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INVITED REVIEW

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**The Prehistory of Audiology and Otolology**

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Audiology and otology have developed over time through numerous experts who have contributed to the knowledge of the anatomy, physiology, and pathology of the ear. Although it seems very difficult, if not impossible, to include all the expert physicians and scientists who contributed to the progress of audiology and otology, it might be interesting to review how this knowledge came to us from the earliest times of the human civilization.

Even today we cannot avoid reminders of those who have aided in the progress of medical science. The conference on audiology and otology jointly hosted by the International Association of Physicians in Audiology and the Mediterranean Society of Otolology and Audiology was held in June 2004, near the small town of Stagira, the birthplace of the famous Greek philosopher Aristotle, a follower of Hippocratic medicine. In September of the same year, the European Federation of Oto-Rhino-Laryngological Societies Congress on Otolaryngology opened its program with a ceremonial presentation of the Hippocratic oath. That ceremony took place on the island of Cos, the birthplace of Hippocrates, who has been called "the Father of Medicine." It might be interesting to discover how the knowledge of medicine in general and of otology and audiology, particularly, developed through time. Some 4000 years have passed from the epoch of Sumerian cuneiform medical texts till the present-day electronic retrieval of medical information and Internet medicine.

### **Ancient medicine: from gods to fathers of medicine**

Otorhinolaryngologists today may be surprised to discover what their forefathers knew. There are certainly those who believe that their field of specialization cannot be traced back to a certain "Father." However, if they read abstracts from the Hippocratic collection, they may be persuaded that the specialty owes its existence to Hippocrates.<sup>1</sup>

The literature is rich with writings and books dedicated to Hippocrates and Hippocratic medicine. The famous "Hippocratic collection" is a cache of manuscripts on medicine as practiced during ancient times and on medical ethics and education. It has been thought that some of these manuscripts were written by Hippocrates, although historians believe that most of them were written by the Hippocratic followers.<sup>2</sup>

Medical knowledge of the ear and insight into otologic diseases came late in history, and clinical progress was painfully slow. From the earliest times, there have been folk remedies for earache and related ailments. Profound deafness, however, was long regarded as a sign of feeble intelligence, and the deaf were thought to be both unteachable and untreatable.<sup>3</sup>

Historians recognize 4 early civilizations in the period between 3500 and 1500 BC, which all developed in river valleys: Mesopotamia in the Tigris-Euphrates valley in the Middle East, Egypt near the Nile River, India near the Indus River, and China near the Yellow River.<sup>2</sup> These ancient people believed that gods and demons governed human life with their supernatural powers. Gods, demons, and evil were thought to cause disease, misfortune, and death. Medicine in ancient civilizations was practiced mostly by priests and magicians, because healing required the spiritual and physical catharsis obtained by combining confession and exorcism with purgative drugs. Vegetables, herbs and minerals, alcoholic beverages, fats and oils, animal parts and byproducts (honey, wax, and milk) were thought to have medical virtues and, therefore, were constituents of medical treatment. Such prescriptions were found in Sumerian cuneiform medical texts; in the Egyptian papyri of Ebers, Smith, and Kahun; in the Indian

ayurvedic medical texts; and in the traditional Chinese medicine.

Remedies and case histories taken from the Ebers, Smith, and Kahun papyri provide the most significant insights into ancient Egyptian ideas about health and disease, anatomy and physiology, and magic and medicine. The earliest known scientific document, the Edwin Smith Surgical Papyrus of 3000-2500 BC, includes descriptions of battle injuries to temporal bones and how they affected the hearing and speech of the wounded. In the Ebers papyrus, the longest, most complete, and most famous of the medical papyri, probably written about 1500 BC, there is a chapter on "Medicine for the Ears with Weak Hearing".<sup>2</sup>

Perhaps the most striking aspect of ancient Indian healers was their mastery of surgical skills. Ayurvedic texts describe more prosaic but still challenging operations such as cesarean section, lithotomy, tonsillectomy, amputation, and plastic surgery. Plastic surgery, especially the art of reconstructing noses, lips, and ears, was probably the most remarkable aspect of the Indian physicians' achievements. Noses and ears were at risk among Indian warriors, who fought without helmets, and among the general run of sinners and criminals, because justice was meted out by mutilation and amputation.<sup>2,3</sup>

Medicine in ancient civilizations followed the philosophic theories on the creation of the universe and the religious attitudes on human life and death. In the ancient known world, knowledge was communicated by means of myth, epic poems, songs, and stories of gods and heroes, as found in ancient medical texts. According to the Mesopotamian legend the Gilgamesh Epic, human beings lost possession of the most powerful, life-giving herb in creation because the superhero Gilgamesh, a being two-thirds god and one-third human, lost it when a serpent took it from his hand while he was asleep. In Egyptian mythology, Imhopter was a powerful symbol and true ancestral god of the healing profession (Figure 1). The family of gods of medicine in the Greek mythology were Apollo and his son, Asclepius (Figure 2).<sup>2</sup>



