

The fate of medical knowledge and the neurosciences during the time of Genghis Khan and the Mongolian Empire

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✓In 25 years, the Mongolian army of Genghis Khan conquered more of the known world than the Roman Empire accomplished in 400 years of conquest. The recent revised view is that Genghis Khan and his descendants brought about “pax Mongolica” by securing trade routes across Eurasia. After the initial shock of destruction by an unknown barbaric tribe, almost every country conquered by the Mongols was transformed by a rise in cultural communication, expanded trade, and advances in civilization. Medicine, including techniques related to surgery and neurological surgery, became one of the many areas of life and culture that the Mongolian Empire influenced. (DOI: 10.3171/FOC-07/07/E13)

KEY WORDS • Avicenna • Genghis Khan • history of neuroscience • Mongolian empire • Persia

REPORTS ABOUT THE HISTORY of medicine in Asia are scarce. This article provides an overview of the fate of Asian medicine, specifically Persian, Indian, and Chinese scientific, neurological, and surgical knowledge before and during the Mongolian invasion and hegemony. It is generally held that medical knowledge passed into parts of Europe from the south, directly from the Arab countries by way of the Byzantine Empire or from North Africa via the Iberian peninsula.^{3,5} Little attention has been focused on another route that may have passed on an even greater amalgamation of knowledge. In the 12th century, the Mongols invaded a large area belonging to the three existing cultural giants. During this period, communication among these cultures as well as with Europe appears not to have been destroyed, as once thought, but in fact flourished. The spread of scientific knowledge, including that related to the nervous system, received an impetus from this East–West exchange.

The name Genghis Khan (1162–1227), of which there are several spellings, is well known in the West. He is remembered most for warfare, and he and his descendants are typically imagined in gruesome terms. He has traditionally been considered the scourge of civilization, at least in the West. On December 31, 1995, however, an article in the *Washington Post* selected Genghis Khan as the “Man of the Millennium.” Recent research shows that his conventional portrait as a purveyor of militaristic horror may be inaccurate.^{8,23} Scholars now suggest that Genghis Khan and his descendants brought about a “pax Mon-

golica” and secured the fabled trade routes between Europe and eastern China known as the Silk Road.^{8,23} After the initial shock and destruction associated with invasion by an unknown barbaric tribe, almost every country conquered by the Mongols was quickly transformed by a rise in cross-cultural communication, expanded trade, and sociocultural advances.²³

Historical Background

Genghis Khan (Fig. 1) was born “Temüjin Borjigin” in the mountainous area of Burkhan Khaldun in Mongolia’s Khentii Province near the Onon and the Kherlen rivers around AD1162 to his mother, Hoelun, and his father, Yesukhei, a minor tribal leader. According to legend, Temüjin, the future Genghis Khan, was born with a blood clot in his fist, indicating that he was destined to become a conquering leader. While he was still very young, his father was poisoned, giving him the claim to the clan’s leadership. The clan refused to be ruled by a boy, and Temüjin and his family were abandoned. During his childhood he learned valuable lessons about survival in the Asian steppes and the need for alliances, preparing him to become the Great Khan.^{8,23}

Eventually, Genghis Khan controlled the largest contiguous empire in the history of the world.^{8,23} In 25 years, Genghis Khan’s army conquered more of the world than the Roman Empire had done in 400 years of conquest. Genghis, his sons, and his grandsons subjugated the most



FIG. 1. Chinese portrait of Genghis Khan (1162–1227). (Public domain: http://en.wikipedia.org/wiki/Image:Genghis_Khan.jpg).

densely populated civilizations of the time. Ultimately, Genghis Khan conquered, occupied, and controlled more than twice the amount of land and twice the population than any other person in human history.²³ Using both persuasion and brutal force, the Mongolian leader united diverse tribes and cultures. His empire eventually encompassed all or part of modern China, Mongolia, Russia, Ukraine, Korea, Azerbaijan, Armenia, Georgia, Iraq, Iran, Kazakhstan, Kyrgyzstan, Uzbekistan, Tajikistan, Afghanistan, Turkmenistan, Moldova, Kuwait, Poland, and Hungary.^{8,23}

