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Ben Franklin's Adventures in Occupational and Environmental Toxicology

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This is the tercentenary of the commencement of Boston-born[1] Benjamin Franklin's (Figure 1) career as a successful colonial printer.[2] He began his apprenticeship at twelve years old to his brother James, a local printer, and mastered one of the most lead-exposed trades of his day. In 1723 Franklin fled from his unhappy apprenticeship with his brother and ended up in Philadelphia where he found work in a printing house. In 1724 he went to London for 18 months where he learned the latest techniques in the printing trade.

When he returned to Philadelphia he worked for Samuel Keimer who was the publisher of the *Pennsylvania Gazette*. In 1728 Franklin set up his own printing house and soon bought the *Gazette* from Keimer, going on to become the official printer of Pennsylvania in 1730 and a prosperous leading citizen of Philadelphia.

Figure 1. A bust of Benjamin Franklin by Jean-Antoine Houdon, 1779 adopted from *The Philadelphia Museum of Art*. [Free access] https://www.philamuseum.org/collections/permanent/90227.html

A nearly identical bust, c. 1800, in *Benjamin Franklin House*, London, is viewer-rotatable in 3D at https://benjaminfranklinhouse.org/the-house-benjamin-franklin/artefacts/ (go to "Franklin Bust") [Free access]

Franklin cultivated a wide circle of medical contacts in America, Britain, and Europe and although he had no education or training in medicine he had a keen lay interest in medical matters. He invented medical devices, helped fund and found the permanent Pennsylvania Hospital[3] which opened in December 1756, consulted on medical issues[4] with physicians and lay people, and was considered by many to be "Doctor Franklin."[5] His musings on lead toxicology may be of particular interest to the readers of *BCTOX*.

Franklin recalled that during his youth in Boston he heard comments "against New England rum, that it poisoned their people, giving them the dry belly-ache, with a loss of the use of their limbs. The distilleries being examined on the occasion, it was found that several of them used leaden still-heads [conical or columnar vapor traps] and worms [coiled distillate collection tubes], and the physicians were of opinion that the mischief was occasioned by that use of lead. The legislature of Massachusetts thereupon passed an act, prohibiting, under severe penalties, the use of such still-heads and worms thereafter."[6] The distillery law referenced by Franklin was enacted by the Province of Massachusetts-Bay in New-England in 1723 and it was titled "An Act for Preventing Abuses in Distilling of Rum and other Strong Liquors, with Leaden Heads [covers] or Pipes [coils]."[7] Whereas colonial New England rum production methods had introduced lead contamination into liquors and caused illness for many consumers, there were various even earlier examples of widespread adverse health effects from beers and wines that had been similarly adulterated with lead, often used as a sweetener.

François Citois, Cardinal Richelieu's physician, described an epidemic of colic in the province of Poitou in 1572 and recurrent outbreaks in that region and elsewhere became known as colica Pictonum.[8] Similar cases were called entrabado in Spain and hütten katze in Germany. According to Eisinger, "the syndrome of symptoms of the colica Pictonum and those of the Devonshire colic, the bilious colic, the paralytic, spasmodic, or epileptic colic, the saturnine[9] colic, the German"Grimmen", and the English and American "dry belly-ache", "gripes",


LIBELLUS
De
HARGYRII
FUMO NOXIO MORBI-
ejusq; metallico frequentiori
morbo vulgò dicto
Die Hütten Katze
Oder
Hütten Rauch
Cum
APPENDICE
de
MONTANO AFFECTU ASTHMA-
tico metallicidis familiari, quem Ger-
manicâ linguâ appellamus
Die Bergsucht oder
Berg Kranckheit.
AUTORE
SAMUELE STOCKHUSIO, M.D.
Illustrissimorum Ducum Brunsuicensium
& Luneburgensium, Imperialisq; Civitatis
Goslariæ MEDICO.
GOSLARIÆ,
Typis NICOLAI DUNCKERI.
ANNO M. DC. LVI.