Figure 1: Imhotep

The unity of nature was a common ancient theory that explained the physiologic and pathologic phenomena that occurred within the human body. The Egyptian medical theory of "the movement of fluids in a system of channels" that brought nourishment to the body, just as the flooding of the Nile brought nourishment to the land, was parallel to the Indian medical theory of the 3 dosas, the primary humors, fluids, or principles—Vata, Pitta, and Kapha, translated as wind, bile, and phlegm—that determined all vital functions. The classical Chinese medical theory of the 5 phases and yin and yang dualism nearly coincided with the refined mathematical concept of Pythagoras of Samos (530 BC) and with Empedocles' theory of the 4 elements, which became a major theme in the history of medicine.

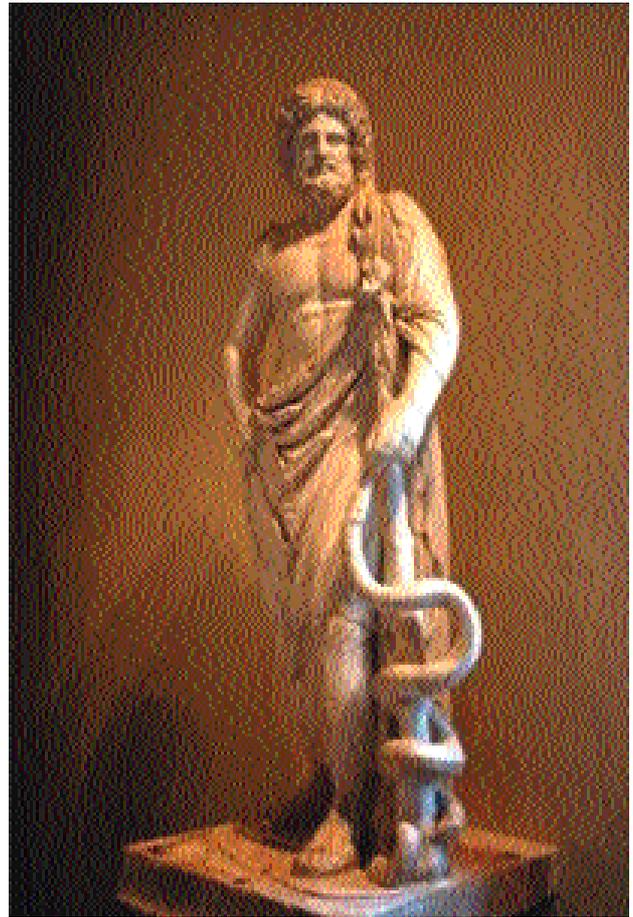


Figure 2: Asclepius

Shamanistic, religious, and empirical approaches to healing are universal aspects of the history of medicine. Where Greek medicine appears to be unique is in the development of a body of medical theory associated with natural philosophy, that is, a strong secular tradition of free inquiry or what would now be called science. The intellectual traditions established in ancient Greece, from the Mycenaean period, about 1500 BC, provided the foundations of Western philosophy, science, and medicine.<sup>2</sup>

The Greek philosopher and mathematician Pythagoras of Samos, an island in the Aegean Sea, was the first to write of acoustics when he discovered the inverse relationship between the length of a monochord string and the pitch of the note it produced.<sup>3</sup> Empedocles (500-430 BC), a Greek philosopher from Magna Graecia, was the patron of the theory of 4 elements (Fi-

gure 3). According to this theory, all things were composed of various mixtures of 4 primary and eternal elements: air, earth, water, and fire. Changes and transformations in the universe and the human body were simply reflections of the mixing and separating of the eternal elements. He was the first to describe the cochlea and it was he who named it.