Genghis Khan's success is partially due to his transformation of warfare as the world then knew it. The Mongolian army learned from each battle and adapted newly acquired technology in their campaigns. During the conquest of Persia and Europe, for example, the engineering knowledge gained from sieges of Beijing and other Chinese cities gave the Mongols superior siege technology and expertise.⁸ Europe was confined to an immobile force of heavily armored knights and fortified cities and castles. According to traditional thinking, a fortified castle protected by a few good knights could outlast any army, withstand any attack, and thus repel any invasion. Genghis Khan had his own theory of effective warfare: swift and decisive attack with a disciplined cavalry was his preferred method. His brilliant use of knowledge and technologies adopted from conquered cultures, especially methods of siege warfare, made the impenetrable fortress and its associated entourage of knights and warriors obsolete.²³

Genghis Khan actively defined new boundaries of the conquered lands. He may have decimated armies, but not the citizens. He created a system that unified enclaves of

conquered people into distinct nations, all of which became part of the greater Mongolian Empire. As part of the Mongolian Empire, the nations were obliged to pay taxes and duties to the Khan. However they also enjoyed some autonomy. In fact, the borders of these unified nations, including those of China, India, Russia, and Korea, remain much the same today as they did when established by their Mongolian conquerers.

Weatherford and others²³ have argued that Genghis Khan created a “new world order” in which cultural isolation became archaic. Before the Khan, Europeans and Chinese were unaware of each other's existence. After the Khan, cultural interaction and economic exchange between the two were not only possible but encouraged. One of Genghis Khan's unique advances was to encourage the diversity of his empire. Mongolians could legally become followers of Islam, Christianity, Buddhism, Taoism, or any other religion they desired, as long as their practice did not interfere with the Khan's political ambitions. The sharing of knowledge, information, and cultural identity was encouraged. By securing trade routes and establishing medical exchange programs, the Mongols made culture and information more portable. The *pax Mongolica* made it possible for travelers and traders to cross back and forth within Eurasia. The best known of the West to East explorers is Marco Polo (1254–1324), who started his eastward trek in 1271 with his father (Nicolo Polo) and his uncle (Matteo Polo), and finally met Genghis Khan's grandson Kublai Khan (Fig. 2) in 1275.⁸ Later, Marco Polo would build a strong relationship with Kublai Khan and serve in high-level Mongolian government positions.

Neuroscientific, Neurological, and Surgical Knowledge Before the Mongolian Invasion

In the following sections, we briefly summarize some of the most important features of medical and neuroscientific knowledge in the greatest oriental cultures before the Mongolian invasion.

Persian Medicine

Archeological research has revealed that trephinations had been performed in Iran as early as in the Iron Age (1200 BC),⁷ presumably to treat cranial and intracranial lesions such as depressed fractures of the skull.⁷ Among the most famous physicians of medieval Persia are Razi, known to the West as Rhazes (AD864–930), and Ebn Sina (Figs. 3 and 4), in the West known as Avicenna (980–1036 AD).^{10,19,20} There has been some confusion and controversy surrounding the heritage of these famous medieval physicians³ due to the use of inaccurate generalized terms such as “Islamic medicine” or “Middle Eastern medicine.” Indeed some medical knowledge traveled with the religious expansion of Islam to various countries.⁴ Yet the translation, analysis, and advancement of Greek medicine by Persian scholars (who were Muslims) have little to do with Islam or religion per se. The analysis of Greek medical texts by these Persian scholars occurred in a highly scientific, not religious, manner—although their philosophical assessment may have been influenced by their monotheistic religion (compared with the multiplicity of



FIG. 2. Portrait of Kublai Khan (1215–1294), grandson of Genghis Khan. (Image in the public domain: http://en.wikipedia.org/wiki/Image:Kublai_Khan.jpg).

gods worshipped in ancient Greece). Furthermore, many of the medical texts and traditions flourished primarily in non-Arabic languages. For example, many of the medical texts were written in Persian or were translated from Greek into Persian and only secondarily from Persian into Arabic.^{3,5} Many of the scholars in so-called “Islamic medicine” were Jewish or Christian rather than Muslim, and “Islamic medicine” also served Hindus and many other non-Muslim societies.⁵

One of these scholars, Rhazes, is credited with the first description of smallpox and is regarded as a pioneer in neurosurgery, pediatrics, and ophthalmology.^{2,20} In his manuscripts, he described the cranial nerves and the sensory and motor function of peripheral nerves, as well as recognizing their paired origin from the spinal cord.²⁰ Among his extant medical writings are *A Treatise on Smallpox and Measles* and an encyclopedic work on medicine and surgery entitled *Liber Continens*.² He gave detailed descriptions of the intervertebral foramina, and divided the spinal nerves into eight cervical, 12 thoracic, five lumbar, and three sacral and coccygeal nerves.²⁰ Furthermore, based on this neuroanatomical knowledge, he wrote clinical chapters on sciatic nerve disease, facial paralysis, traumatic lesions of the nervous system, tremors, epilepsy, and headaches, among other clinical conditions.^{2,20} Rhazes also used the knowledge he acquired to criticize the work of his predecessors Galen and Hippocrates.²⁰ Hippocrates (460–370 BC) is credited as being the “father of spine surgery;”⁹ in his book *On Joints and On Nature of Bones*, he noted various forms of spinal lesions and gave detailed anatomical descriptions.¹

