

Mercury Poisoning, Emperor Qin Shi Huang and his Terracotta Army

Reza Afshari, School of Population and Public Health, University of British Columbia, Canada. Reza.Afshari@bccdc.ca

Abstract:

Emperor Qin Shi Huang (259 BCE - 210 BCE) was the founder of the Qin dynasty, and the first emperor of a unified China. His impact on Chinese society was enormous and ranged from unification of diverse state walls into a single Great Wall of China, developing a massive new national road system and creating a city-sized mausoleum guarded by the life-sized Terracotta Army.

Throughout his adulthood, Emperor Qin sought immortality and sent explorers to find the secret to immortality from different corners of the world. It is documented that he continuously consumed mercury pills for immortality. Emperor Qin ran a tyrannical government with strict discipline, which intensified as he aged. He used to scrutinize every petty detail and occasionally suffered from overworking himself. Some of his clinical findings are consistent with mercury-induced neurotoxicity. His successor Qin Er was mentally ill, and murdered his older brother, to seize the throne. He executed 12 princes, 10 princesses and many generals; he ordered for the city walls to be lacquered and uprisings not to be reported to him as they made him sad. It is plausible that his mental judgment was impaired as a result of low dose mercury poisoning; a practice that he presumably followed as it was his father's immortality recipe. When his underground mausoleum was examined by modern archeologists in 1970s, high concentrations of mercury, some 100 times the naturally occurring rate, confirms the credence of the historical account.

Mercury poisoning and Emperor Qin Shi Huang's life and death are intertwined in mystery and reality. Mercury pills did not bring him immortality in physical terms and perhaps just the opposite, contributed to his sudden premature death at the age of 49. However, he achieved immortality through his works and with acknowledging the toxic effects of mercury! Even after millennia we are talking about it. His army still stands under his discipline with horses and carriages intoxicated with mercury to trap their souls.

Introduction

The history of toxicology is mesmerizing and a highly effective source for medical and health education.¹⁻³ What if we could use it to improve health literacy^{4,5}, to change the attitude of professionals and the public⁶, and to persuade others to act more socially responsible⁷ as well as incorporate historical events into medical and health curricula?⁸

We have already discussed a few examples.^{4,9-16} Here is another one; The world was stunned when the Terra Cotta Army was discovered in the 1970's in China

Who was Emperor Qin Shi Huang

Qin Shi Huang (259 BCE - 210 BCE) was the founder of the Qin dynasty, and the first emperor of a unified China with a truly centralised bureaucratic system. His charisma and power has never been mimicked in Chinese history. He first became the king of the small State of Qin at the age of 13. He built a formidable fighting machine by mobilising the whole population. The territory that he governed extended from Mongolia to Hong Kong, as large as the whole Roman Empire at its peak. After his successful campaign, he declared himself "Qin Shihuangdi" or First Divine Emperor of the Qin.¹⁷ He died at the age of 49.

China's multiple States were diverging prior to his reign, and it is even plausible to say that China would not exist without Qin Shi Huang.¹⁸

The legacy of the First Emperor of China

- Unification of diverse State walls into a single Great Wall of China
- Developing a massive new national road system
- Building a city-sized mausoleum guarded by the life-sized Terracotta Army
- Developing a standard for weights and measures, a single currency and a universal writing system
- Banning and burning many books and executing scholars

Emperor Qin's Personality

Emperor Qin ran a tyrannical government with cruelty and strict discipline. He used to scrutinize every petty detail and occasionally suffered from overworking himself. His brutality intensified as he

aged. He is also acknowledged in history for his decisive actions and for his monumental achievements through resilience and ruthlessness.

Qin was paranoid and feared "the inkbrush as much as the sword". He executed 400 scholars and intellectuals for not being subjective to his ideas or for talking behind his back.



Figure 1. Terracotta Army – Photo Courtesy of Pixabay

Qin's *ultimate charisma* is unique throughout human history, a feature that never faded away until his death. He was innovative, a visionary, courageous and passionate for the work that allowed him to exercise absolute influence and authority over his people.