Figure 2. The title page of Samuel Stockhausen's 1656 book "A Monograph Concerning a Harmful Litharge Dust Disorder as well as a Common Mining Disease Called The Hütten Katze or Hütten Rauch." Adopted from *Bayerische StaatsBibliothek* [Free access]

or "griping of the guts" are all the same, and written accounts differ only in emphasis. There can be no doubt that they are all the same disease, whose pathognomonic may be found in all important medical works until the eighteenth century."[10]

The injurious effects of adulterated wine were documented by Eberhard Gockel, city physician of Ulm, in 1696,[11] after he had conducted a primitive case-control study of an outbreak of colica Pictonum in two monasteries, finding that those monks who were afflicted drank wine which was sweetened with "litharge" (PbO – lead oxide) but the monks without symptoms had not drunk such contaminated wine. Gockel then tried the contaminated wine himself and "was attacked by the most atrocious colic pains." Gockel was acquainted with an earlier book in 1656 by the German physician Samuel Stockhausen, in the mining town of Goslar, who had written about the role of lead in causing hütten katze or colica Pictonum in a work titled "Libellus de Lithargyrii Fumo Noxio Morbifico eiusque Metallico Frequentiori Morbo Vulgo Dicto Die Hütten Katze oder Hütten Rauch" (Figure 2).[12]

The court physician to Duke Eberhard Ludwig of Württemberg had brought Gockel's findings on lead toxicity to the Duke's attention and Ludwig proclaimed an edict in 1696 which stated, in part, "we command all apothecaries and chemists among you not to sell such poisonous and dangerous substances as litharge to any persons who

wishes to buy them… All those who engage in wine correction contrary to our proclaimed prohibition will be dealt with most severely: the falsified wine will first of all be spilled on the ground and the falsifier will be punished with a fine of 100, 200 or more *Reichsthaler* and will furthermore forfeit, without reprieve, his body and his life, as a detestable example" (one such offender, Johann Jacob Ehrni, was publicly beheaded in Stuttgart in 1706).[13]

Despite Gockel's insight into lead contaminated wine his findings never received widespread reception possibly due to his obscurity far from a prominent medical school or university. Moreover, communication among the international medical community was undeveloped and local publications had very restricted distribution. Wine trading centres such as Ulm and the Duchy of Württemberg became concerned that undue exposure and publicity about their wine tampering practices would damage the local trade and economy. Duke Ludwig had ordered Gockel's findings to be made known to physicians within his rule but it appears that this report was suppressed and "the first treatise about the colica Pictonum which subscribed unequivocally to Gockel's findings was written by George Baker (figure 3), seventy years after Gockel's book was published.[14]

Meanwhile, the dry-gripes or belly-ache continued to be of considerable medical interest across the Atlantic, particularly by a long-standing physician friend of Franklin, Dr. Thomas Cadwalader (1708-1779). Cadwalader described colic associated with drinking rum or punch (fruit juice and rum) which were made by distillation through lead piping.[15] It has been suggested that Franklin heavily edited Cadwalader's manuscript which was published by Franklin's press in 1745, since at that time "this was the printer's prerogative, for he acted not only as a publisher, but also as editor, or even re-write man."[16] In any case, Felton claims that the value of Cadwalader's book "lies in Franklin's recognition of the writing… as an early record of the toxicity to man of a metal in an absorbable state."[17]

Franklin lived abroad from 1757 to 1785 except for three years when he was back in New England. From 1757 to 1775 he resided at 36 Craven Street[18] in London and he served as the Pennsylvania colony's agent in England (he was back in America from 1762 to 1764). From 1776 to 1785 he was based in Paris as the first U.S. Ambassador to France at the court of Louis XVI. Franklin's time in both Britain and Europe brought him into close contact with some key medical figures there such as Sir George Baker.

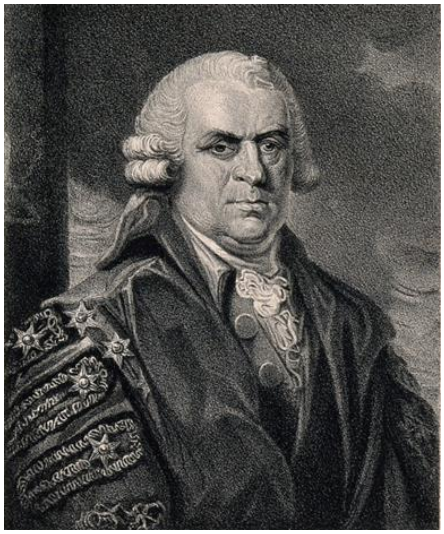

Figure 3. Sir George Baker, lithograph by G. P. Harding, 1837. Adopted from The Wellcome Collection, London. [Free access]