In the ninth book of his *Anatomic Procedures*, Galen (AD 129–201) explained that a transverse cut through the cord may cause paralysis of the part of body below the level of the cut.²² Both Rhazes, and later Avicenna, studied earlier Greco-Roman literature but added their own observations and critiques.^{10,20} Rhazes, for example, wrote an entire manuscript raising doubts about and criticizing some aspects of Galen’s work.²⁰ Avicenna, known in his time as “the prince and chief of physicians,” compiled

most of the body of medical knowledge available to him into the *Canon of Medicine*.¹⁰ In addition, he expanded on Galenic knowledge with several personal contributions. His description of the brain divides it into medulla and cortex. Avicenna described the spinal cord thus: “a broad stream which flows smoothly out of the bubbling source of the brain.” Among his numerous contributions, he is considered the first to describe and characterize meningitis as a disease, and he was aware of the pupil and its movements, as well as central and peripheral types of facial weakness. Avicenna also explained many neuropsychiatric conditions: hallucination, insomnia, mania, nightmare, melancholia, dementia, epilepsy, paralysis, stroke, vertigo, and tremor.¹¹ Ultimately, the *Canon of Medicine* became the standard of medical science in Europe for centuries, together with works of Hippocrates and Galen.¹⁹

Indian Medicine

Refined surgical techniques in India were developed as early as the sixth century BC. Sushruta, also known as the “Father of Indian Surgery,”^{16,21} described more than 300 different surgical procedures in *Sushruta Samhita*, including a rhinoplasty technique by rotation of a skin flap from the forehead that is mainly the same as the technique used in modern times. He is credited as being the first surgeon to describe cataract extraction. His surgical methods for this included displacing the opacified lens down and away from the line of vision. In *Sushruta Samhita*, he also describes more than 120 surgical instruments (from forceps, specula, and scalpels to scissors, saws, needles, and trocars). In short, all the principles of surgery (the concepts of accuracy, precision, economy, hemostasis, and perfection) find an important place in Sushruta’s writings.^{16,21}

Mental disorders were also an important subject of ancient Indian medical writings. Najabuddin Unhammad (AD 1222), an Indian physician, depicted seven different types of disorders: schizophrenia (Sauda-a-Tabee); depression (Muree-Sauda); delusion of love (Ishk); organic mental disorder (Nisyan); paranoid state (Haziyan), and delirium (Malikholia-a-maraki). The treatments for these maladies included physiotherapy, drugs, hypnotism, psychotherapy using talismans, charms, and prayers. Some of the more unusual treatment methods described included terrorizing the patient with snakes, lions, elephants, or men dressed as bandits.¹⁵

Chinese Medicine

Little is known about ancient Chinese surgical procedures and understanding of the mind and brain. One of the few sources consists of a manuscript written around AD 220 by Zhang Zhong Jing (AD 150–219), considered the “Hippocrates of traditional Chinese medicine.”⁶ In his treatise on cold disease damage, known as *Shang Han Lun*, Zhang Zhong Jing described a variety of diseases (in 397 sections), including headache, stiffness, anxiety, and fevers.⁶ Because Confucianists regarded the human body as sacred, surgery was considered hierarchically inferior to other branches of medicine. Hua T’o is one of the rare names mentioned in connection with surgical therapy. He treated a patient’s arm wound by cutting the flesh and scraping the bone.⁶

Exchange of Scientific and Medical Knowledge

When the Mongols invaded Eurasia, they conquered cultures that had extensive medical knowledge. In fact, medicine became one of the many areas of life and culture that flourished under Mongolian rule. Keeping an army healthy was vital to an empire in a state of continual expansion. The Mongols therefore created hospitals and training centers to encourage the exchange and expansion of medical knowledge. Institutions in China employed doctors from India and the Middle East in addition to Chinese healers. The body of interdisciplinary knowledge accumulated was then disseminated throughout the empire, including to the West, where it probably found its way to European centers.²³ This diffusion of information seems to correlate well with the beginning of medical training in Europe, and with increased use of and references to the so-called “Arabic” medical luminaries. Kublai Khan further diversified medical knowledge in the empire by founding an institution for the study of Western medicine under the direction of a Christian scholar.²³

