntgen rays, on diseases such as Lupus, epithelioma of skin and mucosa, *tigne* and onychomycosis. Radiation treatment was first praised as being effective, painless and practicable in the clinic but many years later it was reported that the irradiation

tion of the head or neck of children was the cause of numerous skin and brain neoplasia and thyroid cancer (4). An Italian method for the use of Röntgen rays in childhood cardiology was proposed by prof. Francesco Visco, (Pediatric Clinic of Naples) during the VII Italian Pediatric Congress held in Palermo between the 20th and 23rd of April 1911. In his presentation, Visco referred to the first work of Dr. Severino Arnone in 1910 (9).

The experimental irradiation of ten pregnant women conducted in Germany in 1925 by J. Zappert informed the Italian physicians about the secondary damage of this practice for the mother and the baby, especially during the first trimester. The study of ten cases of pregnant women exposed to irradiation in Germany in 1925 allowed to outline the secondary damage of this practice for the mother and the baby, especially during the first three months. To verify the harmlessness of irradiation before pregnancy, the Pediatric Clinic of Siena, directed by M. Pincherle, carried out an experiment and reported the outcomes (10). In the treatment of rickets, among pediatricians, it was common opinion that cow's milk, powdered milk, or other food or drugs, if properly irradiated, could have special therapeutic powers. In 1928, irradiation techniques of milk, liquid and powder were discussed in a well-known pediatric magazine appeared to have become common methods (11, 12). The new practice, appropriately and variously dosed, was used experimentally in pediatrics to irradiate nursing mothers. An experiment in air irradiation was conducted by Luigi Spolverini on ten mothers hospitalized in Pavia with the aim of increasing their milk secretion (13). Bread, wheat flour, olive oil, subjected to radiation, were given to rats by Spolverini in order to evaluate their eutrophic action. At the end of the experiment, the author concluded that to obtain the desired effect in young organisms it was necessary to make food adequately irradiated with skillful use (14). The eutrophic action of irradiated foods was experimented also by other authors (15). Average doses of radiation at close range on powdered milk and fresh cow's milk were used by the pediatrician Spolverini, with good results for the treatment of seven cases of rickets. The same author recommended higher doses of radiation in particularly serious cases. Interested in the physical changes

produced by UV radiation on food and on bodies, the pediatrician Luigi Spolverini published more than three hundred scientific papers on this subject (16). As it is known, even if today rickets is mainly limited to genetic forms (hypophosphatemic, vitamin-D resistant, renal tubular acidosis), a nutritional rickets could be developed in immigrated children with dark skin (17). Ultraviolet rays were used experimentally from 1923 to 1926 in the therapy of hypocalcemic rickets in 20 children between the ages of six months and three and a half years. The children, encouraged to live as much as possible in the open air, were irradiated with lamps of various kind, in sessions three times a week or every other day, for 40–60 minutes, in the anterior and posterior regions of the body. The relationship between clinical symptomatology and humoral relief was not constant but the results achieved on the reduction of tetany were considered satisfactory by the authors (18). Several French authors observed that the radiation therapy (splenic and hilar) had given inexplicable nonhomogeneous results in the treatment of 64 children affected by asthma and spasmodic coritza (19). The second International Congress of Pediatrics (Stockholm 18th-21st August 1930) was an opportunity to discuss and exchange views among pediatricians all over the world on the properties and beneficial effects of UV radiation and radiated ergosterin for the wet nurses, in order to prevent and cure rickets, tetany and osteomalacia. In the introductory report of Adolf Hess, in favor of these therapies, he warned the audience about an indiscriminate use, without scientific basis, of UV and irradiated products, some of which, like ergosterin, had still obscure mechanisms of action (20). In 1947, at the XVIII Italian Congress of Pediatrics, curated by Orazio Malaguzzi Valeri, the theory on the relationship between spring solar radiations and stunted manifestations, such as tetany, was presented. The lack of ultraviolet radiation was identified as the cause of hypophosphatemia or of rickets, but for some doctors these diseases were connected with food or vitamin deficiency. Tetanus crises were more frequent in spring, but the intimate relationship between spasmophilia and vitamin D deficiency and UV rays was quite clear to academics. The studies conducted by Frontali in Italy, revealed how sunlight had the power to mobilize phosphate ion deputies in the blood stream, with un-