The English county of Devonshire (Devon) developed a greatly expanded orchard industry during the seventeenth century and produced vast amounts of cider which the inhabitants drank in large quantities. There were seasonal outbreaks of what became known as the Devonshire Colic and the first medical description of this condition was published in 1703 by Dr. William Musgrave (1655-1721).[19] Musgrave was particularly interested in the association of colic and gout and he observed that "the gout is not infrequently produced from the colic." Dr. John Huxham (1691-1768) who lived in Plymouth later published his essay on the Devonshire Colic in Latin in 1739 and in English in 1759.[20] Tony Waldron notes that "although his description of the symptoms of the Colic was an almost classic account of lead poisoning, Huxham did not consider this as a possible cause of the disease. Instead, he thought that the disease arose as a result of drinking the cider before it was properly fermented."[21]

Dr. George Baker was born in Devonshire in 1722, received his MD in 1756, and settled in London in 1761 soon after Franklin had arrived in that city. Baker and Franklin were both members of the Royal Society and the Royal Society Club and they had ample opportunities to converse about matters of mutual interest. Baker researched the Devonshire Colic and he gave five lectures about it to the Royal College of Physicians in London during the summer of 1767. It is clear that Dr. Baker had discussed his topic at length with Franklin since, in a lecture at the Royal College on July 13, 1767, he says that "my suspicions, concerning this subject, have been greatly confirmed by the authority of Dr. Franklyn (sic) of Philadelphia. That gentleman informs me, that, at Boston, about forty years ago, leaden worms were used for the distillation of rum. In consequence thereof, such violent disorders were complained of by the drinkers of new rum, that the government found it expedient to enact a law, forbidding the use of any worms, except such only as were made of pure block-tin… Dr. Franklyn (sic) likewise informed me, that the colic of Poitou is not so frequent a disease in any of the colonies, as it was formerly; and that the reason, commonly assigned, is that the people now drink their punch very weak in comparison with what they were formerly accustomed to."[22]

Despite fierce early opposition from many of his medical colleagues, Baker's explanation of the Devonshire Colic as a lead-induced disorder eventually prevailed among his own circle.[23] However, Childs points out that "for whatever reason, Baker's brilliant and scholarly exposition of the true nature of the colic made almost no impression, unfortunately for Americans, on contemporary American physicians." She notes that in a new edition of a medical text on tropical diseases Benjamin Rush the editor stated that dry belly-ache "was a common disease in Philadelphia between the years 1760 and 1770… Its rare appearance has been ascribed to the disuse of punch and of late and heavy suppers, to the use of flannel next to the skin, and to the abolition of porches, which afforded a temptation to our citizens to expose themselves for several hours, in a state of inactivity, to the damp evening air."[24]

In the same year that Baker published his "Essay Concerning the Cause of the Endemial Colic of Devonshire", Franklin visited La Charité hospital in Paris with Sir John Pringle and he described that visit to his friend Benjamin Vaughan, "when I was in Paris with Sir John Pringle in 1767, we visited La Charité, a Hospital particularly famous for the Cure of that Malady [Colica Pictonum], and brought from thence a Pamphlet containing a List of the Names of Persons, specifying their Professions or Trades, who had been cured there. I had the Curiosity to examine that List, and found that all the Patients were of Trades, that some way or another, use or work in Lead; such as Plumbers, Glaziers, Painters, &c."[25]

Franklin was himself afflicted with gout and a large bladder stone.[26] It has been suggested that he likely had occupational lead exposure during his years of work as a printer and had further lead exposures with his enjoyment of foods from lead containers and frequently imbibing lead fortified wines especially Madeira. Franklin may well have developed "saturnine gout" - a painful legacy of his adventures in lead toxicology.

References

[1] Franklin was born on January 17, 1706 at 17 Milk Street, the 15th child of 17 offspring who were born to Josiah Franklin, a soap and candle maker. Josiah's first wife, Anne Child, had seven children and Franklin's mother, Abiah Folger, had ten more.