Weatherford recounts that a “house of healing” was established near Tabriz, in what is now Azerbaijan—further evidence of the cultural cross-pollination still evolving in the field of medicine in the East. This house of healing served as both a working hospital and a center for medical research and training. Using Chinese illustrations, Rashid al-Din of Persia published the first known book on Chinese medicine outside China in 1313.²³ Not all Chinese practices were accepted by other cultures, but some proved popular. For example, acupuncture was not accepted in the Middle East because according to traditional Muslim law it required too much physical contact between the practitioner and patient. However, the practice of pulse diagnosis was embraced because the physician had only to touch the patient’s wrist to diagnose an illness and to prescribe treatment: “using this novel method, doctors could treat female patients without violating the honor of her family.”²³ This was not the world of Muslim fundamentalism, however: medieval Persian culture was innovative, curious, and tolerant.⁸

Naturally, the chief goal of the Mongolian Empire was to increase its wealth and power. Because it relied on taxation and duties for this growth, its conquered subjects needed to be economically successful. Thus, trade was encouraged. However, a simple exchange of goods alone between peoples will not effectively spur economic growth. A system for conveying knowledge of and an understanding of the products exchanged must also be introduced. For example, drugs cannot be helpful or profitable unless the purchaser knows how to use them. Doctors were therefore also “exchanged” between cultures to disperse such knowledge. Persian and Arab doctors traveled to China, and Chinese doctors went to the Middle East^{8,23} and the far western parts of the Mongolian empire.

Through this exchange of medical knowledge, it became apparent that each culture had some especially strong skills and lacked expertise in other areas. The Chinese were adept at pharmacology, had an excellent knowledge of gross anatomy, and specialized in certain unusual treatments like acupuncture and moxibustion (the burning of herbs at puncture points). Muslim doctors possessed a relatively sophisticated knowledge of surgery.²³



FIG. 3. Hungarian stamp of Avicenna.

During Mongolian rule, the traditional medicines of many cultures grew in their own right, both independent of, and influenced by, the interaction of the various medical blocs. In the 13th and 14th centuries, Chinese medicine in particular became more developed and specialized. Although both traditional physicians and pharmacists (apothecaries) were regarded as healers in China, these fields of study and practice had long been separate. During the Mongolian era, specialties in the medical community increased dramatically, developing complex, narrowly focused subdivisions. For example, the doctors for great blood vessels differed from the doctors who treated the small vessels. There were specific doctors for the skin, the eyes, and the mouth. Physicians specialized in the treatment of specific diseases. Some healers focused on moxibustion, some on acupuncture, and some on massage. Still others were experts in incantations or dietetics. The latter were considered “medical specialists” and often held in higher regard than other types of doctors.⁶

Genghis Khan’s Legacy

When Genghis Khan died in 1227, his dominion stretched from the Pacific Ocean in the East to the Black Sea in the West. At its height, the Mongolian empire enveloped the steppes of Siberia to the north, the coasts of the Arabian Sea to the south, and all intervening lands. In the following years, the empire would extend southward into India and China and westward into eastern and central Europe. The empire that the Khan spent his entire life amassing encompassed more land than the combined land mass of North and Central America. Within 150 years, however, this vast empire began to show signs of decline and decay. Nonetheless, some of Genghis Khan’s descen-



FIG. 4. Polish (left) and old Soviet Union (right) stamps, both in honor of Avicenna and indicative of the continued popularity of the Persian scholar in eastern European countries affected by the Mongolian invasion.

dents ruled various parts of Europe and Asia for seven more centuries. Sea trade routes developed in Europe from Scandinavia, south to the Iberian peninsula, through the Mediterranean, and to eastern Africa. Overland trade routes ran from central Europe to Kiev, Moscow, London, Paris, Venice, and throughout the Danube River region. Genghis Khan's descendants held familiar roles: Khans, Sultans, Shahs, Emirs, and Dalai Lamas. Some of these rulers reigned in India until they were deposed by the British in 1857 and, even more recently, they ruled in Uzbekistan until deposed by the Soviets in 1920.²³

Although rule through his bloodline persisted after his death, during his time Genghis Khan claimed that merit, not genealogy, defined the man—a revolutionary concept for the time. Genghis Khan knew how to organize men and organize them well; he learned how to unite men and his great influence ensured that if necessary they would willingly die for him. As previously mentioned, he altered the method of warfare for centuries to come and rendered the European knight and fortress system obsolete. In religious matters he was tolerant of any sect that did not oppose him. His government was comparatively just and orderly: anything less than this he considered anarchy and therefore unacceptable. Roads in the Mongolian empire were cleared of brigands, and the fragments of the Silk Road were united into one of the most important trading routes in history.⁸ He established a postal service, and commerce in his empire flourished. Traders and craftsmen could travel unmolested for the entire breadth of Asia and through a great portion of Eastern Europe. Genghis Khan respected and encouraged learning. Along with trade came the spread of scientific information and exchange of ideas.