He repeatedly defied the odds in social sciences. It is technically proposed that relationships between charismatic personality and leader effectiveness is like a double-edged sword (curvilinear or inverted U-shaped), meaning that up to a point charismatic personalities facilitate social development, a trend that would not persist if charisma continuously increases.¹⁹ Emperor Qin is a clear figure in defiance of this theory. His extraversion, impulsivity, dominance, confidence and reactivity remained solid as it is obvious from his monumental works. He remained strategically, judgmentally and operationally in control for his entire life.

It is difficult to conceptualise Qin's social-cognitive model of behaviours. His reign came with dramatic increases in sophistication and customised mass production, which is evidently portrayed by constructing the Terracotta Army mausoleum.

It became clear that Chinese imperialism was going to end if he really died. He did not train or introduce a successor. He executed scholars, influential figures and commoners to an extent that the Empire ran out of man power and was left in limbo and chaos. I wonder if he himself wanted it that way, or he really believed that he is going to last for 10,000 generations. Even biblical figures Adam and Noah did not live that long!

Unfortunately, his strong personality was devoid of good human qualities, moral values or compassion. He never fought for happiness or freedom of his subjects or pressured them to be “good” citizens, instead valuing submission above all. He was harmful to society and the livelihood of his people.

What was the Terracotta Army

When archaeologist Zhao Kangmin was notified that local farmers had found life-size pottery heads and several bronze arrowheads near the city of Xian in central China in April 1974, he would have never thought that he was on the verge of discovering the tomb of China's first emperor, Qin Shi Huang. Eventually 8,000 (1300 soldiers) soldiers, including horses and chariots, were discovered in this site (Figures 1 and 2).²⁰

Qin Shi Huang's mighty tomb was guarded by the Terracotta Warriors in a site 200 times bigger than Egypt's Valley of the Kings. His huge mausoleum was supposed to protect the emperor in the afterlife.

Although this site is widely recognised as a Chinese national treasure these days, his discoverer Zhao Kangmin who died in 2018 at the age of 81 remained underappreciated according to a BBC report.

Surprisingly, three of the original seven farmers who reported the site died under terrible circumstances.²¹ Was this site a curse for those who revealed it similar to the discoverers of the Egyptian mummies?

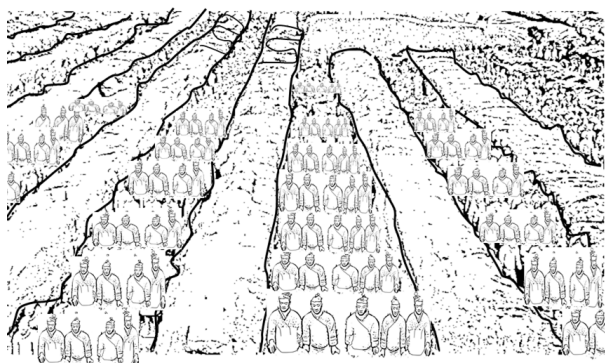


Figure 2. Terracotta Army – Emperor Qin's mausoleum. RA©

Qin magnified his *personal* charisma with a stable *professional* charisma demonstrated by his Terracotta Army. He promised not only a blissful afterlife, but also a tangible manifestation of immortality in the shape of individual human sized personas. In his followers' eyes, Qin was definitely a healer to cure death.

--- The Terracotta Army is another example of his long lasting charisma, manifested both in his private and professional life. The construction of this mausoleum was a visual confirmation of his charisma. --- Which one of his inner circle could have not been mesmerised by being involved in developing or even witnessing this mausoleum. He promised what were seen as immortal clay statues that would trap and keep alive their souls and last for millennia!

The warriors' faces are solid and their bodies still. At 185 to 194 centimetres, they are modestly taller than ordinary people to

reflect their impressive personalities and give everyone a sense of superiority. --- No visitor forgets the powerful atmosphere of the mausoleum. The Terracotta Army has become a part of the human psyche!

