



Theophrastus Bombastus Von Hohenheim (Paracelsus) (1493–1541): The eminent physician and pioneer of toxicology

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ARTICLE INFO

Edited by Dr. A.M Tsatsaka

Keywords:

Paracelsus
History of toxicology
Medicine
Alchemy
Toxicity
Mercury
Chemistry

ABSTRACT

Theophrastus Bombastus Von Hohenheim known as Paracelsus was a German-Swiss *homo universalis*, or Renaissance man, whose interests included medicine, chemistry and toxicology. Characterized as a rebellious and great reformer of established medicine of his era, Paracelsus preferred observing nature, over studying ancient texts to find appropriate treatments for various diseases. He also used unconventional curative methods, such as minerals and other inorganic substances, which caused much controversy among his contemporaries. The main purpose of this article is to highlight his contribution on toxicology and the use of mercury.

1. Introduction

The main purpose of this article is to highlight the great impact of Paracelsus, a German-Swiss alchemist and physician of the 16th century, on toxicology. Paracelsus is recognized as the most influential medical scientist in Western Europe during the Renaissance. He travelled extensively throughout Europe to learn medicinal and wound healing techniques. For example, he studied chemistry and toxicology while working in the mines of Austria, where he observed miners' diseases caused by the fumes of melted metals in the laboratories. He interacted with physicians and alchemists from Spain to the Netherlands and Alexandria (Egypt). Paracelsus rejected Galen's (129-c. 200) and Avicenna's (980–1037) theories of medicine and pharmacopeia, which had prevailed for 15 centuries, and instead introduced the use of chemical substances, such as minerals, into medicine. He was also the first to emphasize the importance of dosing in medicinal treatments [1–3].

The Renaissance period between the 15th and 17th centuries marks the transition from the middle Ages to modernity, from the Early Middle Ages to the Enlightenment. During the Renaissance, literature, arts, and science flourished in a cultural rebirth. With the invention of typography and Johannes Gutenberg's printing press around 1440, the knowledge of

the Classical Era could be transmitted much more rapidly via printed texts, ushering in a period of reformation and innovation and making Latin the *lingua franca*. In 1492, Christopher Columbus (1492–1499) travelled to America, soon followed by curious voyagers and scholars who crossed the Atlantic Ocean to explore and discover the New Land. Leonardo Da Vinci (1452–1519), Raffaello (1483–1520) and Michelangelo (1475–1564) invented new architecture, painting and sculpture styles. Martin Luther (1483–1546) demanded a reformation of the Roman Catholic Church. Erasmus of Rotterdam (1469–1536) and Galileo Galilei (1564–1642) advanced philosophy and science. Among these contemporaries, Paracelsus sought to bridge the fields of toxicology and medicine [2–4].

2. Background

Paracelsus was born as Theophrastus Philippus Aureolus Bombastus von Hohenheim in the village of Einsiedeln, Switzerland, in November or December of 1493 [Figs. 1–3]. He was the only child of Wilhelm (or Willem) Bombast von Hohenheim (1457–1534), a German chemist, physician and botanist, and Elsa Ochsner, a Swiss matron of the local pilgrim hospital of the area. His mother died soon after his birth [1–10].

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<https://doi.org/10.1016/j.toxrep.2021.02.012>

Received 12 January 2021; Received in revised form 11 February 2021; Accepted 20 February 2021

Available online 23 February 2021

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Fig. 1. Paracelsus. Line engraving by W. Marshall after J. Payne. Source: Wellcome Library London.



Fig. 3. Frontispiece of the French edition of Paracelsus surgical book *La grande chirurgie de Phippe Aoreole*, Lyon: A. de Harsy, 1603. Source: BIU Santé Paris.



Fig. 2. Frontispiece of Paracelsus book entitled: "Operum latine redditorum", Bâle: Petri Perna, 1575. Source: BIU Santé Paris.