known modalities, in order to fix calcium to bones (21). In 1929, G. Careddu, a young assistant of prof. Gino Frontali, director of the Pediatric Clinic of Cagliari, described in his work "Infantile Splenic Anemia and Actinic therapy", appeared in the Journal of Pediatric Clinic, the use of irradiation in twelve cases of mediterranean anemia in Sardinia.

For an unknown period, the children who arrived in Pediatric Clinic underwent an experimental actinic cure with irradiations on all of their body, supplied at a distance of sixty cm and with increasing duration from a 150V Hanau mercury vapor lamp (podium presentation: Maria Francesca Vardeu, *Storia della beta talassemia in Sardegna, Convegno di Storia della Medicina Bergamo e la Sardegna: due "isole" gemelle. Punti d'incontro e analogie attraverso argomenti di storia della medicina. Bergamo, Sala Mosaico della Camera di commercio, 1-2 dicembre 2007*) il contributo delle scuole italiane di Pediatria). Mercury-vapor lamps (22) were usually used in houses in the past for their brilliance, even if today they are in disuse also in external environment due to their toxicity. The vapours, contained in a glass or quartz tube, were ionized by a stream of electrons and ions produced by two electrodes, giving a brilliance mainly in the ultraviolet radiation. The exterior part of the lamp is completely covered by a fluorescent powder (yttrium vanadate or yttrium aluminate) transforming ultraviolet radiation in radiation in the visible spectrum (Examples of this instrumentation can be consulted here: *Storia dell'ISS: Collezione di strumenti dell' ISS, Archivio Fotografico, www.iss.it*). Already in 1911, Petrone and Lo Re reported that the first therapeutic treatment with Röntgen rays of infantile splenomegalies with anemia was performed by the Roman paediatrician Luigi Concetti on a three-year-old boy who came to his observation in the early 1900s. The case was presented at the Congress of Pediatrics held in Rome in 1905 where Concetti (23) said that after twenty-five irradiations, the spleen tumor had decreased considerably, but, unfortunately, anemia and systemic toxicosis appeared in the child. In 1939, Tecilazic, at the XVII Italian Congress of Pediatrics, referring to Cooley's anemia therapy, stated that all the attempts made to decrease hyperplasia of erythropoietic tissue, by irradiating the bones and spleen with Roentgen rays, had given negative results. Ultraviolet radiation or Rontgen rays were

applied to children for the treatment of lymphatism, and in adenoidism, directly or by inhalation, with nebulized and irradiated drug solutions. It was thought that the radiation had a beneficial effect in the treatment of pertussis, mumps, and infantile atrophic diseases or in all cases of endocrine hypofunction. Roentgen rays were frequently used in common diseases of childhood, but also in vulvovaginitis, in the treatment of meningococcal and tuberculous meningitis and in the treatment of post poliomyelitis. In 1938, irradiation of the spleen was still practiced as a preventive hemostatic procedure in the surgical preparation of tonsillectomies. The Nasopharyngeal cord of patients with diphtheria bacilli was "sterilized" with a local application of X-rays. This method was still considered safe in 1939 by the president of SIP, the pediatrician G.B. Allaria. A detailed and significant radiological case study was conducted on children affected by mediterranean anemia and carried out by the Pediatric Clinic of Bologna (directed by Maurizio Pincherle) and the Bologna Orthopedic Clinic (directed by Valerio Putti). It was published in 1938 in an important pediatric journal and proposed the somatic criteria that were used for the identification of the Cooley anemia in the Italian children (24-32).

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