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Review

Lead Poisoning: Historical Aspects of a Paradigmatic "Occupational and Environmental Disease"

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Lead poisoning is one of the earliest identified and most known occupational disease. Its acute effects have been recognized from antiquity when this condition principally afflicted manual workers and slaves, actually scarcely considered by the medicine of that time. The Industrial Revolution caused an epidemic of metal intoxication, urging scientists and physician of that period to study and identify specific symptoms and organ alterations related to chronic lead poisoning. During the 20th century, the acknowledgment of occupational and environmental toxicity of lead fostered public awareness and legislation to protect health. More recently, the identification of sub-clinical effects have greatly modified the concept of lead poisoning and the approaches of medicine towards this condition. Nowadays, lead poisoning is rarely seen in developed countries, but it still represents a major environmental problem in certain areas. Consequently, it may appear as a paradigm of "occupational and environmental disease," and the history of this condition seems to parallel the historical development of modern "Occupational and Environmental Health" as a more complete medical discipline.

Key Words: Lead poisoning, Occupational health, History

Introduction

Lead poisoning is a classic example of an occupational disease that is rarely seen in developed countries, although sub-clinical cases do occur. At the same time, lead intoxication from non-occupational sources has been, and still is, an environmental problem in several areas. Therefore, this condition could be properly looked upon as a paradigm of occupational and environmental diseases. An analysis of the historical pathways that acknowledges its dual aspect could provide useful information on the connections between the workplace and the environment and, subsequently, on the origins and the development of the medical discipline now known as "Occupational and Environmental Health".

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Early Acknowledgments during the Pre-industrialized Era

Lead was one of the first metals humankind learned to use due to its ease of extraction and its ductility. Consequently, lead poisoning has already existed in antiquity [1]. The first clear descriptions of lead toxicity dated back to the second century BC, when the Hellenistic physician Nicander of Colophon identified the acute effects associated with high-dose exposure

(paralysis and saturnine colic). However, in antiquity, chronic lead poisoning had not been well defined within a typical clinical frame, although the extensive use of this metal in different sectors does not exclude the presence of its toxic effects in the exposed population. The lack of interest towards this disease is not a surprise: in ancient times, those who were suffering from it were primarily artisans and, more broadly, workers of a low social class, whose conditions were not protected in general [2-4].

Since the first century BC, the use of lead in the Mediterranean basin has become more and more extensive due to the Romans' conquest of Britain, where the ores were particularly rich in lead, with a resulting increased availability of the metal itself [1]. A suggestive theory considered lead poisoning as the only contributory cause of the fall of the Roman Empire. In ancient Rome, water and sewage systems made a huge step forward in hygienic conditions and represented one of the essential factors to preventing the development of epidemic episodes in one of the greatest cities of that period [5]. The pipes were made of lead and consequently released metal salts in the transported water, resulting in high plasmatic levels of lead and thus shorter life expectancy, fertility disorders, and lower birth rates among those who drank that water, which meant those ruling the Empire [6]. Not coincidentally, many Roman emperors and patricians had reproductive problems and, to ensure an adequate offspring, had to turn to adoption. This theory has been partially challenged; lead poisoning would have derived from wine and not from water intake. The raw water came directly from the mountains and was therefore rich in calcium carbonate, which would have coated the pipes and formed a strong protection against the release of lead salts. Rather, it was the widely used wine preservative, the so-called *sapa*, a preparation of must, which was slowly cooked in lead containers [1]. This substance (which sees an etymological link with the Latin verb *sapio*, "to taste good") was also able to sweeten a poor quality wine, due to the content of lead acetate (also known as "lead sugar") produced during cooking [7].

The first medical hypotheses related to lead poisoning were formulated during the Renaissance. From this period on, the medieval artisans acquired the dignity of artists and their professional life became worthy of being studied and analyzed. The economic and cultural development in the fifteenth century drew workshop instructors and young apprentices into big cities, where they were engaged in the decorations of cathedrals and mansions of the new emerging masses, consisting of the commercial and financial middle-upper class [4]. Among workers, the greatest exposure to lead were most likely the painters, because of the use of lead-based colors, including lead carbonate or cerussite (also known as "white lead"), a substance which was irreplaceable with the realization of the color "white" until the nineteenth century. Remarkable painters who became victims of lead poisoning may have been Piero della Francesca (c. 1416-1492), Rembrandt (1606-1669), and Francisco Goya (1746-1828) [8,9]. In addition, workers who engaged in other craft occupations were highly exposed to the metal. For example, in 1473, the German physician, Ulrich Ellenbog (1440-1499) pointed out to the goldsmiths and metalworkers the benefit of preventive measures to avoid poisoning and subsequent death arising from lead and mercury; he practically advised them "to keep the windows open" and "to cover the mouth with a rag" while working with metals [3].

In addition, during the Renaissance, there was a strong interest for metals, certainly influenced by alchemy; in this regard, we must mention the "De Re Metallica" (1556), written by the Saxon physician Georgius Bauer (better known as Agricola, 1494-1556), pioneer of the study of health problems amongst German miners. Considering the described scenario, the inclusion of lead, mercury, and arsenic in the pharmacopoeia of the German-Swiss physician and alchemist Paracelsus (1493-1541) might appear as a counter-current theory, but it has to be considered in compliance with his own principle, "dosis sola facit, ut venenum not fit" ("only the dose permits something not to be poisonous"). The theories of Paracelsus, while representing the basis for the future development of toxicology, were bitterly criticized and condemned by the scientific world at the time [10]. Two centuries later, in 1656, Samuel Stockhausen, a German physician openly against the Paracelsian medical model, advised the miners of the mining town of Goslar to avoid the aspiration of dusts, attributing the etiology of miners' asthma to the "noxious fumes" of a lead compound, the litharge [3]. In the following decades, the "Transactions of the Royal Society of England" published numerous articles about the risks of the manufacturers of white lead and glass. Meanwhile, Bernardino Ramazzini (1633-1714) identified all the lead processing techniques, used by potters, tinsmiths, and painters, as dangerous [7]. In his "De Morbis Artificum Diatriba" (1700), the Italian physician said about the workers in metal mines, "since […] the use of metals is practically indispensable in all kinds of production, their health deserves attention and their illnesses ought to be studied so precautions and remedies may be offered." [11] In particular, Ramazzini stated about the potters who worked with lead, "first of all they suffer from palsied hands, abdominal colic, fatigue, cachexia, and they lose their teeth. It is, therefore, extremely rare that one can see a potter who does not have a lead-coloured, cadaverous looking face." [11]

Once the harmful effects of lead were evidenced in work-