Paracelsus inherited his interest in medicine, botany, and herbs from his father [1,2,4,5]. The two went for long walks in the countryside of Villach in Carinthia (Austria), where they moved in 1502 [2,3]. His father, in addition to practicing as a physician, directed the mines of the Fuggers, a wealthy family of the area who established in Augsburg a hospital for the treatment of syphilis and traded the "Holy Wood" guaiac exclusively [11]. Paracelsus thus had the opportunity to learn all about minerals. He also briefly worked in the Fuggers' silver mines in Schwaz (Austria) and in their chemical laboratory, where he observed miners' diseases, such as silicosis, and other damage caused by the inhalation of mercury and arsenic fumes [2,12].

Around 1507, at the age of 14, Paracelsus decided to study medicine, and in 1509, he enrolled in the University of Vienna (Austria) to learn arithmetic, music, astrology and geometry [1]. One year later, he obtained his baccalaureate in medicine from the same university. In 1515, he finally attained his medical decree from the University of Ferrara (Italy) [4,10]. It is assumed that he continued his studies in Italy, receiving his doctorate in medicine, or *doctor in utraque medicina*, from the University of Ferrara in 1515 or 1516 [1,4,5,8,10]. He also likely changed his name around this time, as it was a tradition to use Latin names at the universities. Paracelsus thus chose a combination of para (i. e. "better") and Celsus, or better than Celsus, referring to Aulus Cornelius Celsus of the 2nd century AD, a Roman estate owner who had written the medical encyclopaedia *De Re Medicina* [1,4–7,12,13].

Although it was customary in that era for students to visit only the most important centres of learning, Paracelsus travelled all over Europe. He spoke German as well as Latin and ancient Greek. According to his own writings, he visited Spain, Portugal, Catalonia, England, Scotland, Ireland, Denmark, Prussia, Russia, Latvia, Poland, Hungary, the

Netherlands, Croatia, Dalmatia, France, Sicily (Italy), Constantinople (Turkey), Crete (Greece), Rhodes (Greece) and Alexandria (Egypt). In all these places, he investigated the art of healing and observed other physicians, surgeons, monks, alchemists, the elderly and the homeless [2–6,8,9,12,14].

Around 1524, he returned to Villach (Austria), where his father still lived. He tried to establish himself in Salzburg (Austria) but soon fled to avoid arrest and persecution for his participation in the Peasants' Revolt [4,9,10]. Later, he obtained citizenship in Strasburg (Austria), where he began writing his *Opus Paramirum* and teaching anatomy at the School of Surgery. However, due to lack of experience in the above field he gave up lecturing [4,10]. In 1526, he was called back to Basel (Switzerland) by a famous publisher named Johannes Froben (c. 1460–1527), known also as Frobenius, who suffered from an infected injury. Paracelsus cured him and saved his leg from amputation [2,3,5]. Soon after, Froben's close friend Erasmus, the humanist scholar, asked Paracelsus to heal his gout. Paracelsus gave him laudanum, a tincture of opium that Paracelsus is thought to have invented and which he used on his instruments [2,3]. The same year, upon recommendation by Erasmus, Paracelsus was appointed the town physician [1,3–10]. The position included a professorship at the University of Basel (Switzerland), where he gave lectures on chemistry in German and soon provoked controversy among his peers [1,3–5,9,13].

Paracelsus criticized the medical practices of his colleagues, the dogmatism of the Catholic Church and the doctrines of Protestantism. He publicly burnt the books of Galen and Avicenna, whose teachings had been the standard medical theory for 15 centuries. Paracelsus aimed to prove that he held the supreme knowledge, which he learned not through reading books but by observing nature [3–5,7,9,12,13,15–17]. Paracelsus was forced to leave Basel (Switzerland) in 1528 due to his rebellious character [17]. He continued travelling around Europe and wrote several treatises, staying so busy that he did not learn of his father's death until four years afterward. His most important book, *The Great Surgery Book (Die Große Wundarzney)* was published in 1536. It was based on his battlefield experiences observing how soldiers healed open wounds [2,4,5,17].