Still, to some, Genghis Khan remains completely and utterly ruthless. The British scholar Steven Runciman once wrote of Genghis Khan, "He had no regard for human life and no sympathy for human suffering. Millions of innocent townsfolk perished in the course of his wars and millions of innocent peasants saw their fields and orchards destroyed. His empire was founded on human misery."¹⁸ Despite his ruthlessness, or perhaps be-

cause of it, the history of the world has been deeply marked by his influence. His importance and influence on medicine and almost every other aspect of life in the modern world are undeniable, and his lasting influence on the Mongolian dynasties in India, China, and Persia is impressive.

In India the Moghuls (derived from "Moghal," meaning Persian Mongol) left a legacy of magnificent mosques, palaces, forts, and gardens embellished with luxurious but delicate decorations. The Taj Mahal, a masterpiece of Moghul architecture and one of the most well-known wonders of the world, is perhaps the best example. Akbar (1556–1605), whose grandson commissioned the Taj Mahal, was probably the most popular Moghul ruler, and is remembered as tolerant. He even started a new faith, Din-i-Ilahi, which constituted an attempt to blend Islam with Hinduism, Christianity, Jainism, and other faiths.²⁴ Interestingly, today a media tycoon is known as a "mogul."

In Persia, Shah Ismail Safavi united all of Persia under Iranian leadership after approximately nine centuries of fragmented or foreign (Arabic and Mongolian) rule. The reign of Shah (Persian King) Abbas Safavi (1587–1629) marked the pinnacle of this dynasty. A strong supporter of the arts and architecture, he adorned Isfahan with some of the finest monuments in the world. During this period Persian craftsmen and artists were known for creating fine silks, cloths, porcelain, metalwork, calligraphy, miniatures, and carpets.¹³

In China, Kublai Khan, the grandson of Genghis Khan, established the Yuan Dynasty and proclaimed the capital to be at Da Du (now Beijing). He encouraged Chinese arts and demonstrated religious tolerance.¹⁷ The genetic legacy of Genghis Khan is also considerable. A large population of people throughout an immense region of Eurasia, from the Pacific to the Caspian Sea, and the lower Volga River in Russia carry the genetic "fingerprint" of Genghis Khan through the Y chromosome.^{12,25} This population of about 16 million men probably represents the male-line descendants of Genghis Khan.²⁵ Approximately 8% of Eurasian men carry this specific Y chromosome, and this group composes about 0.5% of the world's total population.²⁵

It has been stated previously that the foundation of medical thought in the great civilizations of ancient Greece, India, and China, are remarkably similar.⁴ Greek and Indian medical traditions were carried from East to West and back again through Persia.⁴ After the Chinese conversion to Buddhism, Chinese pilgrim-monks traveled to India and returned bearing medical texts in Chinese translations. However, it was not until after the shock of the Mongolian invasion, when *pax Mongolica* was established within one of the largest empires of the world, that an extensive amalgamation of Asian medical knowledge was possible. It remains to be determined how much of this knowledge reached Europe, since the Mongolian empire included vast parts of Eurasia. Nevertheless, history has brought a few fascinating cases demonstrating an exchange between Eastern and Western medicine by the time *pax Mongolica* was settled. The period of *pax Mongolica* coincides with a westward drift of scientific and philosophical knowledge, translations by Christian monks of many noteworthy Greek and Arab medical treatises,

and the rise of medical schools in such places as Salerno, Montpellier, Bologna, and Oxford. In 1467, more than half of the books catalogued in Ferrari's library (Pavia, Italy) were Arabian commentaries on Greek medicine; Avicenna was quoted more than 3000 times, Rhazes and Galen 1000, and Hippocrates only 140 times.¹⁴ It is intriguing to postulate that the spread of Greek, Arab, Persian, and Indian scientific and medical knowledge and the rise of medical teaching in Europe may not have been in spite of Genghis Khan, but because of him.

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