In pursuit of immortality

Throughout his adulthood, Emperor Qin was hungry for immortality, and seriously searched for it. In the absence of contemporary scientific information on balanced diet and exercise to elongate his life, he was actively seeking advice from all scholars and physicians and even sent explorers to find the secret to immortality from different corners of the world. It is highly controversially claimed that some of his methods were inspired by ancient Greek influence.²² Historic writings show that a herb that was collected from an auspicious local mountain was suggested to him for immortality.²⁰

In the pursuit of immortality, he was delusional. He viewed death as an absolute failure, and eventually misled himself that he is going to last for 10,000 generations. Even today, many people believe that he is going to come back and run an Empire that extends beyond his homeland geographical Empire, China. --- Did you enjoy watching the action-adventure fantasy film directed by Rob Cohen, “The Mummy: Tomb of the Dragon Emperor”? Be honest, do you want to be the devil who brings him back or the hero who defeats him? People are fascinated with the concept of immortality, in particular if the dead is going to come back to life.

In his quest for immortality, Emperor Qin eventually fell in love with mercury and started consuming mercury pills that were prepared by his alchemists and court physicians for this purpose.²³

How could mercury cause immortality?

In my view, the “theory” behind using mercury for immortality was based on first, the observation that “mercury was able to absorb gold and silver from ores.”²⁴ Elemental mercury, even today, is used in artisanal and small-scale gold mining. In this process, mercury is mixed with gold-containing materials, forming a mercury-gold amalgam. The combination is then heated, by which mercury is vaporized leaving the gold and silver behind.²⁵

--- Second, in the case of death, it was presumed that the soul, the most precious element of beings, is separated from the body and goes to heaven somewhere in the sky according to the dominant belief prior to and around Qin's era. The physical body was then buried. Creating the heavenly bodies was a land mark of his thoughts. Taking both factors into account, they were looking to keep the soul in the body after death. Perhaps having mercury in the body would prevent the golden part of being, the soul, to leave the body, and therefore immortality may happen and last for 10,000 generations as he promised. This is my theory, anyway.

Emperor Qin and his over Terracotta Army made up of 10,000 warriors, highly contaminated even today (see below), kept the place secret as it was the location that their souls were trapped. They were so efficiently secretive that no one new such an Army even existed for over 2,000 years until the mausoleum was discovered by accident in 1970s.

Emperor Qin regularly consumed low dose mercury and gradually intoxicated himself with this element. He died suddenly at the age of 49, which is alleged to be related to mercury poisoning. In addition to pursuing immortality, other evidence exists supporting mercury's involvement in his life.

Evidence from ancient texts

100 years after the he died, the great historian Sima Qian wrote that his tomb mound had a stockpile of treasures in an imitation of the universe, mercury representing the rivers and oceans and gems on the ceiling representing the stars.²⁶ But Sima Qian did not mention

the place of his tomb and if such an army exists. --- Apparently, secrets of the Emperor's and his army's mausoleum were sealed.

Evidence from archeological studies

When his underground mausoleum was discovered in 1974, archeologists inserted probes deep into and tested the tomb mound for heavy metals. Their study revealed unusually high concentrations of mercury some 100 times the naturally occurring rate, which confirms the credence of the historical account (Figure 3).²⁷ Later extensive geochemical studies also confirmed abnormally high concentrations of mercury in his mausoleum (Figure 4).^{28 29 30}

The actual tomb is still sealed (untouched) due to its conditions, which according to rumors is protected with many tricks and supernatural curses!

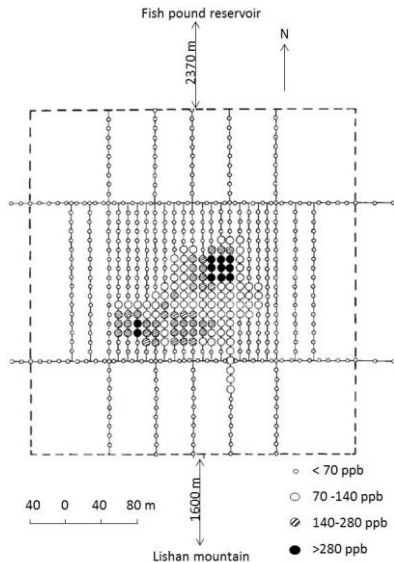


Figure 3. Sample layout and mercury content over the tomb mound of Emperor Qin Shi Huang. Adopted with modification from reference⁽²⁸⁾.