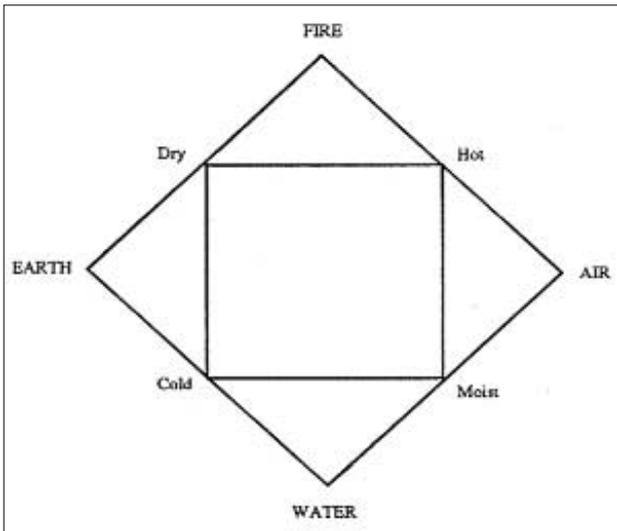


Figure 3: Empedocles' theory of 4 elements

### Hippocrates and Hippocratic medicine

Hippocrates (460-379 BC), the Greek physician called "the Father of Medicine," was the son of Asclepius, the Greek god of medicine (Figure 4). He was born on the island of Cos where he studied medicine at the temple of Asclepius. He worked there as a medical doctor and teacher of medicine. He traveled to other cities, Efesos, Pergamon, Cyprus, Epidauros, Athens, and Larissa. The establishment of medicine as an art, a science, and a profession of profound value and dignity has been associated with his life and work.

Hippocrates was a patron of the theory of humors (Figure 5). According to this theory, the human organism consists of the 4 natural elements, air, earth, fire, and water. The 4 fluids (humors) corresponding to these elements are blood, black bile, yellow bile, and phlegm. They circulate in the body and correspond to the heart, spleen, liver, and brain. These humors give rise to the 4 qualities, warm, cold, dry, and wet. A bal-

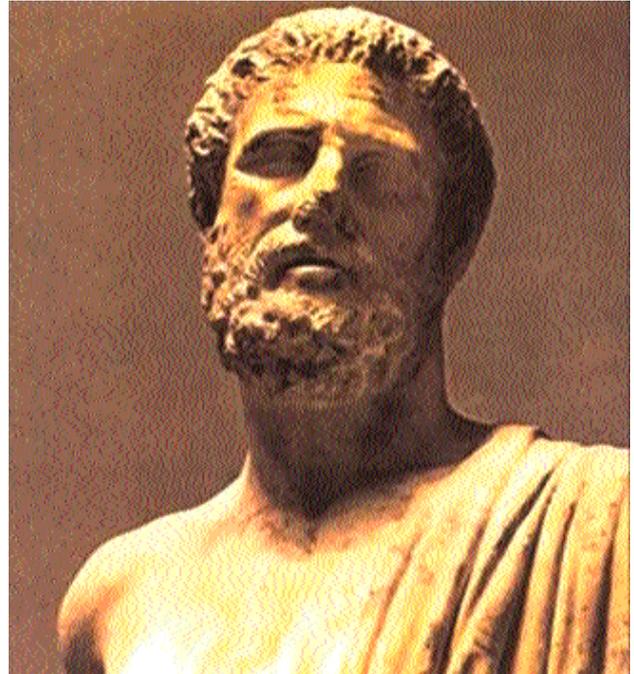


Figure 4: Hippocrates

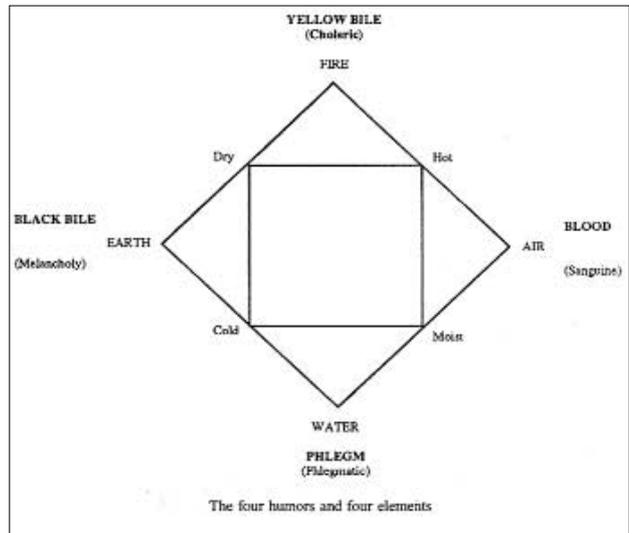


Figure 5: Hippocrates' theory of humors

ance of humors keeps the human organism healthy, while a change in their proper proportion causes illness. Diseases are caused by external factors, seasonal and environmental conditions, diet, and activities. The Hippocratic theory coincided with Empedocles' theory of 4 elements through which the philosopher tried to explain the creation of the universe.