In his *Book of the Three Principles*, Paracelsus argued that all diseases should be named after their cure. For example, leprosy should be named the gold disease, as it was treated with gold, and epilepsy the vitriol disease, as it was cured using vitriol. Due to his opposition towards established rules of medicine and his empirical methods of research and teaching, he was named the “Luther of Medicine.” [2,4,5,8,16] During the 48 years of his turbulent life, Paracelsus emphasized the importance of observation through travelling and the value of experimentation in scientific discovery. Many of his other books were published after his death on the 24th of September 1541, in Salzburg, Austria [4–6,8,9,13,18].

3. Contributions to toxicology

Working in the mines of Villach (Austria), Paracelsus acquired basic knowledge of metals and their properties [2,4]. This knowledge set the foundation for his element-based medicinal treatments and pharmacopeia, and it complemented his knowledge of herbal drugs, which he did not view as a panacea. On the contrary, he believed that treatments should be tailored to specific illnesses and that the information should be part of an arcana, or specialized knowledge. According to his theory, specific cures could heal specific diseases [2,13,16,18–20].

As an alchemist, Paracelsus often used minerals in his treatments, including arsenic, sulphur, silver, gold, copper, lead and antimony, although his main interest was the use of mercury [13,17,20–22]. Mercury (or quicksilver), and its various preparations involving mixing it with fats, was already widely used in medicine. Paracelsus expanded its use to treat syphilis and dropsy, as it acted as a diuretic when ingested. Paracelsus did not consider mercury to be a real metal due to its lack of malleability and its liquidity, which prevented it from being

hammered or cast [2,20,21,23].

Paracelsus stated that alchemy's main purpose should be the transmutation of metals into gold for the treatment of disease [2]. Although he did not write treatises exclusively on chemistry or alchemy, he included chemistry in his many writings, mainly in *De Mineralibus*, *De Natura Rerum* and *Archidoxa*. Building on his knowledge of alchemy, Paracelsus theorized the constitution of matter based on three elements (*tria prima*): sulphur (for its combustibility), salt (for its stability) and mercury (for its liquidity) [2,18,20,22,24–26]. He wrote, “For all that fumes and disappears in vapors is mercury; all that burns and is consumed is sulphur; all that is ashes is also salt.” [15].

Influenced by his father's involvement in occupational diseases, Paracelsus further extended his interest in toxicology. He wrote that diseases were associated with specific organs and that each chemical yields its greatest effect on a particular site in the human body, thus introducing a theory of targeted organ toxicity [25,26]. Paracelsus reformed medical education by introducing chemical agents, such as inorganic salts, metals and minerals [15,18,24–27]. As a treatment for syphilis, he recommended mercury in its inorganic compound form. For digestive problems, he gave iron antimony and zinc-oxide ointment. He was the first to use the word “zinc” to describe the mineral [1,2,17,25]. He also experimented with mixing metals with mercury and with the uses of aluminium and gases from solutions and calcinations [2].

Paracelsus was the first to claim the importance of dose in his *Third Defence*, which he wrote in response to those who criticized him for using toxic substances as therapies: “What is there that is not a poison? All things are poison, and nothing is without poison. Solely the dose determines that a thing is not a poison.” Thus, Paracelsus emphasized the importance of dosing in distinguishing between toxicity and treatment [15,18,27–31].

4. Conclusion

A significant figure in medical history, Paracelsus encouraged his colleagues and followers to question the ancient texts and to consult nature and folklore culture as guides in the field of science. His innovative, although extraordinary, methods of using inorganic elements as the basic treatments for specific diseases caused controversy among his contemporaries. Nevertheless, Paracelsus is remembered as the Pioneer of Toxicology.

Funding sources

No funding sources need to be credited.

CRediT authorship contribution statement

Spyros N. Michaleas: Conceptualization, Investigation, Methodology, Supervision, Writing - original draft, Writing - review & editing. **Konstantinos Laios:** Conceptualization, Investigation, Methodology, Supervision, Writing - original draft, Writing - review & editing. **Gregory Tsoucalas:** Conceptualization, Investigation, Methodology, Supervision, Writing - original draft, Writing - review & editing. **Georges Androutsos:** Conceptualization, Investigation, Methodology, Supervision, Writing - original draft, Writing - review & editing.

Declaration of Competing Interest

The authors have no conflict of interests to disclose.

Acknowledgements

None.

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