Archeological studies confirmed the ancient texts. Mercury was in fact used in constructing his mausoleum to simulate the heavenly rivers and streams in his territory. Diamonds and pearls were used to replicate the sun, the moon and other stars.³¹

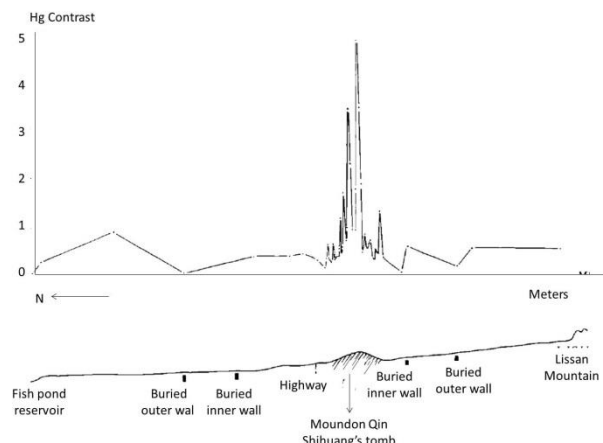


Figure 4. Variation of Hg-content in soil along the Lishan mountain-Fish Pond line. Adopted with modification from reference⁽²⁸⁾.

Evidence of mercury poisoning from the Emperor's clinical manifestation

What is mercury?

Mercury (Hg, quicksilver) exists both naturally and anthropogenically, and is a silver colour liquid under room temperature (Figure 5).



Figure 5. A drop of liquid mercury under room temperature.

Manifestations of chronic low dose mercury toxicity include gastrointestinal, renal and neurologic complications. Neurologic symptoms related to chronic inorganic *mercurialism* are varied and include:

- *mercurial tremor* (a central intention tremor that is abolished during sleep),
- *neurasthenia* (fatigue, depression, headaches, hypersensitivity to stimuli, psychosomatic complaints, weakness, and loss of concentration),
- *erethism* (easy blushing and extreme shyness of the afflicted, anxiety, emotional lability, irritability, insomnia, anorexia, weight loss, and delirium, and
- a mixed sensorimotor neuropathy, ataxia, concentric constriction of visual fields (tunnel vision), and anosmia.

In cases of mercury poisoning violent behaviour, assaults and hallucination has also been reported.³²

Emperor Qin was an apprehensive person and extremely afraid of death. Maghazaji (1974) scientifically reported a case of mercury poisoning with intense fear of dying, so perhaps the Emperor's fear was potentiated by his mercury use.³³ Qin was irritable and an insomniac. He suffered from exhaustion related to work overload and fatigue. He was a brutal version of Alice in Wonderland! Everything amazed him. He was ambitious with lots of ideas and inspirations.

His unstable emotional state manifested through his exaggerated changes of mood. He used to scrutinize every petty detail.

--- Psychologically speaking, his symptoms fit into chronic mercury poisoning! Research has shown that abnormal performance on neuropsychological tests persists over a prolonged period of time following mercury poisoning, and may be irreversible.³²

In general, it is plausible that mercury contributed to his behaviour and death, which makes his case the earliest recorded death as a result of mercury poisoning.³⁴

Having said that, mercury poisoning and, in particular, severe cases are presented with a wide range of clinical manifestations. We have no way today to see if he suffered from those symptoms or not. Judging a poisoning by psychological symptoms alone is farfetched.

Evidence from the Emperor's successor

Due to Qin's brutality, he left behind a large kingdom which was short of scholars and man power, and a paranoid family. Following his unexpected death, an old version of the bloodbaths reminiscent Game of Thrones happened, and eventually, one of his many sons, Qin Er Shi [Huhai] and Premier Li Si, Chief Eunuch Zhao Gao conspired to murder the Emperor's oldest son [Fusu] and the presumed heir to seize the throne. Fusu was ordered to commit suicide using a forged letter from his late father.