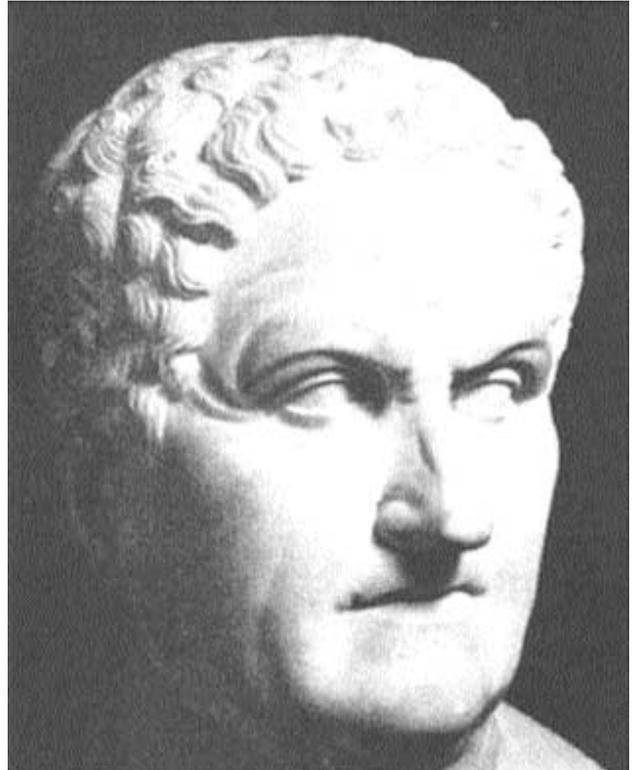
Hippocrates was the first to use in his diagnostics the essential clinical procedures of history, observation, clinical signs and symptoms, palpation, and auscultation. Even though his physiopathologic theory of humors was wrong, his belief that illness is not due to punishment of demons and gods but is instead due to the influence of environmental factors changed the concept of medicine and the medical procedures in diagnosis and therapy. Hippocrates' influence is apparent. For example, René Laennec, in 1800s, invented the stethoscope after he studied the manuscripts of the Hippocratic medicine.<sup>3</sup>

The so-called Hippocratic collection is a group of 50 to 70 manuscripts on medicine attributed to Hippocrates, although most or all of them were written by his followers over a span of centuries. Hippocrates taught his students the ethics and duties a physician should practice for the care of his patients. The Hippocratic Oath, sworn to by medical doctors before starting practice, is based on a code of ethical conduct appearing in the Hippocratic Collection.<sup>1,3</sup>

### **From Hippocrates to Galen**

The insufficient knowledge of anatomy of Hippocrates and of the Hippocratic-era authors did not impede the development of otology during the classical age. Hippocrates' methods of treatment were almost entirely empirical, and he had scant knowledge of anatomy of the ear. He recognized the petrous bone, the auditory meatus, and the eardrum. His hydropathologic theory on the sense of hearing and on the diseases of the ear and ear symptomology (otalgia, otorrhea, tinnitus, vertigo, and hearing loss) was based only on observation. The greatest achievement of Hippocrates and his followers was their emphasis on observation and their belief that all illness derives from natural causes. They emphasized the importance of rest and proper diet.

The theory of humors was adapted by Galen and was accepted through out the middle ages. Galen (130-210 AD), a native of Pergamum of Asia Minor, was one of the followers of Hippocratic medicine (Figure 6). He was the Roman Empire's most famous physi-



**Figure 6:** Galen

an-anatomist, and its most prolific medical author. His knowledge was based on the Hippocratic theory but was extended by experimental observation from his dissections of dogs and monkeys. He recognized the tympanic cavity, the labyrinth, the internal auditory canal, the fallopian canal, and the auditory nerve. He gave the name "labyrinth" to the inner ear. His arbitrary rules for the treatment of signs and symptoms of diseases, including those of the ear, such as otitis, tinnitus, and hearing loss, were followed religiously for the next 14 centuries. He was called the "Medical Pope of the Middle Ages," and he was a mentor for Renaissance anatomists and physiologists.<sup>2,3</sup> Further, Galen followed Hippocrates' theory on hearing: "The sound waves hit the eardrum and the oscillations of the ear vacuum are transmitted to the brain."<sup>1</sup>

### **Hippocrates' and Galen's belief on deaf-mutism**

Hippocrates believed wrongly that, in deaf-mute patients, both the hearing and speech organs had been affected. His theory that deaf-mute children were

developmentally challenged was adapted by such followers as Aristotle and Galen and influenced scientific knowledge and the progress of medicine for about 2000 years. Until the 16th century, deaf-mute children were treated as disabled, invalid, and demonized individuals and were rejected by society. In ancient Sparta, deaf-mute children were thrown down Keada, a precipitous ravine, to be killed.<sup>1</sup> In 1692, Conraad Amman, a Swiss surgeon, refuted the Hippocratic theory on deaf-mutism and proved, with his published lecture, that, in deaf-mute individuals, the function of speech organ is normal.<sup>1,4</sup>

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