[2] See Wroth, Lawrence C. (August, 1942). "Benjamin Franklin: The Printer at Work." Journal of the Franklin Institute **234**(2): 105-132. By 1743, Franklin had established three printing houses, in Philadelphia, Charleston, and New York.

[3] See Franklin's own history of the hospital project in "Some Account of the Pennsylvania Hospital; From its first Rise, to the Beginning of the Fifth Month, called May, 1754." Philadelphia: B. Franklin and D. Hall, 1754. (Reprinted in facsimile with an introduction by I. Bernard Cohen. (1954). Baltimore: Johns Hopkins Press.)

[4] In 1784 Franklin was chosen by Louis XVI of France to head up a nine-member commission to assess the merits of Franz Mesmer's animal magnetism ("mesmerism"). See McConkey K.M. and Campbell Perry. (October, 2002). "Benjamin Franklin and Mesmerism, Revisited." International Journal of Clinical and Experimental Hypnosis **50**(4): 320-321.

[5] Franklin was awarded honorary doctor of law degrees from the University of St. Andrews in 1757 and from Oxford University in 1762. On his notable contributions to medicine see Diller, Theodore. (March, 1909 and June-September, 1909). "The Writings of Benjamin Franklin Pertaining to Medicine and the Medical Profession." The Aesculapian **1**(2): 65-84 and **1**(3-4): 156-197 (accessible at the archival website of The Bulletin of the Medical Library Association and The Journal of the Medical Library Association at https://www.ncbi.nlm.nih.gov/pmc/journals/72/, and expanded in Diller, Theodore. (1912). "Franklin's Contribution to Medicine: Being a Collection of Letters Written by Benjamin Franklin bearing on the Science and Art of Medicine and exhibiting his Social and Professional Intercourse with various Physicians of Europe and America." Brooklyn, NY: Albert T. Huntington, available at https://archive.org/details/franklinscontrib00dillrich.) See also Huth, Edward J. (December, 2007). "Benjamin Franklin's Place in the History of Medicine." The Journal of the Royal College of Physicians of Edinburgh **37**(4): 373-378, Gensel, Lisa. (December, 2005). "The Medical World of Benjamin Franklin." Journal of the Royal Society of Medicine **98**(12): 534-538, Hirschmann, J.V. (2005). "Benjamin Franklin and Medicine." Annals of Internal Medicine **143**(11): 830-834, and Finger, Stanley. (2006). "Doctor Franklin's Medicine." Philadelphia: University of Pennsylvania Press.

[6] Franklin, in a letter written to his friend Benjamin Vaughan, July 31, 1786. A letter press copy of Franklin's original handwritten letter to Vaughan is viewable at the *Library of Congress* website at https://www.loc.gov/item/mss21451025/ "Benjamin Franklin Papers: Series II, 1726-1818; 1785, May 26-1786, Dec. 10 (vol. 23)" where the 4-page original letter is found at *Images 185-188*. The type text of this letter is found at the *Online Library of Liberty* website at http://oll.libertyfund.org/titles/franklin-the-works-of-benjamin-franklin-in-12-vols "The Works of Benjamin Franklin, Vol. XI Letters and Misc. Writings 1784-1788" (go down the *Table of Contents* to the fourth entry titled *"To Benjamin Vaughan"*). Both the handwritten and the text copies of this so-called *"lead letter"* by Franklin are reproduced in Felton, Jean Spencer. (November, 1967). "Man, Medicine, and Work in America: A Historical Series. III. Benjamin Franklin and His Awareness of Lead Poisoning." Journal of Occupational Medicine **9**(11): 543-554. The text of Franklin's lead letter was published in McCord, Carey P. (September, 1953). "Lead and Lead Poisoning in Early America." Industrial Medicine and Surgery **22**(9): 393-399, and by journal editors, e.g., (September, 1965). "Franklin on Bifocals and Lead Poisoning, 1785-86." Medical Affairs. *Classics in Medical Literature from the University of Pennsylvania, 1765-1965*: 24-27; (March-April, 1976). ""Dr." Franklin." Public Health Reports 91(2): 178-183 – reprinted from Wright, Robert D. (February, 1939). The Health Officer **3**(10); (March, 1981). "The Franklin Letter on Lead Poisoning." Journal of Chemical Education **58**(3): 274; and (July, 1997). "Ben Franklin's Letter on Lead Poisoning." New Solutions **7**(4): 80-81.