He was too weak to fill his father's shoes, and his family's dynasty that was supposed to last for 10,000 generations lasted just three years before he was brutally overthrown and forced to commit suicide. The young Emperor was mentally peculiar and ill.

He executed 12 princes, 10 princesses and many generals. He astonishingly ordered to lacquer the city walls and to not report uprisings; those who did were punished for making him sad. --- What if his mental judgment was impaired as a result of mercury poisoning? His strange behaviours were more consistent with low dose mercury poisoning; a practice that he presumably followed after his father's immortality recipe.

Reliability of the report

Revisiting a 2000 year old cold case through a scientific lens is very difficult. I tried to evaluate the strength of evidence regarding the reliability of toxic attribution of this event, which are summarised in Table 1.

First, we know for sure that Emperor Qin was regularly consuming mercury pills from the ancient Chinese historical documents in pursuit of immortality. Second, recent archeological and environmental toxicological studies confirm his obsession and high exposure to this element. As a result to both independent evidence (historical documents and archeological toxicology tests), the myth of Emperor Qin's high mercury exposure is scientifically reliable.

Table 1. Strength of evidence and reliability of toxic attribution of events.

Type of evidence*	Strength
Documentation of high exposure	+++
Environmental laboratory findings	+++
Psychological and clinical findings	+*
His son's behavioural profile	++
Suspicious Circumstances	+
Human laboratory findings	-[?] **
Reliability of attributing to toxic exposure	Confirmed

⁻ No evidence (improbable), ⁺ weak evidence (possible), ⁺⁺ moderate evidence (probable), ⁺⁺⁺ strong evidence (confirmed).

* Differential diagnosis including personality disorders is highly plausible (++)

** His body is to be exhumed and tested for mercury by Chinese authorities.

Third, his peculiar psychological and behavioural profile to some extent could be justified by low dose mercury poisoning. His era was filled with suspicious circumstances. Although he escaped many assassination attempts, we know with high degree of certainty that he died of mercury poisoning after all. His successor that presumably follow his father's recipe for immortality from childhood, showed more representative clinical manifestation.

In summary, the Emperor's behaviour could be in part attributed to mercury toxicity, although the extent of which may never be known. --- Let's assume that only 30% of his extraordinary behaviour was attributed to mercury toxicity. What would have been mercury's effects on the unification and building the Great Wall, development of the national road system and his mausoleum that is still guarded by the life-sized Terracotta Army? All of which are wonders and pride of humanity even after two millennia.

If he was not exposed to mercury, the course of history could have been changed for better or worse. At least we know with a high degree of certainty that mercury's effects that led to his premature death terminated his extraordinary contribution to human development. On the dark side of it, so many scholars would have been saved if he was not obsessive, paranoid and picky.

Mercury in this case has changed the course of history as it targeted the most powerful man on earth at the time.

Conclusion

Emperor Qin motivated people around through both love and fear of this world and afterlife. He effectively engaged with his subjects and was able to raise societal awareness to rationalise his views, and reconstruct the culture and the Empire by imposing social changes. Are you familiar with Nietzsche's favorite, Zarathustra brought the news; God is dead! He undermined Christian moral appeals but also created a new set of values to avoid ethical vacuum and banish nihilism. Do you see the similarity with Emperor Qin?

--- He was the earthly incarnation of Friedrich Nietzsche's Übermensch (Superman).

The world was all about him. He did not share his leadership, but his team's effectiveness remained high. He never cared about peoples' suffering, but only pursued his own charismatic needs. In my view his absolute power originated through three sources. First, as it was known from the antiquity, he discovered the power of fear among the elites and commoners.

Second, he promised afterlife, which at his time was the dominant belief in China. Both of which, however, existed in many other contemporary disciplines and religious ideologies.

What has separated him from all other rulers, however, is what he put in front of the eyes of his subjects in this world, in a tangible near future. Prior to him, relatives and close acquaintances of a deceased influential figure were buried with him to serve him in afterlife.