[7] The full text of the 1723 Law is provided in Felton, Jean Spencer. (November, 1965). "Man, Medicine, and Work in America: An Historical Series. II. Lead, Liquor, and Legislation." Journal of Occupational Medicine **7**(11): 572-579. The specific motions and readings of this first consumer protection act to manage lead toxicity in America are found in the *Journals of the House of Representatives of Massachusetts*, 1715-1779, 65 vols. in 55, (Boston: Massachusetts Historical Society, 1919-1990): Volume 5: 1723-1724, pages 44, 98, 104, 107, 157, 161, 258, 264, 312, 315, accessible at the *State of Massachusetts* website, https://www.sec.state.ma.us/arc/arcdigitalrecords/housejournals.htm.

[8] Citois, François. (1616). "De Novo et Populari apud Pictones Dolore Colico Bilioso Diatriba." (A Discussion about the New and Common Bilious Colicky Pain in Poitou). Poitiers: Antony Mesnier. The original publication in Latin is found at http://fondosantiguos.com/obra/189/de-novo-et-populari-apud-pictones-dolore-colico-bilioso-diatriba The first chapter is provided in an English translation by Major, Ralph H. (1945). "Classic Descriptions of Disease." Springfield: Charles C. Thomas, pages 314-315.

[9] The symbol ♄ was used in astrology to represent the planet Saturn. In alchemy, lead was associated with Saturn, hence the term "saturnine" meaning lead-related, e.g., saturnine gout.

[10] Eisinger, Josef. (October, 1982). "Lead and Wine. Eberhard Gockel and the colica Pictonum." Medical History **24**(3): 279-302.

[11] Gockelii, Eberhardi. (1696). "De vini acidi per acetum lithargyri cum maximo bibentium damno dulcificatione" (Concerning the Sweetening of Acid Wine with Litharge with the Greatest Harm to Those Who Drink It). Miscellanea Curiosa, sive Ephemiridum Medico-Physicarum Germanicarum Academiae Naturae Curiosorum. Decuriae 3, Annus 4, Observatio 30:77– 85. The original publication in Latin is found at the *Biodiversity Heritage Library* website at https://biodiversitylibrary.org/page/45543332. Gockel wrote a subsequent account in German as Eberhardo Gockelio, titled "Eine curiose Beschreibung dess An. 1694, 95, und 96 durch das Silberglett versüssten sauren Weins und der davon entstandenen neuen und vormals unerhörten Wein-Kranchkheit." (A remarkable Account of the Previously Unknown Wine Disease which in 1694, 95, and 96 was caused by sour wine sweetened with litharge). Ulm: 1997. The original publication in German is available online at the *Bayerische StaatsBibliothek* digital website at https://reader.digitale-sammlungen.de/de/fs1/object/display/bsb10472045_00001.html.

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[18] This building is now operated as *Benjamin Franklin House* and is the only extant home of Franklin.

[19] Musgrave, William. (1703). "Dissertatio de Arthritide Symptomatica." The original publication (in a 1715 edition) in Latin is available online at the *Bayerische StaatsBibliothek* digital website at https://reader.digitale-sammlungen.de/de/fs1/object/display/bsb10055150_00001.html.

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[24] Childs, St. Julien Ravenel. (May-June, 1970) "Sir George Baker and the Dry Belly-Ache." Bulletin of the History of Medicine **44**(3): 213-240.

[25] Franklin, in a letter to his friend Benjamin Vaughan, July 31, 1786. (See footnote 6).

[26] According to Finger and Hagemann, "it has been suggested that Franklin's bladder stone was probably the size of a small pea when he first complained about it, and that it might have weighed 400 to 500 grams, occupying much of his bladder, when he died." Finger, Stanley and Ian S. Hagemann. (June, 2008). "Benjamin Franklin's Risk Factors for Gout and Stones: From Genes and Diet to Possible Lead Poisoning." Proceedings of the American Philosophical Society **152**(2): 189-206, 198.