Emperor Qin broke gloriously this frightening tradition. Imagine how impressive this act would have been among the families of the elites; an ultimate display of charisma! Wives, administrative folks, servants, etc. should have loved him.

--- Instead of being slaughtered, they were now supposed to serve him. He created an Army of Clay Statues resembling his acquaintances to be buried with him, not the real people. This honorable act is unique and has not repeated in history.

While capturing the minds of his subjects through constructing the Terracotta Army, he used the mysterious power of mercury in cementing their loyalty and devotion through their potential immortality. Similarly to mercury's ability to separate gold and silver from ore, it was formulated that it can keep the soul not to be separated from the clay if remains there. As a result, he unleashed an enormous social energy not only by the power of fear and promising afterlife, but by bringing distinctively the heaven to the earth.

His top warriors were able to see the immortality buy their own eyes or what he promised, a 10,000 generation glorious Empire. The afterlife was no longer an empty promise, but a tangible reality! In addition, you would have been killed if you did not join him after all!

His long term low dose ingestion of mercury pills did not bring him immortality, and perhaps just the opposite contributed to his sudden premature death at the age of 49. However, he achieved immortality through his works and by celebrating mercury. We still acknowledge his work a couple of millennia after his death. Although he died 2000 years ago, in reality he still rules his 56 square kilometres -that is right 56 square kilometres - tomb complex proudly and firmly.

His army still standing under his discipline with horses and carriages intoxicated with the mercury that has trapped their souls. --- Viva mercury!

Declaration and acknowledgement

This article has been written in Celebrating the Chinese New Year 2019.

Reference

- Jonasson ME, Afshari R. Historical documentation of lead toxicity prior to the 20th century in English literature. *Hum Exp Toxicol* 2017;960327117737146.
- Afshari R. Chronicle of Datura Toxicity in the 18th and 19th Century. *Asia Pacific Journal of Medical Toxicology* 2017;5(4):101-06.
- Afshari R. The Chronicle of Arsenic Poisoning in the 19th Century. *Asia Pac J Med Toxicol* 2016;6(2):36-41.
- Afshari R. Historic Perspective (Ferdowsi); Scholarship of Teaching. *Future of Med Edu J* 2012;2(3):1.
- Yahaghi MJ, Afshari R. *Education and Health in Shahnameh (National Epic of Iran, Ferdowsi (1010 CE))*: Mashhad University of Medical Sciences Publishing Group, Iran, 2012.
- Afshari R, Zavar A, Alidoust M, et al. Knowledge and Attitude of Health Network Staff towards Illegal Drug Use. *Addiction and Health* 7(1-2):96-98.
- Afshari R, Bellinger DC. Socially Responsive Toxicology; Looking Outside the Windows of Medical Wards: A Tale of Lead Exposure. *Asia Pac J Med Toxicol* 2015;4(3):95-96.
- Afshari R. Incorporation of medical research and education in Asia Pacific region. *Future of Medical Education Journal* 2015;5(4):3-4.
- Afshari R. The "Voice" and Execution of Socrates. *BC Toxicology News Monthly Bulletin (BCTOX)* 2018;3(3):439-241 <https://bit.ly/2CPMPNY>.
- Afshari R. Mithridatium (Universal Antidote), Mithridatism and Mad Honey Chemical Warfare. <https://bit.ly/2L5DPZA>. *BC Toxicology News Monthly Bulletin (BCTOX)* 2018;4&5(3):264-66.
- Afshari R. Use of Chemical Warfare Agents in Ancient History: The case of Persians and Romans in Dura-Europos, Modern Syria in 256 CE. *Asia Pacific Journal of Medical Toxicology* 2018;7(3):54-59.
- Afshari R. Gustav III's risk assessment on coffee consumption; A medical history report. *Avicenna J Phytomed* 2017;7(2):99-100.
- Afshari R. Fall of Easter Island Civilization and Toxic Prion Exposures. *Asia Pacific Journal of Medical Toxicology* 2018;7(2):29-32.
- Afshari R. What's Santa Claus poisoned with? --- For Christmas fans! *BC Toxicology News Monthly Bulletin (BCTOX)* 2018;3(11):399-402 <https://bit.ly/2Uxu3Rd>.
- Afshari R. What poison killed Hamlet? --- For Shakespeare lovers! *BC Toxicology News Monthly Bulletin (BCTOX)* 2018;9(3):378-79 <https://bit.ly/2Oy3LPf>.
- Afshari R. Solve the mystery: what could be the "acute high dose" or "long term low dose" chemical/drug exposure that caused Edgar Allan Poe's death? *BC Toxicology News Monthly Bulletin* 2017;2(10):154-56 <https://bit.ly/2M7HfIQ>.
- Carelli F. The terracotta army. *London J Prim Care (Abingdon)* 2008;1(1):56-7.
- Gracie C. Qin Shi Huang: The ruthless emperor who burned books. <https://www.bbc.com/news/magazine-19922863> (accessed Dec 08, 2018). *BBC Magazine*, Oct 15, 2012.
- Vergauwe J, Wille B, Hofmans J, et al. The double-edged sword of leader charisma: Understanding the curvilinear relationship between charismatic personality and leader effectiveness. *J Pers Soc Psychol* 2018;114(1):110-30.
- How China's first emperor searched for elixir of life. <https://www.bbc.com/news/world-asia-china-42477083> (accessed Dec 09, 2018). *BBC* Dec 25, 2017.
- Zhao Kangmin: The man who 'discovered' China's terracotta army. <https://www.bbc.com/news/world-asia-china-44244493> (accessed Dec 09, 2018). May 26, 2018.
- Western contact with China began long before Marco Polo, experts say. <https://www.bbc.com/news/world-asia-china-37624943> (accessed Dec 09, 2018). *BBC* Oct 12, 2016.
- Forrai J. History of amalgam in dentistry. *Rev Clin Pesq Odontol* 2007;3(1):65-71.
- Li Y, Ma C, Zhu C, et al. Historical anthropogenic contributions to mercury accumulation recorded by a peat core from Dajiuhu montane mire, central China. *Environmental Pollution* 2016;216:332-39.
- EPA. International Cooperation. Artisanal and Small-Scale Gold Mining Without Mercury. <https://www.epa.gov/international-cooperation/artisanal-and-small-scale-gold-mining-without-mercury> (accessed Dec 09, 2018).
- History Extra. Uncovering China's Terracotta Army. <https://www.historyextra.com/period/uncovering-china-terracotta-army/> (accessed Dec 07, 2018). Feb 09, 2018.
- Raoch J. Emperor Qin's Tomb. <https://www.nationalgeographic.com/archaeology-and-history/archaeology/emperor-qin/>. *National Geographic*.
- Yong C, Tong L. Application of mercury survey technique over the mausoleum of emperor qin shi huang. *Journal of Geochemical Exploration* 1985;23(1):61-69.
- Chang Y, Li T. Application of the geochemical exploration hydrargyrum measurement in archeology. *Geology in China* No. 7 21 22 *Geology in China* 1987;7:21-22.
- Yuan B, Liu S, Lu G. An Integrated Geophysical and Archaeological Investigation of the Emperor Qin Shi Huang Mausoleum. *Journal of Environmental & Engineering Geophysics* 2006;11(2):73-81.
- China Daily. Excavation of tomb ruled out. http://www.chinadaily.com.cn/english/doc/2006-02/22/content_522654.htm (accessed Dec 08, 2018). Feb 22, 2006.
- Bluhm RE, Bobbitt RG, Welch LW, et al. Elemental mercury vapour toxicity, treatment, and prognosis after acute, intensive exposure in chloralkali plant workers. Part I: History, neuropsychological findings and chelator effects. *Hum Exp Toxicol* 1992;11(3):201-10.
- Maghazaji HI. Psychiatric aspects of methylmercury poisoning. *J Neurol Neurosurg Psychiatry* 1974;37(8):954-8.
- Rice KM, Walker EM, Jr., Wu M, et al. Environmental mercury and its toxic effects. *J Prev Med Public Health* 2014;47(2):74-83.